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# A comparison of the effectiveness of three commonly used scoring methods for prioritizing areas of need

Penta, Mary Q., Ph.D.

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U·M·I
300 N. Zeeb Rd.
Ann Arbor, MI 48106

# A COMPARISON OF THE EFFECTIVENESS OF THREE COMMONLY USED SCORING METHODS FOR PRIORITIZING AREAS OF NEED

by

Mary Q. Penta

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The purpose of this study was to investigate the comparability in an educational setting of the mean difference, Del-N, and weighted needs index methods of scoring dual-response needs assessments. Accuracy in the assessment of need is essential to the effectiveness of the needs assessment process, and the choice of scoring method affects the accuracy of that assessment. The three methods included in this study were found to be comparable in a previous study using a single sample of 84 respondents in a business training setting. This study used data from a total of 339 respondents from 19 public elementary, middle, and high schools in central North Carolina. Dual-response needs assessment instruments based on standards of the National Council of Teachers of Mathematics or the National Science Teachers Association were administered at sampled schools. Needs assessment scores were used to calculate mean difference, Del-N, and weighted needs indices for each school. Spearman rank order correlation coefficients were calculated to assess the comparability of the indices generated with each of the methods. The sample correlation coefficients ranged from a low of .79 to a high of .98, and confidence intervals constructed on the sample values supported the research hypothesis that the population correlation coefficient equaled or exceeded .80. Based on this evidence, the three methods were deemed to be comparable in an educational setting. However, the frequent occurrence of tied ranks with both the mean difference and weighted needs index versus almost no ties with Del-N, makes Del-N the method of choice when strict prioritization of need is desired by needs assessors or needs assessment clients.

APPROVAL PAGE

This dissertation has been approved by the following committee of the Faculty of the Graduate School at The University of North Carolina at Greensboro.

Dissertation Advisor ______________________

Committee Members ______________________

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# CHAPTER I
# INTRODUCTION

The widespread use of needs assessments in educational program evaluation began in the mid-1960s, when such a process was often required by government funding agencies (Witkin, 1992; Zangwill, 1977). Prior to the 1960s, needs assessment theory and methodology developed primarily in sociology, human services, and marketing (Johnson, Meiller, Miller, & Summers, 1987; Neuber, 1980; Witkin, 1991). With the mandated needs assessments of the 1960s, educators furthered the development of theory and methodology for needs assessment (Witkin, 1992). During the 1980s, when needs assessments were mandated less often, educators continued to employ them in program planning and evaluation (Stufflebeam, McCormick, Brinkerhoff, & Nelson, 1985; Witkin, 1991,1992).

In the contemporary evaluation milieu, needs assessments serve numerous purposes. They are frequently used within educational organizations prior to restructuring existing programs or to establishing new ones (Witkin, 1991). In such cases they may be used informally to trigger and guide discussion of important issues; or they may be used more formally to prioritize needs and develop plans to meet the needs at the top of the priority list (Kaufman, 1983).

In addition to serving differing purposes, needs assessments also use diverse formats. They may be very flexible and qualitative or quite structured and quantitative. The more flexible methods typically involve interviews, focus groups, or open-ended questionnaires as the primary methods of gathering data about various aspects of an existing or anticipated program. More structured methods usually employ surveys that ask participants to give numeric ratings for crucial aspects of a program. With either format, an assessment of need is made by comparing "what is" in an existing program to "what should be" in an ideal program. That is, the gaps or discrepancies between existing and ideal conditions are identified (Kaufman, 1972). In a qualitative approach, group discussion and consensus-building processes are used to define gaps and identify levels of need. With a quantitative approach, numeric values are calculated for discrepancies between "what is" and "what should be" and then used to rank order the gaps. Areas at the top of the ordered list are given priority for program planning (Kaufman, 1983).

Whatever the purpose or format of a needs assessment, accuracy in assessing need is critical because important programmatic decisions are often based on outcomes of the needs assessment process. Schools may undertake an assessment to identify needs before putting a new program in place, or they may restructure an existing program based on identified needs. In either case, developing programs to meet identified needs requires commitments of time and money. The accuracy of a needs assessment is vital to the efficient allocation of resources; and its inaccuracy can mean misapplication of already limited resources.

## Purposes and Procedures

When quantitative surveys are used to gather data for a needs assessment, an effective scoring method must be employed so that the assessment of need is as accurate as possible. There are three commonly-used methods for scoring needs assessment survey instruments: the mean difference method (Johnson, 1986), the

Del-N method (Misanchuk, 1982), and the Weighted Needs Index (WNI) (Cummings, 1985). The mean difference method, which is effective for prioritizing needs and straightforward to calculate, does not differentiate well between areas rated as having very high importance versus areas of low or no importance. The more computationally complex Del-N method is effective for prioritizing need, and it accounts well for differences between ratings of very high importance verses those of low or no importance. But it fails to provide a threshold below which needs with ratings of low or no importance would not be addressed.

To develop the Weighted Needs Index, Cummings (1985) combined the advantages of the mean difference and Del-N methods into a single approach. Cummings' index weights for the effects for areas of high importance versus areas of low or no importance; it sets a lower limit for importance ratings below which need is not assessed, and it is less complicated to calculate than Del-N (McKillip, 1987). An initial study of the three methods demonstrated them to be comparable for prioritizing need (Cummings, 1985). The study, however, was conducted with a limited number of subjects in a business setting, not in the public schools. The assessment focused on training needs for the construction industry, rather than program needs in education. In his summary and conclusions, Cummings stated: "Future research should focus on a broader range of needs and on larger and more diverse samples of respondents and content areas" (p. 15). For example, with a larger and more diverse sample, would the three methods be as comparable in an educational setting as Cummings found them to be in a business setting?

This study addressed the question of the comparability of the three scoring methods using a needs assessment in public schools in the state of North Carolina.

It examined the numeric assessment of need generated by each of the three scoring methods and compared the prioritization of need between and among them. The major research question was: Does the prioritization of need for the three methods differ in an educational setting? This major research question was investigated using data from a needs assessment of mathematics and science programs by over 339 staff members from 19 public schools in North Carolina.

## Organization of the Study

The following chapters present complete information about the design and implementation of this study. All relevant literature is summarized in Chapter II, including a brief history of needs assessment in educational program evaluation, an overview of various needs assessment approaches, and particulars of numeric scoring for survey type needs assessments. The methodology to be used is described in Chapter III. Results of data analysis and discussion of the study appear in Chapters IV and V, respectively.

# CHAPTER II

# REVIEW OF RELEVANT LITERATURE

This chapter provides a brief history of needs assessment in educational settings and gives an overview of various needs assessment approaches. It describes the discrepancy model of needs assessment and reviews ways in which the model is used. Methods for identifying and quantifying discrepancies are presented along with descriptions of instrument formats typically used for this type of needs assessment. Three methods for scoring discrepancy type instruments are described at length, because comparable efficacy for prioritizing need was the central focus of this study.

## Needs Assessment in Educational Program Evaluation

Legislation enacted in the mid-1960s and early 1970s as part of Lyndon Johnson's Great Society spurred the growth of needs assessment in educational program evaluation. To obtain funding, authors were often required to include a needs assessment component in their proposals or in their evaluation plans (Witkin, 1991, 1992; Zangwill, 1977). Legislative changes of the 1980s brought a respite from mandated needs assessments (Witkin, 1984) but not from the use of needs assessment (Stufflebeam, McCormick, Brinkerhoff, & Nelson, 1985). By the 1980s needs assessments were well established in the repertoire of educational evaluators and program planners (Kaufman, 1983). There were also non-legislative factors, such as systems planning, management by objectives, and calls for program accountability, that encouraged the continued use of needs assessment (Witkin, 1984, 1992).

Witkin (1984), a noted and effective needs assessment practitioner, viewed needs assessment as "any systematic procedure for setting priorities and making decisions about programs and allocation of resources" (p. 2). Numerous needs assessment models, some highly qualitative and some very quantitative, can be employed for setting priorities (McKillip, 1987). Whatever the model, though, the end is the same: to set priorities and make programmatic decisions based on these priorities (Kaufman, 1983).

**Models of Needs Assessment**

McKillip (1987) enumerated three models of needs assessment: the marketing model, the decision-making model, and the discrepancy model. As might be deduced from its name, the marketing model is often used by businesses to determine the needs for goods and services in a targeted market population (Kotler, 1982). The decision-making model employs multiattribute utility analysis that uses multiple data sources in a three-stage process of modeling problems, quantification, and synthesis (McKillip, 1987). The discrepancy model, frequently used in educational settings, involves identifying both existing conditions and ideal conditions and then assessing the gaps, i.e., discrepancies, between them (Kaufman, 1972, 1983; McKillip, 1987; Witkin, 1977; 1984).

Regardless of the model employed, the term *need* occurs in any needs assessment. And at this point it is appropriate to clarify the perspective taken in this investigation regarding its definition. Modern philosophers have produced entire volumes to define the term *need* ( Ramsay, 1992; Thomson, 1987;). Educational evaluators debate the philosophers' definitions (McKillip, 1993; Scriven, 1991; ). Within the confines of this investigation, however, a very specific, applied definition of *need* based on the discrepancy model was used.

That is, within an organization, some assessment is made of the current situation ("what is") versus some improved or ideal situation ("what is desirable" or "what should be"), and any discrepancy between "what is" and "what should be" is defined as a *need* (Kaufman & Herman, 1991). Such a definition of *need* is consistent with current practices and appropriate for this study, which, in assessing the comparability of three numeric methods for scoring needs assessment surveys, embraces a practical rather than a philosophical perspective. For the philosophical perspective the reader is referred to Ramsay (1992) and Thomson (1987); and to McKillip (1993) and Scriven (1991) for spirited debate.

## The Discrepancy Model

Evaluators use all three of the models mentioned above, the marketing model, the decision-making model, and the discrepancy model, for their work in educational settings; but it is the discrepancy model that is often used for needs assessment surveys. A cornerstone of the discrepancy model is the identification of existing conditions and ideal conditions so that they can be compared to determine what discrepancies, if any, exist between the present situation and an optimal situation (Kaufman & English, 1979; Kaufman & Herman, 1991; McKillip, 1987). The following paragraphs will describe methods frequently used by educators during the last three decades to determine present and optimal conditions.

### Determining "What Is" and "What Should Be"

The methods needs assessors employ to determine existing and ideal conditions run the gamut from highly qualitative approaches involving in-depth information from a few select informants to highly quantitative approaches that rely on numeric data from a large sample informants. Kaufman and English

(1979) used terminology from systems theory to categorize the various approaches. They designated the more in-depth approaches as Alpha needs assessments, and the highly quantitative approaches as Beta needs assessments. Alpha assessments are used when global questions are asked about the existing order of things within an organization and when deep change is anticipated. In such situations, in-depth information is gathered from stakeholders in order to ascertain existing conditions and to project ideal conditions. Methodologies employed in an Alpha approach include public forums, focus groups, case studies, scenarios, simulations, observations, and interviews to determine interrelationships among inputs, processes, products, outputs, and outcomes (Kaufman & English, 1979; McKillip, 1987).

An Alpha needs assessment is a large-scale, holistic endeavor undertaken at a macro level. Needs assessment at this level does occur in educational program evaluation; however, Beta type needs assessments are more common and usually more feasible. A Beta needs assessment was used in this study. In a Beta assessment, assessors and stakeholders assume that the overall structure of an organization is sound, but that planning should be undertaken to determine how to adjust or improve specific parts of the organization (Kaufman & English, 1979). Beta needs assessment is smaller scale than Alpha, and its methodologies are on a comparable scale. For example, information about "what is" can be gathered in a resource inventory to count the number of clients currently utilizing a service (rates under treatment) and compare that with the number of citizens in the community who are eligible for the service (McKillip, 1987). Needs assessors can examine social indicators and other existing demographic information to determine possible levels of need for existing or planned programs (Witkin, 1984). Testing programs, cost-benefit analyses, job performance and productivity studies, resource inventories, and social indicators are useful in Beta-type assessments; and survey methods are frequently employed to gather data for this type of needs assessment (Cooley & Bickel, 1986; McKillip, 1987; Witkin, 1984).

Using Survey Methods to Assess Existing and Ideal Conditions

Surveys are an efficient and relatively inexpensive way to gather information for a needs assessment (Nickens, Purga, & Noriega, 1980). They should be used within a theoretical framework that allows for problem solving and decision making; multiple-response survey designs fit best into such a framework (McKillip, 1987; Witkin, 1984). In multiple-response surveys, as in single response designs, respondents provide information about survey items by choosing among options on an ordinal scale (Witkin, 1984). The dual-response survey, with one scale for rating "what is" and one scale for rating "what should be" for each item, is the most common of the multiple-response designs. Because researchers are able to compare respondents' ratings on each of the two scales, a dual-response survey falls within a decision making or problem solving framework. Data are collected that reflect the respondents' opinions about existing and desirable or ideal conditions, and researchers can use these data to make comparisons. Employing dual-response surveys requires accurate assessment of differences between existing and ideal conditions. Information is provided below about typical formats of multiple-response needs assessment surveys. Subsequently, ways of assessing differences will be discussed.

A typical multiple-response needs assessment survey consists of a set of items along with two five-point rating scales for each item in the set. The items are usually derived from statements of goals or standards that represent exemplary practice or characterize outstanding programs in the field (McKillip, 1987; Witkin, 1984). For example, the items on the needs assessment in Figure 1 are based on the Standards of the National Council of Teachers of Mathematics (NCTM, 1987).

Read each of the following statements carefully and circle a number on the first scale to indicate the level of **Importance**. Then circle a number on the second scale to indicate the level of **Achievement**.

**1. The mathematics curriculum includes a balanced treatment of all seven topics included in the NC Standard Course of Study--numeration, geometry, patterns, measurement, problem solving, data analysis, and computation.**

| | | | | |
|---|---|---|---|---|
| No Importance | Low Importance | Average Importance | Above Average Importance | High Importance |
| 1 | 2 | 3 | 4 | 5 |
| No Achievement | Low Achievement | Average Achievement | Above Average Achievement | High Achievement |
| 1 | 2 | 3 | 4 | 5 |

**2. Mathematics is presented as a subject to be explored in "what if" situations, rather than a series of facts and algorithms to be memorized.**

| | | | | |
|---|---|---|---|---|
| No Importance | Low Importance | Average Importance | Above Average Importance | High Importance |
| 1 | 2 | 3 | 4 | 5 |
| No Achievement | Low Achievement | Average Achievement | Above Average Achievement | High Achievement |
| 1 | 2 | 3 | 4 | 5 |

**3. The mathematics curriculum includes experiences with data analysis and probability; students collect, graph, and interpret data.**

| | | | | |
|---|---|---|---|---|
| No Importance | Low Importance | Average Importance | Above Average Importance | High Importance |
| 1 | 2 | 3 | 4 | 5 |
| No Achievement | Low Achievement | Average Achievement | Above Average Achievement | High Achievement |
| 1 | 2 | 3 | 4 | 5 |

Figure 1. Needs assessment items based on standards of the National Council of Teachers of Mathematics.

In the dual-response format, such as that recommended by Johnson and Dixon (1984), one rating scale focuses on existing conditions; and one rating scale focuses on ideal or desired conditions (see Figure 1). Survey participants are directed to choose the one response on each scale that best represents their opinion. Wording for the response scales can vary, but is always directed to "what is" (existing conditions, e.g.. *Achievement*) and "what should be" (ideal conditions, e.g., *Importance*). To gather data about "what is," respondents may be asked to rate how well an item is being achieved in their school or work setting; then they are asked to rate how important the item is in that setting, i.e., "what should be." Another common pairing asks for respondents' opinions about what "does" exist versus what "should" exist (Cummings, 1985). Business training settings commonly use scales for competence and relevance, with ratings for competence representing "what is" and ratings for relevance representing "what should be" (McKillip, 1987; Misanchuk, 1982).

Commonly Used Scoring Methods for Prioritizing Areas of Need

When a dual-response needs assessment survey is used, it is essential to describe or quantify the gap between "what is" and "what should be" so that discrepancies can be prioritized for use in program planning and allocation of resources (Kaufman, 1983; Witkin, 1984). The earliest method to have wide acceptance for scoring discrepancy needs assessments was the mean difference approach. For each item, the "what is" and "what should be" ratings are averaged across respondents, and the "what is" average is subtracted from the "what should be" average. Positive differences indicate that existing conditions fall short of ideal conditions (Cummings, 1985; Johnson, 1986). In other words, there is a need to improve existing conditions so they approach ideal conditions. The larger the difference, the greater the need for improvement. The value of the mean difference for each item can be used to rank order the items, with items having the highest mean differences receiving top priority for action.

The mean difference method is fairly straightforward to compute, but it does not account for possible interrelationships among ratings for existing and ideal conditions. The National Science Teachers Association (NSTA, 1987) has developed one method for presenting some of these interrelationship to clients. The NSTA approach uses a 5x5 matrix like the one in Figure 2.

| | | | | | |
|---|---|---|---|---|---|
| 5 High Achievement | | | | | |
| 4 Above Average Achievement | | | | | |
| 3 Average Achievement | | | | | |
| 2 Low Achievement | | | | | |
| 1 No Achievement | | | | | |
| | 1 No Importance | 2 Low Importance | 3 Average Importance | 4 Above Average Importance | 5 High Importance |

Figure 2. National Science Teachers Association *Importance/Achievement* matrix.

The matrix assumes a dual-response needs assessment format with five-point scales to rate *Importance* ("what should be") and *Achievement* ("what is"). *Importance* has possible ratings of 1 to 5 along the horizontal axis of Figure 2; and ratings for *Achievement* are arranged on the vertical axis. This format is effective for presenting needs assessment findings to clients (NSTA, 1987). For each item, responses can be tallied and recorded. Then an overlay (Figure 3) can be used to identify levels of need for each item. Program strengths, tallies of ratings of 3 or above on both *Importance* and *Achievement* for the item, appear in the nine cells at the upper right of the matrix. Needs, ratings of 3 or above in *Importance* but 2 or below in *Achievement*, are tallied in the six cells at the lower right of the matrix. The responses falling in the six cells in upper left represent areas of concern. Time is probably being wasted to obtain high achievement on unimportant items, because *Importance* is rated 2 or below but *Achievement* is rated 3 or above. The four cells in the lower left represent a neutral area; ratings for both *Importance* and *Achievement* are 2 or lower.

The NSTA approach does not include a method to quantify discrepancies between *Importance* and *Achievement* ratings. Thus, it does not allow, as does the mean difference method, for ranking and prioritizing needs. And although the overlay accounts visually for various co-occurrences of *Importance* and *Achievement* ratings within the matrix, it does not weight them numerically.

| | | | | | |
|---|---|---|---|---|---|
| 5 High Achievement | Concern | Concern | Strength | Strength | Strength |
| 4 Above Average Achievement | Concern | Concern | Strength | Strength | Strength |
| 3 Average Achievement | Concern | Concern | Strength | Strength | Strength |
| 2 Low Achievement | Neutral | Neutral | Need | Need | Need |
| 1 No Achievement | Neutral | Neutral | Need | Need | Need |
| | 1 No Importance | 2 Low Importance | 3 Average Importance | 4 Above Average Importance | 5 High Importance |

Figure 3. NSTA overlay for interpreting *Importance* & *Achievement* ratings.

Misanchuk's (1982) Del-N method uses a proportionate reduction in error method to deal with co-occurrences of the various *Importance* and *Achievement* ratings in the matrix. In addition to accounting for matrix dynamics, it also provides a numeric value for discrepancies so that items can be prioritized. The highest level of need, as defined in the Del-N method, results when the highest rating for *Importance* (5) co-occurs with the lowest rating for *Achievement* (1). This is depicted in the lower right hand (A1-I5) cell of the matrix in Figure 4. The lowest level of need, depicted in the upper left hand (A5-I1) cell of Figure 4,

| | | | | | |
|---|---|---|---|---|---|
| 5 High Achievement | 1.0000 | 0.8839 | 0.7906 | 0.7289 | 0.7071 |
| 4 Above Average Achievement | 0.8839 | 0.7500 | 0.6374 | 0.5590 | 0.5303 |
| 3 Average Achievement | 0.7906 | 0.6374 | 0.5000 | 0.3953 | 0.3536 |
| 2 Low Achievement | 0.7289 | 0.5590 | 0.3953 | 0.2500 | 0.1768 |
| 1 No Achievement | 0.7071 | 0.5303 | 0.3536 | 0.1768 | 0.0000 |
| | 1 No Importance | 2 Low Importance | 3 Average Importance | 4 Above Average Importance | 5 High Importance |

Figure 4. Del-N cell weightings based on proportionate reduction in error.

results when the lowest rating for *Importance* (1) co-occurs with the highest rating for *Achievement* (5). The Del-N method employs the idea of "proportionate reduction in error" to weight these two cells and all other cells in the matrix. The weightings are used to reduce the amount of error that each cell contributes to the prediction of high need. For example, in the A1-I5 cell, need is high because the item has been rated as having the lowest *Achievement* but the highest *Importance.* When observations in this cell are used to predict high need; the prediction is perfect. The cell is weighted 0.0000, because it contributes no error to the prediction of high need. For the A5-I1 cell, *Achievement* has the highest rating and *Importance* has the lowest rating. When observations in this cell are used to predict high need, error is great because the cell represents an area of low or no need. The weighting for this cell is 1.0000 due to its completely erroneous prediction of high need. With Del-N (see Figure 4), cells A5-I1 and A1-I5 get respective weightings of 1.0000 and 0.0000. Other cells on the diagonal, A4-I2, A3-I3, and A2-I4, receive weightings of 0.7500, 0.5000, and 0.2500, respectively. These weightings along with weightings for the off-diagonal cells in this symmetric matrix are given in Figure 4. For simplicity in assigning error weights, Misanchuk suggests a linear progression based a unit diagonal length.

In addition to the above assumption of a reduction in error schema of cell weightings, the Del-N method also makes the assumption that reasonable expected marginal probabilities can be assigned (Misanchuk, 1982). The expected marginal probabilities assigned with Del-N range from a low 0 for ratings of *No Importance* or *No Achievement* to a high of .4 for ratings of *High Importance* or *High Achievement* (Figure 5).

| Probability⇒ | 0 | .1 | .2 | .3 | .4 | |
|---|---|---|---|---|---|---|
| 5 High Achievement | | | | | | .4 |
| 4 Above Average Achievement | | | | | | .3 |
| 3 Average Achievement | | | | | | .2 |
| 2 Low Achievement | | | | | | .1 |
| 1 No Achievement | | | | | | 0 |
| | 1 No Importance | 2 Low Importance | 3 Average Importance | 4 Above Average Importance | 5 High Importance | ⇑Probability |

Figure 5. Expected marginal probabilities for the Del-N method.

This assumption and its associated expected probabilities rest on the presupposition that areas included in a needs assessment are key areas that are important to the organization, and that an organization that is managing to stay in business is achieving at least adequately in most of these key areas (Cummings, 1985; Misanchuk, 1982). If key areas are used in a needs assessment, they are also important areas; and the likelihood of their being rated *Low* in *Importance* is less than the likelihood of their being rated *Above Average* or *High* in *Importance*. Additionally, if the organization is doing its job even moderately well, it is probably achieving at some minimally successful level in key areas. Based on this assumption, the expected probability of having ratings of *No* or *Low Achievement* is less than the expected probability of having ratings of *Average* or *Above Average Achievement.* Using these assumptions, it is reasonable to assign a set of expected marginal probabilities beginning with the lowest probability for ratings of *No Importance* or *No Achievement* and increasing as ratings move toward *High Importance* or *High Achievement.* For the expected probabilities in Del-N, Misanchuk assigned a monotonically increasing set of proportions ranging from 0 to .4 (Figure 5).

To calculate Del-N, the observed proportions are used in the following formula along with the cell weightings and expected marginal probabilities.

$$\text{Del-N} = 1 - \frac{\sum_{i=1}^{R} \sum_{j=1}^{C} WijPij}{\sum_{i=1}^{R} \sum_{j=1}^{C} WijPi.P.j}$$

Wij is the individual cell weight (Figure 4). Pij is the observed proportion of observations falling into cell ij, and Pi.P.j is the product of the expected marginal probabilities for cell ij (Figure 5). When the cell weights (Figure 4) are multiplied by the expected probabilities (Figure 5) and summed across all 25 cells in the matrix, the denominator .58672 is obtained, and the formula becomes

$$\text{Del-N} = 1 - \frac{\sum_{i=1}^{R} \sum_{j=1}^{C} WijPij}{.58672}$$

In comparison to the mean difference method, the values generated using Del-N weight items according to various co-occurrences of *Importance* and

*Achievement* ratings within the data, they quantify discrepancies between ratings for *Importance* and *Achievement*, and they allow ranking of the discrepancies in order to prioritize areas of need. Although a useful tool for scoring needs assessments, the method is computationally complex (Cummings, 1985). Additionally, when needs are prioritized using Del-N, areas where *Importance* ratings exceed *Achievement* ratings are emphasized, regardless of the level of the respondents' ratings. For example, if *Importance* is rated 2 (*Low* ), and *Achievement* is rated 1 (*No*), a need will be identified with Del-N. But in some situations needs assessors or clients may not want a need identified for an item that respondents rate as being of *Low Importance.*

Cummings (1985) developed the Weighted Needs Index (WNI) to provide a threshold on *Importance* ratings below which needs would not be identified. That is, resources would not be used to meet needs in areas rated of *No* or *Low Importance.* (Cummings, 1985; McKillip, 1987). Rather than emphasizing any area where *Importance* ratings exceed *Achievement* ratings, regardless of the level of the rating for *Importance*, WNI emphasizes areas with an *Importance* rating of 3 or higher and an *Achievement* rating of 3 or below. As with Del-N, this is done with cell weightings (Cummings, 1985; McKillip, 1987). But the weighting scheme is much simpler (see Figure 6).

| | | | | | |
|---|---|---|---|---|---|
| 5 High Achievement | 0 | 0 | 0 | 0 | 0 |
| 4 Above Average Achievement | 0 | 0 | 0 | 0 | 0 |
| 3 Average Achievement | 0 | 0 | 0 | 1 | 3 |
| 2 Low Achievement | 0 | 0 | 1 | 2 | 4 |
| 1 No Achievement | 0 | 0 | 3 | 4 | 5 |
| | 1 No Importance | 2 Low Importance | 3 Average Importance | 4 Above Average Importance | 5 High Importance |

Figure 6. Cell weightings for the Weighted Needs Index.

The assumptions embodied in Cummings' weighting scheme are that no need is assessed if the relative ratings of *Importance* and *Achievement* are not discrepant and if ratings of *Low Importance* (2) to *No Importance* (1) co-occur with ratings of *Above Average* (4) to *High* (5) *Achievement.* With this approach, 17 cells in the 25-cell data matrix receive weightings of zero, and 8 cells are weighted with whole numbers ranging from 1 to 5 as presented in Figure 6.

Using the weights in Figure 6, the formula for calculating WNI is

$$WNI = \frac{\sum_{i=1}^{3} \sum_{j=3}^{5} fij \quad Wij}{N}$$

In the formula, the frequency of responses in each cell is represented by fij. Wij is the weight for cell ij. And N is the total number of respondents for the item. Values of WNI range from 0 to 5, with higher numbers associated with higher levels of need (Cummings, 1985; McKillip, 1987). WNI has an appropriate level of sophistication in dealing with various co-occurrences of *Importance* and *Achievement* ratings, and it provides numeric values that can be used to rank order and prioritize needs based on discrepant ratings.

In the mid-1980's, Cummings (1985) compared the mean difference, Del-N, and WNI methods for scoring needs assessments. The dual-response instrument that he developed contained 25 items encompassing skills needed by managers and staff in his company to service their clients in the construction industry. Two-hundred-forty-seven surveys were mailed out. After two follow-up mailings, the response rate was 66 percent. Completed instruments were received from 86 managers and 77 staff members. With these instruments, Cummings calculated discrepancies using the mean difference method, the Del-N method, and the WNI method. All three methods were used to calculate discrepancies for the managers' responses and for staff responses. He then used the discrepancy scores generated by the three methods to rank order, by method, each of the 25 items on his survey.

Cummings found the pattern of rankings between and among the three methods to be comparable, both for managers and for staff, in a business training setting. Additionally, the rank order correlations between and among the methods were high, .85 or greater, for both managers and staff. For managers, the correlation between the mean difference and Del-N methods was .94, the correlation between the mean difference and WNI was .92, and the correlation between the Del-N method and WNI it was .95. For staff, the correlation between mean difference and Del-N was .85. Between mean difference and WNI, it was .92; and between Del-N and WNI, it was .95. The pattern that Cummings found included high correlations among all three methods, with the lowest correlations between the methods least closely related to each other, i.e., mean difference and Delta N (.85 for staff and .92 for managers); and the highest correlations between the more similar Del-N and WNI methods (.95 for both staff and managers).

Based on Cummings' findings, needs assessment results in a business training setting should be comparable with either the mean-difference, Del-N or WNI methods. Either of the three may be used with similar results for scoring and ranking discrepancies in dual-response needs assessment surveys. However, because the mean difference method does not weight for various co-occurrences of ratings, it does not fully represent the dynamics in the *Importance/ Achievement* matrix. Del-N and WNI both account for co-occurrences of various ratings within the matrix. Of the two, WNI is computationally less complex, and its weighting scheme protects against identifying needs in areas rated as having *Low* or *No Importance* (Cummings, 1985; McKillip, 1987).

If needs assessors working in public education can be assured of the comparability of the three methods for prioritizing school level needs, they can feel confident in choosing the method that best suits the objectives the particular needs assessment situation. Though his findings suggested good comparability, they were generated in a business environment; and Cummings (1985) has recommended that further research be undertaken to compare the three scoring methods. He suggested that research be done in other content areas, with other respondents, and across a broader range of needs. The present study has done that by examining the comparability of the three methods in an educational setting. It encompassed the content areas of mathematics and science; the respondents were 339 public school teachers from 19 schools in North Carolina; and areas of need related to mathematics and science content and pedagogy in elementary, middle, and high schools.

A stability analysis comparing the basic WNI and Del-N formulas to variant forms was included to determine the robustness of the indices under different weighting schemes. Apart from the two probability scheme variations, normal and uniform, that Misanchuk (1982) used to evaluate the stability of Del-N, there is little information in needs assessment literature regarding other stability analyses. Misanchuk's probability schemes were included in the Del-N stability analysis for this study.

Specifically, this study investigated the stability of Del-N and WNI by correlating indices calculated with the basic formulas with indices calculated using slight variations of each formula. It was expected that the Spearman rank order correlation coefficients between the basic formulas and each of their variants would equal or exceed .80. Using random subsamples of teachers from each of the 19 schools, the study assessed the comparability between subsamples for the mean difference, Del-N, and WNI scoring methods, hypothesizing that the resulting subsample correlations would equal or exceed .80 for each method. In the main analysis of the study, which assessed the overall comparability of the three scoring methods, it was also hypothesized that the Spearman rank order correlations would equal or exceed .80. The following research hypothesis represents the expected pattern of correlation coefficients that was investigated

$$\rho_{\text{mean diff/del-n}} < \rho_{\text{mean diff/wni}} < \rho_{\text{del-n/wni}}$$

This hypothesis postulated that the more computationally similar methods would correlate more closely with each other than with less computationally similar methods.

# CHAPTER III
# METHODOLOGY

In the preceding chapter, three methods for scoring dual-response needs assessment instruments, the mean difference, Del-N, and WNI methods, were presented. After studying these methods, Cummings (1985) concluded that they were comparable in a business training setting, and he recommended further research to compare them in other settings. The present study evaluated the comparability of these three needs assessment scoring methods for mathematics and science programs in selected public schools in the state of North Carolina. The procedures for collecting data and making these comparisons are described in this chapter.

## The Sample

The sample for this study consisted of teachers at the 19 public schools participating in a school-wide planning process facilitated by the Mathematics and Science Education Network (MSEN) at the University of North Carolina in Chapel Hill. The sample, which included all schools involved in the planning process at either the beginning of the 1992-93 or 1993-94 school years, was purposeful, rather than random. Local system administrators were instructed to target schools with high minority populations or high numbers of students in poverty, or schools in rural areas, to participate in the planning process. At the beginning of the 1992-93 school year, 7 schools participated; 12 schools participated at the beginning of the 1993-94 school year. All participating schools were from counties in central North Carolina. Of the seven schools that participated in 92-93, five were elementary schools, one was a middle school, and one was a high school. In 93-94, eight elementary schools, three middle schools, and one high school participated.

Content Focus of Schools in the Sample

Staff members at participating schools chose to focus planning efforts on either their mathematics or their science program. Of the seven schools participating in the 92-93 school year, two elementary schools and the middle school focused on mathematics. The three other elementary schools and the high school focused on science. In 93-94, when a total of 12 schools participated, one elementary school and one middle school chose to focus on mathematics. The other seven elementary schools chose science, as did the remaining two middle schools. For the high school, a science focus was used. Table 1 shows the number of respondents by school year, school level, and content focus. The mathematics form of the needs assessment was used at schools that chose to emphasize mathematics, and the science needs assessment was used at schools focusing on science.

Numbers of Respondents at Schools in the Sample

As part of the planning process, a needs assessment instrument was completed by all teachers at the participating elementary schools. At participating middle and high schools, the needs assessment instrument was completed by all mathematics and/or science teachers. For the needs assessment administered at the beginning of the 1992-93 school year, there were a total of 82 respondents from mathematics-focused schools and 59 respondents from schools that focused on science (see Table 1). For the 1993-94 school year, there were 38 respondents in schools that used the mathematics needs assessment and 160 respondents in schools that used science assessment (see Table 1).

Table 1
Number of Respondents and Content Focus for Schools Participating During the 1992-1993 and 1993-94 School Years

| School and Level | Mathematics Focus 1992-93 | Mathematics Focus 1993-94 | Science Focus 1992-93 | Science Focus 1993-94 |
|---|---|---|---|---|
| Elementary School A | 30 | | | |
| Elementary School B | 33 | | | |
| Elementary School C | | | 14 | |
| Elementary School D | | | 19 | |
| Elementary School E | | | 19 | |
| Elementary School F | | 21 | | |
| Elementary School G | | 8 | | |
| Elementary School H | | | | 16 |
| Elementary School I | | | | 19 |
| Elementary School J | | | | 26 |
| Elementary School K | | | | 12 |
| Elementary School L | | | | 23 |
| Elementary School M | | | | 38 |
| Middle School A | 19 | | | |
| Middle School B | | 9 | | |
| Middle School C | | | | 12 |
| Middle School D | | | | 9 |
| High School A | | | 7 | |
| High School B | | | | 5 |
| 1992-93 Totals | 82 | | 59 | |
| 1993-94 Totals | | 38 | | 160 |

Subsamples for Schools in the Study

Subsamples were taken for each participating school. Respondents who completed the needs assessment at each school were randomly divided into two groups designated Subsample A and Subsample B. At each school, this allowed within method comparisons of the rank order correlations for the mean difference, WNI, and Del-N scoring methods. Table 2 lists the numbers of teachers in Subsamples A and B at each school.

Table 2

Number of Teachers in Subsamples A and B for Each School

| School and Level | Year | Subsample A | Subsample B |
|---|---|---|---|
| Elementary School A | 1992-1993 | 15 | 15 |
| Elementary School B | 1992-1993 | 17 | 16 |
| Elementary School C | 1992-1993 | 7 | 7 |
| Elementary School D | 1992-1993 | 10 | 9 |
| Elementary School E | 1992-1993 | 10 | 9 |
| Elementary School F | 1993-1994 | 11 | 10 |
| Elementary School G | 1993-1994 | 4 | 4 |
| Elementary School H | 1993-1994 | 8 | 8 |
| Elementary School I | 1993-1994 | 10 | 9 |
| Elementary School J | 1993-1994 | 13 | 13 |
| Elementary School K | 1993-1994 | 6 | 6 |
| Elementary School L | 1993-1994 | 12 | 11 |
| Elementary School M | 1993-1994 | 19 | 19 |
| Middle School A | 1992-1993 | 10 | 9 |
| Middle School B | 1993-1994 | 5 | 4 |
| Middle School C | 1993-1994 | 6 | 6 |
| Middle School D | 1993-1994 | 5 | 4 |
| High School A | 1992-1993 | 4 | 3 |
| High School B | 1993-1994 | 3 | 2 |

**The Needs Assessment Instrument**

In several of its projects in North Carolina, the Mathematics and Science Education Network (MSEN) has worked with schools and school systems to assist in a planning process for improving mathematics or science programs in the schools. To aid in this process, MSEN has collaborated with faculty at its various Centers throughout the state to design needs assessment instruments for mathematics or science. Results from administration of the instruments are used to help teachers and administrators assess strengths and weaknesses of their mathematics or science programs prior to developing school improvement plans in mathematics or science.

Format of the Instrument

The overall format is the same for the mathematics and science needs assessment instruments. Both contain 30 items and utilize a dual-response, discrepancy format (Johnson & Dixon, 1984; Witkin, 1984). With the discrepancy format, respondents are instructed to rate all items by choosing one response on each of two five-point scales ( Figure 7). One scale provides options ranging from 1 for a rating of *No Importance* to 5 for a rating of *High Importance*. A second scale provides options ranging from 1 for *No Achievement* to 5 for *High Achievement*.

Listed below are thirty statements that could characterize effective elementary mathematics programs. The statements focus on content (#1-11), instructional practices (#12-21), student assessment (#22-24), and school mathematics environment (#25-30). For each statement, indicate:

1) its importance for your school; and
2) the extent to which this characteristic is achieved at your school.

Use the following scales to rate **Importance** and **Achievement** for each statement. First circle a number to indicate the level of **Importance**. Then circle a number to indicate the level of **Achievement**.

| No Importance | Low Importance | Average Importance | Above Average Importance | High Importance |
|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 |

| No Achievement | Low Achievement | Average Achievement | Above Average Achievement | High Achievement |
|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 |

Figure 7. Dual-response scales for rating the 30 items on the mathematics needs assessment instrument (scales on the Science instrument are identical).

## Content of the Instruments

Because items on a discrepancy-format needs assessment instrument are usually derived from standards of exemplary practice in the field (McKillip, 1987), the 30 items on the mathematics needs assessment were based on the standards of the National Council of Teachers of Mathematics (NCTM, 1989), and the science instrument's 30 items were based on principles drafted by the National Science Teachers Association (NSTA, 1987). Copies of both needs assessment instruments, reprinted with permission from MSEN, are included in Appendix A.

## Reliability of the Instruments

In the fall of 1993, MSEN staff conducted studies to estimate the internal consistency and test-retest reliability for both the mathematics and science needs assessment instruments. Cronbach's Alpha was used with samples of over 500 teachers to estimate the internal consistency reliability of the *Importance* and

*Achievement* ratings. Coefficients of internal consistency for the mathematics instrument were .97 for *Importance* and .95 for *Achievement*. For the science assessment, alpha was .98 for *Importance* and .97 for *Achievement*. Although alpha was calculated, it is not a good indicator of reliability for a needs assessment like the one used in this study. The very high values of alpha reported here can be interpreted as indicating a negative rather than a positive outcome in this case. The large estimates of alpha indicate that respondents who rated one item as having higher *Importance* or *Achievement* levels tended also to rate other items as being high in *Importance* or *Achievement*, and that respondents who rated these variables lower for one item also tended to give lower ratings for other items. Whereas, with a typical dual-response needs assessment based on accepted practice standards in the field, it would be expected that individual respondents would tend to give high ratings for some items and low ratings for other, versus exhibiting a response set favoring only high or low ratings across items.

In a separate study, which was appropriate for this type of needs assessment, samples of over 60 teachers completed the mathematics or science assessments twice within five days to estimate test-retest reliability for the instruments. Results of this analysis demonstrated acceptable reliability levels on both scales for both instruments. The coefficient of stability computed for the *Importance* scale of the mathematics-focused assessment was .87; it was .77 on the *Achievement* scale. On the science instrument, the test-retest reliability estimate for the *Importance* scale was .77. For the *Achievement* scale, it was .76 (Penta, Mitchell, & Franklin, 1993).

Using the Instruments for Data Collection

For both the 1992-93 and 1993-94 school years, a staff member from MSEN coordinated the planning process. She worked with this researcher to plan administration of the needs assessment at participating schools. At the beginning of each of the two school years, this staff member conducted a general meeting with the two lead teachers from every school to orient them to the planning process that would occur during the year. She allocated time for each of them to work individually to complete the needs assessment. She also provided instructions and copies of the assessment for them to take back and administer at their schools. They were instructed to have teachers at their schools work independently in completing the needs assessment. At the elementary school level, the form was used with all teachers because teachers typically teach mathematics and science along with or in addition to other subjects. At the middle and high school levels, which were departmentalized by subject, the forms went only to mathematics or science teachers, depending on the school's content focus. The completed forms were then returned to MSEN for data entry and analysis. Because lead teachers were responsible for collecting the needs assessment forms from teachers at their respective schools, the response rate exceeded 90%.

In addition to the needs assessment, demographic information and information about teaching practices was collected from respondents who completed the needs assessment. An analysis of all of this information was provided to each participating school along with tallies of the results from the needs assessment instrument. MSEN's project staff member again met with lead teachers to review the results. Neither of the three needs assessment scoring methods investigated in this dissertation were used to score the instrument at that time. Instead, an adaptation of the National Science Teachers Association overlay described in Chapter II (see Figure 3) was used. Lead teachers were trained to use the overlay and given copies to take to planning meetings at their schools. In these meetings the needs assessment results were used informally to promote discussion of the strengths and weaknesses in the schools' mathematics or science program and to guide the development of school improvement plans.

**Methodology for Assessing the Comparability of Three Scoring Methods**

Three scoring methods, the mean difference, Del-N, and WNI methods, were used to calculate scores from data collected during the 1992-93 and 1993-94 administrations of the needs assessment. For every school, each of the three methods were used to calculate scores for every item on the needs assessment. That is, for each school, a mean difference score was calculated for each of the 30 items, a Del-N score was calculated for the same 30 items, and so was a WNI score. The 30 scores for each of the three methods were then entered into a data set and used to prioritize or rank order the items by school. Additionally, the ranks for each school were used to calculate Spearman's rank order correlations between pairs of methods: the mean difference method with Del-N, the mean difference method with WNI, and Del-N with WNI.

Calculating scores with the Mean Difference, Del-N, and WNI Methods

For mathematics and for science, the needs assessment instrument has a dual-response format where respondents are instructed first to circle ratings ranging from 1 (No) to 5 (High) for *Importance* and then to circle ratings from 1 (No) to 5 (High) for *Achievement*. Both the *Importance* and *Achievement* ratings were used to calculate scores with all three or the scoring methods under investigation.

The analysis was stratified by school; i.e., a level of need for every school was calculated for all 30 items using each of the three methods. Additionally, need was assessed by the subject area focus, either mathematics or science, and by level of school, elementary, middle, or high school. In 1992-93 data were gathered from seven schools: two elementary schools that focused on mathematics, three elementary schools focusing on science, one middle school focusing on mathematics, and one high school that focused on science (see Table 1). The 1993-94 data were gathered from 12 schools: one elementary school with a mathematics focus, seven elementary schools that focused on science, one middle school with a mathematics focus, two middle schools focusing on science, and a single high school that also focused on science (see Table 1).

The Mean Difference Method. Using the mean difference method, the *Achievement* ratings and the *Importance* ratings for each of the 30 items were averaged, by school, across respondents. The *Achievement* average for each item was then subtracted from the *Importance* average for that item. Positive differences occurred when average *Achievement* ratings were less than average *Importance* ratings; that is, when *Achievement* fell short of *Importance*. The greater the difference, the greater the need from improvement in order for *Achievement* to approach *Importance*. The value of the mean difference for each item was used to rank order the 30 items for each school, with items having the highest mean difference ranked first.

The Del-N Method. With the Del-N method, the cell weightings and expected marginal probabilities from Figures 4 and 5 in Chapter II were used together with the observed proportions to calculate a Del-N index, by school, for each of the 30 items. As explained in Chapter II, the cell weightings in Del-N are based on a proportionate reduction in the amount of error that a particular co-occurrence of *Importance* and *Achievement* ratings contributes to the prediction of high need. The expected probabilities assigned, also explained in Chapter II, are based on the assumption that the marginal probabilities increase as ratings move from 1 (No) *Importance* or *Achievement* to 5 (High) *Importance* or *Achievement*. The following formula was used:

$$\text{Del-N} = 1 - \frac{\sum_{i=1}^{R} \sum_{j=1}^{C} \text{WijPij}}{.58672}$$

Wij is the individual cell weight (Figure 4); Pij is the observed proportion of ratings falling into cell ij; and .58672 is the product of the weights (Figure 4) and the expected marginal probabilities for cell ij (Figure 5) summed across all 25 cells in the matrix. For each participating school, values calculated for Del-N, which can range from a high of 1.00 to a low of negative 1.75, were used to rank the 30 times. Items with the highest Del-N values were ranked first.

<u>The Weighted Needs Index (WNI)</u>. Figure 6 in Chapter II presents the cell weightings that were used to calculate the WNI for each school. The following formula was used to calculate WNI for each of the 30 items.

$$\text{WNI} = \frac{\sum_{i=1}^{3} \sum_{j=3}^{5} \text{fij Wij}}{N}$$

In this formula, fij represents the frequency of responses in each cell; Wij is the weight for cell ij; and N is the total number of respondents for the item. The values calculated for WNI, which can range from 0 to 5, were used to rank order the items for each school, with those items having higher values ranked first.

**Methodology for Assessing the Stability of WNI and Del-N**

Before comparisons were made between WNI and Del-N and between these two indices and the mean difference method, a stability analysis was run to ascertain if they were robust enough to preserve their respective orderings of needs under different weighting schemes. In the case of Del-N, which involves a cell weighting scheme and the assignment of expected marginal probabilities, two different probability schemes and two different weighting schemes were tried. The stability assessments for WNI and Del-N were conducted using data from two of the elementary schools in the study, Elementary School B, which used the mathematics needs assessment in 1992-93, and Elementary School M, which used the science needs assessment in 1993-94. These schools were selected because the number of teachers taking the needs assessment at each school was relatively large (33 teachers at Elementary School B and 38 teachers at Elementary School M).

Stability Analysis for WNI

Four different schemes for weighting cells, each a variant of the weighting scheme specified by WNI, were devised and used with the basic WNI formula (termed WNIa for the stability analysis) to calculate WNIb, WNIc, WNId, and WNIe on each of the 30 needs assessment items for the two selected elementary schools. The values of indices a through e were then used to rank the 30 items by index and to calculate Spearman's rank order correlations between WNIa and each of the variants b through e. The cell weighting scheme for WNIb (see Figure 8) consisted of a series of whole numbers between 6 and 9 in all cells receiving non-zero cell weights under WNIa. The cell weights for WNIc (Figure 9) were identical to WNIb, except that the 3-3 cell, weighted zero in WNIb, was assigned a cell weight of 5 for WNIc.

| | | | | | |
|---|---|---|---|---|---|
| 5 High Achievement | 0 | 0 | 0 | 0 | 0 |
| 4 AbvAver Achievement | 0 | 0 | 0 | 0 | 0 |
| 3 Average Achievement | 0 | 0 | 0 | 6 | 7 |
| 2 Low Achievement | 0 | 0 | 6 | 7 | 8 |
| 1 No Achievement | 0 | 0 | 7 | 8 | 9 |
| | 1 No Importance | 2 Low Importance | 3 Average Importance | 4 AbvAver Importance | 5 High Importance |

Figure 8. Cell weights for calculating WNIb.

| | | | | | |
|---|---|---|---|---|---|
| 5 High Achievement | 0 | 0 | 0 | 0 | 0 |
| 4 AbvAver Achievement | 0 | 0 | 0 | 0 | 0 |
| 3 Average Achievement | 0 | 0 | 5 | 6 | 7 |
| 2 Low Achievement | 0 | 0 | 6 | 7 | 8 |
| 1 No Achievement | 0 | 0 | 7 | 8 | 9 |
| | 1 No Importance | 2 Low Importance | 3 Average Importance | 4 AbvAver Importance | 5 High Importance |

Figure 9. Cell weights for calculating WNIc.

| | | | | | |
|---|---|---|---|---|---|
| 5 High Achievement | 0 | 0 | 0 | 0 | 0 |
| 4 AbvAver Achievement | 0 | 0 | 0 | 0 | 0 |
| 3 Average Achievement | 0 | 0 | 0 | 1 | 1 |
| 2 Low Achievement | 0 | 0 | 1 | 1 | 1 |
| 1 No Achievement | 0 | 0 | 1 | 1 | 1 |
| | 1 No Importance | 2 Low Importance | 3 Average Importance | 4 AbvAver Importance | 5 High Importance |

Figure 10. Cell weights for calculating WNId.

| | | | | | |
|---|---|---|---|---|---|
| 5 High Achievement | 0 | 0 | 0 | 0 | 0 |
| 4 AbvAver Achievement | 0 | 0 | 0 | 0 | 0 |
| 3 Average Achievement | 0 | 0 | 1 | 1 | 1 |
| 2 Low Achievement | 0 | 0 | 1 | 1 | 1 |
| 1 No Achievement | 0 | 0 | 1 | 1 | 1 |
| | 1 No Importance | 2 Low Importance | 3 Average Importance | 4 AbvAver Importance | 5 High Importance |

Figure 11. Cell weights for calculating WNIe.

For WNId, each non-zero weighted cell in WNIa was unit weighted (Figure 10). For WNIe, unit weights were assigned just as for WNId, but the 3-3 cell was also unit weighted (Figure 11).

In the WNI stability analysis, the use of zero versus a numeric weight in the 3-3 cell was the only differentiation between WNIb and WNIc, and between WNId and WNIe. These variations were chosen because there is debate among analysts about how to weight this cell, which represents *Average Importance* and *Average Achievement*. Some practitioners use a zero weight because of the lack of need implied when an area of *Average Importance* has an *Average* level of *Achievement* (Cummings, 1985). Others use a numeric weight to indicate some level of need because *Achievement* could be improved even in a area of *Average Importance* (Misanchuk, 1982).

Del-N Stability Analysis

Two different cell weighting schemes (Wij) were used to vary the numerator of Del-N formula to calculate two indices for comparison with the basic index (Del-N was designated as Del-Na for this stability analysis). Figure 12 presents the symmetric matrix of whole numbers from 1 to 9 that were used as cell weights for calculating Del-Nb. To calculate Del-Nc, each cell was unit weighted (Figure 13), i.e., Wij equaled 1 for each cell. The denominator used with these two weighting schemes to calculate both Del-Nb and Del-Nc was .58672, the denominator of the basic Del-N formula.

| | | | | | |
|---|---|---|---|---|---|
| 5 High Achievement | 9 | 8 | 7 | 6 | 5 |
| 4 AbvAver Achievement | 8 | 7 | 6 | 5 | 4 |
| 3 Average Achievement | 7 | 6 | 5 | 4 | 3 |
| 2 Low Achievement | 6 | 5 | 4 | 3 | 2 |
| 1 No Achievement | 5 | 4 | 3 | 2 | 1 |
| | 1 No Importance | 2 Low Importance | 3 Average Importance | 4 AbvAver Importance | 5 High Importance |

Figure 12. Cell weights for calculating Del-Nb.

| | | | | | |
|---|---|---|---|---|---|
| 5 High Achievement | 1 | 1 | 1 | 1 | 1 |
| 4 AbvAver Achievement | 1 | 1 | 1 | 1 | 1 |
| 3 Average Achievement | 1 | 1 | 1 | 1 | 1 |
| 2 Low Achievement | 1 | 1 | 1 | 1 | 1 |
| 1 No Achievement | 1 | 1 | 1 | 1 | 1 |
| | 1 No Importance | 2 Low Importance | 3 Average Importance | 4 AbvAver Importance | 5 High Importance |

Figure 13. Cell weights for calculating Del-Nc.

Calculation of Del-Nd and Del-Ne involved variations in the assignment of expected marginal probabilities rather than variations in the weighting scheme (Misanchuk, 1982). In calculating these two indices, the numerator of the basic Del-N formula was unchanged; however, the denominator differed according to the assigned marginal probabilities. To calculate Del-Nd, an approximately normal distribution (Figure 14) was hypothesized in assigning the expected marginal probabilities (Misanchuk, 1982). Using these marginals along with the weights from the basic Del-N formula (Figure 4), the constant calculated for the denominator was .5167232.

| NormalProb→ | .036 | .238 | .451 | .238 | .036 | |
|---|---|---|---|---|---|---|
| 5 High Achievement | | | | | | .036 |
| 4 AbvAver Achievement | | | | | | .283 |
| 3 Average Achievement | | | | | | .451 |
| 2 Low Achievement | | | | | | .238 |
| 1 No Achievement | | | | | | .036 |
| | 1 No Importance | 2 Low Importance | 3 Average Importance | 4 AbvAver Importance | 5 High Importance | ↑NormProb |

Figure 14. Expected marginal probabilities for Del-Nd normal distribution.

In assigning expected marginal probabilities for Del-Ne, a uniform distribution was hypothesized (Figure 15); and, when these probabilities were used with the original weighting scheme (Figure 4), the constant calculated for the denominator was .5610320.

| Unif Prob→ | .2 | .2 | .2 | .2 | .2 | |
|---|---|---|---|---|---|---|
| 5 High Achievement | | | | | | .2 |
| 4 AbvAver Achievement | | | | | | .2 |
| 3 Average Achievement | | | | | | .2 |
| 2 Low Achievement | | | | | | .2 |
| 1 No Achievement | | | | | | .2 |
| | 1 No Importance | 2 Low Importance | 3 Average Importance | 4 AbvAver Importance | 5 High Importance | ⇑UnifProb |

Figure 15. Expected marginal probabilities for Del-Ne uniform distribution.

For the stability analysis, the index calculated with the basic Del-N formula was labeled Del-Na. The values calculated for Del-N indices a through e were used to rank the 30 items and to calculate Spearman's rank order correlations between Del-Na and each of the variants b through e for the two elementary schools used in the stability analysis.

Analyzing Results of the Stability Analysis

The purpose of the stability analysis was to ascertain if WNI and Del-N were sufficiently robust to retain their rankings of needs under different weighting and probability schemes. Using the two largest schools in the study, rank order correlation coefficients were calculated between the basic form and each of its variations. If rankings are preserved in the variant forms, it was hypothesized that the correlation coefficients between the basic form and its variants would equal or exceed .80.

**Methodology for Comparing the Three Methods**

Two approaches were used to assess the comparability of the three scoring methods for prioritizing areas of need on the mathematics and science needs assessment instruments. For every school in the study, tables of scores from each of the three methods and their associated ranks were compiled to allow visual comparisons of the rank orderings across the 30 items. The rank orders obtained with each method were correlated by school, and tables of the correlation coefficients were compiled for each school year and content area.

Developing Tables for the Three Scoring Methods

When the mean difference, Del-N, and WNI scores had been calculated and rank ordered for all schools, tables were compiled to visualize the comparability of rank orderings across the 30 needs assessment items for each school. The tables, which begin with item number 1 and end with item 30, contain the three indices for every item along with the item's rank order based on each index. If the assumption of comparability is supported, it was anticipated that an item that was ranked first for one of the indices should also rank between first and third place based on the other two indices (Cummings, 1985). Differences were calculated between the 30 item's pairs of ranks from each of the three methods and used to categorize them as similar, moderately similar, or dissimilar. Additionally, tables of rankings for each school were developed and examined for other patterns; for example, the occurrence of frequent ties and multi-way ties among the rankings from any particular method.

Correlating the Ranks from the Three Scoring Methods

In addition to tables of indices and ranks, rank differences, and occurrences of ties, Spearman's rank order correlation coefficient was used to evaluate further the comparability of the methods' rankings for each school. Within the 1992-93 data set, two tables of correlation coefficients were compiled: one to compare needs assessment rankings for the two elementary schools and the middle school that focused on mathematics, and another comparing the results for the three elementary schools and the one high school that focused on science. For the 1993-94 data set, a table reporting correlation coefficients for the two elementary schools and the one middle school that focused on mathematics was developed. Another was developed for the six elementary schools, two middle schools, and the one high school that used the science needs assessment.

Prior to compiling these tables, Spearman's rank order correlation coefficient was calculated among the rankings for each school. That is, for each school, the following correlation coefficients were calculated: r mean diff/Del-N; r mean diff/WNI; and r Del-N/WNI. If there is comparability between methods, it was hypothesized that the correlation coefficients would indicate a strong, positive relationship ($\rho \geq .80$) between each pairing of the three methods (Cummings, 1985). Additionally, it was hypothesized that a pattern would emerge of better agreement of ranks and therefore higher correlations between the methods using computational approaches that are more similar, and less agreement of rankings resulting in lower correlations between methods with less computational similarity. The mean difference method is more similar to the Weighted Needs Index than to Del-N; thus, it was expected to be more highly correlated with WNI than with Del-N. Del-N and WNI are more similar to each other than they are to the mean difference method and were expected to be more highly correlated with each other than with the mean difference method. The research hypothesis for expected the pattern was:

$$\rho_{mean\ diff/del\text{-}n} < \rho_{mean\ diff/wni} < \rho_{del\text{-}n/wni}$$

In Chapter IV of this dissertation, the tables described above are presented and discussed, and the various correlation coefficients between pairings of the three scoring methods are reported and analyzed. The tables are reviewed for patterns of comparability across the three methods, and the correlation coefficients are evaluated to ascertain whether or not the expected patterns emerge, i.e., strong positive correlations among the methods, with the most similar methods having the highest correlations. In Chapter V, support for the research hypotheses is assessed and recommendations for further research are suggested.

# CHAPTER IV
# RESULTS

In Chapter III the methodology used in investigating the central research questions of this study was described. In this chapter the results of that investigation are presented. The first section contains the results of the analysis conducted to determine the stability of the WNI and Del-N indices under selected weighting schemes and, in case of Del-N, different sets of expected probabilities. The results of the analysis of needs assessment scores for subsamples from each school in the study are included in the second section. In section three, the needs assessment scores calculated for each school using the mean difference, WNI, and Del-N methods are presented. Rankings based on the scores are tabulated, and values of the correlation coefficients calculated between them are discussed.

In all three the sections, the primary method used to assess support for the research hypotheses was a detailed analysis of sample statistics to determine if the hypothesized patterns emerged; that is, to ascertain whether the sample data provided convincing evidence in support of the research hypotheses. Formal hypothesis testing was used only in section three, where confidence intervals were constructed around selected sample correlation coefficients to assess support for the hypothesis of comparability among the three methods. Specifically, they were used to indicate support or lack of support for the hypothesized population correlation of .80 or greater between method pairs.

**The Stability Analysis for WNI and Del-N**

A stability analysis was conducted to determine how the cell weighting schemes and postulated expected marginal probabilities described in Chapter III would affect WNI and Del-N. The basic formulas, designated as WNIa and Del-Na for the stability analysis, were adapted to calculate WNIb, WNIc, WNId, WNIe and Del-Nb, Del-Nc, Del-Nd, Del-Ne. For both WNI and Del-N, indices b through e were used to rank order needs assessment scores from Elementary School B (1992-93) and Elementary School M (1993-94). These rankings were then correlated with the ranks obtained when WNIa and Del-Na were used for these two schools.

Results of the Stability Analysis for WNI

To calculate WNIb, whole numbers between 6 and 9 were used to weight all cells that received non-zero cell weights under WNIa (Figure 8). The same scheme was applied for WNIc, except that the 3-3 cell was weighted 5 (Figure 9). Unit weights were used to calculate WNId and WNIe. All cells receiving a non-zero weight in WNIa were unit weighted in WNId (Figure 10). With WNIe, the non-zero cells and the 3-3 cell were unit weighted (Figure 11). Each new index was used to rank order needs for Schools B and M, and these rank orders were correlated with the schools' rank orderings from WNIa. The correlation coefficients, which ranged from a high of .94833 between WNIa and WNIb to a low of .79574 between WNIa and WNIe at School M, are given in Table 3.

Table 3

Spearman Rank Order Correlation Coefficients Between WNIa and WNIb through WNIe for two Elementary Schools*

| School | rWNIa/WNIb | rWNIa/WNIc | rWNIa/WNId | rWNIa/WNIe | N |
|---|---|---|---|---|---|
| Elementary School B | .93122 | .90273 | .89625 | .86474 | 33 |
| Elementary School M | .94833 | .88431 | .91332 | .79574 | 38 |

*p-values (Ho:$\rho$ = 0) for all correlation coefficients in this table = .0001

At both schools, the correlation coefficients between WNIa and WNIb were higher than those between WNIa and any of the other weighting schemes (School B rWNIa/WNIb = .93122; School M rWNIa/WNIb = .94833). In the whole number and unit weighting schemes for both schools, the indices with the 3-3 cell weighted zero, WNIb and WNId, correlated more highly with WNIa (School B rWNIa/WNIb = .93122 and rWNIa/WNId = .89625; School M rWNIa/WNIb = .94833 and rWNIa/WNId = .91332) than did the indices with the 3-3 cell weighted with a whole number, WNIc, or unit weighted, WNIe (School B rWNIa/WNIc = .90273 and rWNIa/WNIe = .86474; School M rWNIa/WNIc = .88431 and rWNIa/WNIe = .79574).

Results of the Stability Analysis for Del-N

The basic Del-N formula, called Del-Na for the stability analysis, was adapted to calculate Del-Nb, Del-Nc, Del-Nd, and Del-Ne. The needs assessment items for Schools B and M were then rank ordered with these indices, and the ranks were correlated with rankings from Del-Na. For Del-Nb and Del-Nc the weightings in the numerator of the basic formula were varied; scheme b used whole numbers from 9 to 1 (Figure 12) and scheme c used unit weights for each cell (Figure 13). For indices d and e, the denominator of the basic formula was adapted to use postulated normal (Figure 14) and uniform (Figure 15) distributions for the expected marginals. For Schools B and M, the correlation coefficients comparing the ranks on Del-Na with ranks on indices Del-Nb through Del-Ne are listed in Table 4.

Table 4

Spearman Rank Order Correlation Coefficients Between DEL-Na and DEL-Nb through DEL-Ne for two Elementary Schools*

| School | rDEL-Na/DEL-Nb | rDEL-Na/DEL-Nc | rDEL-Na/DEL-Nd | rDEL-Na/DEL-Ne | N |
|---|---|---|---|---|---|
| Elementary School B | .92267 | not calculable | 1.0000 | 1.0000 | 33 |
| Elementary School M | .90757 | not calculable | 1.0000 | 1.0000 | 38 |

*p-values (Ho:$\rho = 0$) for all correlation coefficients in this table $\leq .0001$

At Elementary School B, the rank order correlation between Del-Na and Del-Nb was .92267; at Elementary School M, it was .90757. Rank order correlation coefficients could not be calculated between Del-Na and Del-Nc for either of these schools because, with the unit weighted cells in Del-Nc, equal Del-Nc values were calculated for every item on the needs assessment. With equal Del-Nc values for all 30 items, it was impossible to rank the items. The equal index values resulted because of the way the unit weights affected calculation of the numerator for Del-Nc. Using the formula, the cell weights (unit weights) were multiplied by the observed proportion of observations falling in each cell and then summed. With unit weighting, that product was 1 times each observed cell proportion. And the observed cell proportions always totaled 1.000 for the matrix. Thus, with unit weighting, the numerator of the formula was the same for every item, 1.000. When this was divided by the denominator, .58672, it resulted in equal values of Del-Nc for all 30 items, and therefore, equal ranks.

When ranks from the Del-Nd and Del-Ne indices were compared to Del-Na, the correlation coefficient was 1.000 for both indices at both elementary schools. The values computed with the Del-N a, d, and e indices were different, but they ranked the items the same on all three indices. Once again, this was a result of the Del-N formula. Both the d and e versions involved variations in the expected marginal probability scheme, which changed the denominator of the basic formula from .58672 for Del-Na to .5167232 for the normal distribution postulated for Del-Nd and to .561032 for Del-Ne's postulated uniform distribution. Hence, the only variation in the basic formula was a slight change in value of the denominator, which resulted in different numeric values but not different rankings for items across the three indices.

**Results of the Subsample Comparisons**

The central task of this study was to compare the mean difference, Del-N, and WNI methods for scoring needs assessments to each other. Additionally, in order to make within method comparisons, respondents at each participating school were randomly divided into two groups, Subsample A and Subsample B. Mean Difference, WNI, and Del-N scores were computed for each subsample and used to rank order the needs assessment items. Spearman's rank order correlation coefficient was used to compare, by method, the scores from Subsample A with scores from Subsample B at each school. This information is tabulated below by school year and subject area. Tables 5 through 8 contain school name, the subsample correlation coefficients and associated p-values ($Ho:\rho = 0$) for each method, and number of teachers in each subsample. Only one of the coefficients in these tables equaled or exceeded .80 (Table 8, rDel-N A/B =

.89499 for Elementary School M), which was the level set for concluding that the within method indices were comparable.

Subsample Correlation Coefficients

Within method correlation coefficients for the three 1992-93 mathematics schools ranged from a low of .49243 for the correlation between Subsamples A and B on WNI at Middle School A to a high of .78376 for the Del-N correlation between the subsamples at Elementary School B (Table 5). For the four schools that focused on science during 1992-93, the lowest correlation coefficient obtained between subsamples was .45074 for the mean difference method at Elementary School C. The highest coefficient obtained was .73100 for Del-N at High School A (Table 6).

Table 5

Subsample A and Subsample B: Spearman Rank Order Correlation Coefficients and p-values for 1992-93 Schools Using the Mathematics Needs Assessment

| **School** | **r WNI A/B and p-value*** | **r Del-N A/B and p value*** | **r mean diff A/B and p-value*** | **Number in Subsample** |
|---|---|---|---|---|
| Elementary School A | .53119 (.0025) | .59511 (.0005) | .52496 (.0029) | A=15 B=15 |
| Elementary School B | .54105 (.0020) | .78376 (.0001) | .63862 (.0001) | A=17 B=16 |
| Middle School A | .49243 (.0057) | .72400 (.0001) | .64391 (.0001) | A=10 B=9 |

*p value for Ho:$\rho = 0$

Table 6

Subsample A and Subsample B: Spearman Rank Order Correlation Coefficients for 1992-93 Schools Using the Science Needs Assessment

| School | r WNI A/B and p-value* | r Del-N A/B and p value* | r mean diff A/B and p-value* | Number in Subsample |
|---|---|---|---|---|
| Elementary School C | .50292 (.0046) | .65109 (.0001) | .45074 (.0124) | A=7 B=7 |
| Elementary School D | .61455 (.0003) | .54467 (.0019) | .63064 (.0002) | A=10 B=9 |
| Elementary School E | .56398 (.0012) | .64426 (.0001) | .57028 (.0010) | A=10 B=9 |
| High School A | .70098 (.0001) | .73100 (.0001) | .71629 (.0001) | A=4 B=3 |

*p-value for Ho:$\rho = 0$

Among schools that participated during 1993-94, three focused on mathematics (Table 7). The lowest within method correlation coefficient obtained at these schools was .19657 for WNI at Middle School B. The highest was .61464 for Del-N at Elementary School F.

Table 7

Subsample A and Subsample B: Spearman Rank Order Correlation Coefficients for 1993-94 Schools that Used the Mathematics Needs Assessment

| School | r WNI A/B and p-value* | r Del-N A/B and p value* | r mean diff A/B and p-value* | Number in Subsample |
|---|---|---|---|---|
| Elementary School F | .44250 (.0143) | .61464 (.0003) | .58068 (.0008) | A=11 B=10 |
| Elementary School G | .27295 (.1445) | .27500 (.1413) | .22130 (.2399) | A=4 B=4 |
| Middle School B | .19657 (.2978) | .25418 (.1753) | .30380 (.1027) | A=5 B=4 |

*p-value for Ho:$\rho = 0$

Nine schools focused on science (Table 8). The lowest correlation between subsamples in this group was .13291 obtained on Del-N at High School B. Elementary School M had the highest, .89499 for Del-N. In fact, these two correlation coefficients for 1993-94 science schools were also the lowest and highest of all the subsample comparisons.

Table 8

Subsample A and Subsample B: Spearman Rank Order Correlation Coefficients for 1993-94 Schools Using the Science Needs Assessment

| School | r WNI A/B and p-value* | r Del-N A/B and p value* | r mean diff A/B and p-value* | Number in Subsample |
|---|---|---|---|---|
| Elementary School H | .35758 (.0524) | .58932 (.0006) | .40620 (.0259) | A=8 B=8 |
| Elementary School I | .51130 (.0039) | .64256 (.0001) | .57952 (.0008) | A=10 B=9 |
| Elementary School J | .67980 (.0001) | .68765 (.0001) | .63824 (.0001) | A=13 B=13 |
| Elementary School K | .72267 (.0001) | .64212 (.0001) | .56212 (.0012) | A=6 B=6 |
| Elementary School L | .74455 (.0001) | .68854 (.0001) | .56064 (.0013) | A=12 B=11 |
| Elementary School M | .74466 (.0001) | .89499 (.0001) | .78102 (.0001) | A=19 B=19 |
| Middle School C | .52627 (.0028) | .39043 (.0329) | .51848 (.0033) | A=6 B=6 |
| Middle School D | .34367 (.0630) | .48824 (.0062) | .38007 (.0383) | A=5 B=4 |
| High School B | .18253 (.3343) | .13291 (.4838) | .22888 (.2238) | A=3 B=2 |

*p-value Ho:$\rho = 0$

Patterns of Rankings for Subsamples with Low and High Correlations

For each of the lowest and highest subsample correlations from Tables 5 through 8, tables of the relevant subsample indices and their associated item rankings were developed. These tables allow comparisons to be made of the subsample sizes and the index values and their associated ranks for the methods with low and high subsample correlations.

In the reviewing Tables 9 through 12, it appears that the presence or absence of tied ranks affects the value of the rank order correlations. Table 9 contains the indices and rankings for the lowest and highest subsample correlations among 1992-93 mathematics focused schools. The lowest (.49243) was between the subsamples for WNI at Middle School A , where there were numerous ties in rankings for both subsamples, e.g., Questions 1, 7, 8, 17, and 22 all ranked 20 for Subsample A and Questions 11, 17, 22, and 29 all ranked 6.5 for Subsample B. In contrast, at Elementary School B, where the subsample correlation for Del-N was .78376, there were no ties for either subsample.

In Table 10, also for 1992-93, the ranks and index values for the science schools with lowest and highest subsample correlations are presented. The subsample correlation on mean difference between subsamples at Elementary School C, where there are numerous multi-way ties in the rankings for both subsamples, is .45074. On Del-N, High School A has a higher correlation coefficient, .73100, and a lower incidence of tied ranks. Tables 11 and 12 give indices and rankings for the 1993-94 mathematics and science schools with the lowest and highest subsample correlations. In both of these tables, a higher incidence of tied ranks in the subsamples is associated with lower rank order correlations between subsamples. This is particularly apparent for Middle School B in Table 11 and for High School B in Table 12. Middle School B's correlation for WNI is .19657, and there are virtually no untied rankings on WNI in either subsample. Ties seem to be less common with Del-N, but when they occur, as with High School B, they do affect the correlation. For Del-N at High School B, where the correlation coefficient is .13291, there are 3 two-way ties, 1 three way tie, and 2 four-way ties in Subsample A. In Subsample B, there are 2 three-way ties, 1 four-way tie, 1 eight-way tie, and 1 ten-way tie. It should also be noted that sample size has an effect. With smaller sample sizes, ties are more frequent. Middle School B had 5 teachers in Subsample A and 4 in Subsample B. At High School B there were 3 teachers in Subsample A and 2 teachers in Subsample B.

Table 9

Index Values and Associated Ranks for Questions 1 to 30 at 1992-93 Mathematics Schools Having the Lowest and Highest Subsample Correlations

**Lowest: Middle School A** nA=10 nB=9

r WNIA/WNIB=.49243 (p=.0057)

| Qst # | WNI Value A | Rank A | WNI Value B | Rank B |
|---|---|---|---|---|
| 1 | 0.66667 | 20 | 1.33333 | 24 |
| 2 | 0.88889 | 14.5 | 2.00000 | 11 |
| 3 | 0.22222 | 27 | 1.66667 | 18 |
| 4 | 1.00000 | 12 | 1.77778 | 16 |
| 5 | 0.88889 | 14.5 | 1.44444 | 23 |
| 6 | 0.77778 | 16.5 | 1.50000 | 22 |
| 7 | 0.66667 | 20 | 1.11111 | 25.5 |
| 8 | 0.66667 | 20 | 2.55556 | 3.5 |
| 9 | 1.00000 | 12 | 2.11111 | 9.5 |
| 10 | 1.44444 | 6 | 1.88889 | 13 |
| 11 | 0.77778 | 16.5 | 2.22222 | 6.5 |
| 12 | 1.33333 | 7 | 1.55556 | 20 |
| 13 | 1.00000 | 12 | 1.00000 | 28 |
| 14 | 1.11111 | 9 | 2.11111 | 9.5 |
| 15 | 1.11111 | 9 | 2.66667 | 2 |
| 16 | 0.22222 | 27 | 1.55556 | 20 |
| 17 | 0.66667 | 20 | 2.22222 | 6.5 |
| 18 | 1.77778 | 5 | 1.88889 | 13 |
| 19 | 0.22222 | 27 | 1.11111 | 25.5 |
| 20 | 0.11111 | 29.5 | 1.77778 | 16 |
| 21 | 0.55556 | 23.5 | 1.88889 | 13 |
| 22 | 0.66667 | 20 | 2.22222 | 6.5 |
| 23 | 0.55556 | 23.5 | 1.00000 | 28 |
| 24 | 0.11111 | 29.5 | 0.77778 | 30 |
| 25 | 0.44444 | 25 | 1.00000 | 28 |
| 26 | 1.11111 | 9 | 1.55556 | 20 |
| 27 | 2.44444 | 1 | 3.33333 | 1 |
| 28 | 2.33333 | 3 | 2.55556 | 3.5 |
| 29 | 2.33333 | 3 | 2.22222 | 6.5 |
| 30 | 2.33333 | 3 | 1.77778 | 16 |

**Highest:Elementary School B** nA=17 nB=16

r Del-NA/Del-NB=.78376 (p=.0001)

| Qst # | DelN Value A | Rank A | DelN Value B | Rank B |
|---|---|---|---|---|
| 1 | 0.15234 | 14 | 0.19835 | 9 |
| 2 | 0.19304 | 9 | 0.21786 | 7 |
| 3 | 0.08847 | 21 | 0.17212 | 13 |
| 4 | 0.19062 | 10 | 0.14729 | 17 |
| 5 | 0.06845 | 23 | 0.15059 | 15 |
| 6 | 0.26829 | 7 | 0.18508 | 12 |
| 7 | 0.05493 | 24 | 0.07722 | 24 |
| 8 | 0.15462 | 13 | 0.15030 | 16 |
| 9 | 0.10134 | 19 | 0.13419 | 18 |
| 10 | 0.33839 | 3 | 0.27429 | 4 |
| 11 | 0.11848 | 18 | 0.18703 | 11 |
| 12 | 0.14525 | 16 | 0.11645 | 20 |
| 13 | 0.08619 | 22 | 0.08417 | 22 |
| 14 | 0.29668 | 6 | 0.21700 | 8 |
| 15 | 0.09526 | 20 | 0.19276 | 10 |
| 16 | 0.03589 | 26 | 0.05095 | 28 |
| 17 | 0.03891 | 25 | 0.12153 | 19 |
| 18 | -0.07134 | 29 | 0.05753 | 27 |
| 19 | -0.10459 | 30 | 0.07833 | 23 |
| 20 | -0.04235 | 28 | -0.02437 | 30 |
| 21 | -0.03852 | 27 | 0.01957 | 29 |
| 22 | 0.16714 | 11 | 0.06812 | 26 |
| 23 | 0.14944 | 15 | 0.06904 | 25 |
| 24 | 0.13819 | 17 | 0.10623 | 21 |
| 25 | 0.19504 | 8 | 0.15965 | 14 |
| 26 | 0.41242 | 2 | 0.44332 | 2 |
| 27 | 0.15863 | 12 | 0.30664 | 3 |
| 28 | 0.30532 | 5 | 0.25874 | 6 |
| 29 | 0.42877 | 1 | 0.45924 | 1 |
| 30 | 0.31030 | 4 | 0.26759 | 5 |

Table 10

Index Values and Associated Ranks for Questions 1 to 30 at 1992-93 Science Schools Having the Lowest and Highest Subsample Correlations

**Lowest: Elementary School C** nA=7 nB=7

r MDiffA/MDiffB=.45074 (p=.0124)

| Qst # | Mean Diff Value A | Rank A | Mean Diff Value B | Rank B |
|---|---|---|---|---|
| 1 | 1.28571 | 12.5 | 2.00000 | 8 |
| 2 | 1.28571 | 12.5 | 1.42857 | 26.5 |
| 3 | 1.42857 | 8.5 | 1.28571 | 28.5 |
| 4 | 1.42875 | 8.5 | 1.42857 | 26.5 |
| 5 | 1.00000 | 21.5 | 1.171429 | 20.5 |
| 6 | 1.28571 | 12.5 | 1.71429 | 20.5 |
| 7 | 1.00000 | 21.5 | 1.57143 | 24.5 |
| 8 | 1.14286 | 16.5 | 1.85714 | 14.5 |
| 9 | 0.71429 | 27.5 | 1.28571 | 28.5 |
| 10 | 0.57143 | 29.5 | 1.85714 | 14.5 |
| 11 | 1.00000 | 21.5 | 2.00000 | 8 |
| 12 | 1.42857 | 8.5 | 1.71429 | 20.5 |
| 13 | 1.42857 | 8.5 | 2.00000 | 8 |
| 14 | 2.14286 | 3 | 2.42857 | 4 |
| 15 | 1.14286 | 16.5 | 1.71429 | 20.5 |
| 16 | 1.00000 | 21.5 | 1.71429 | 20.5 |
| 17 | 0.57143 | 29.5 | 1.57143 | 24.5 |
| 18 | 0.85714 | 25.5 | 1.14286 | 30 |
| 19 | 1.14286 | 16.5 | 1.85714 | 14.5 |
| 20 | 1.00000 | 21.5 | 1.85714 | 14.5 |
| 21 | 1.00000 | 21.5 | 1.71429 | 20.5 |
| 22 | 0.71429 | 27.5 | 2.00000 | 8 |
| 23 | 1.14286 | 16.5 | 2.00000 | 8 |
| 24 | 0.85714 | 25.5 | 1.85714 | 14.5 |
| 25 | 1.28571 | 12.5 | 2.00000 | 8 |
| 26 | 2.14286 | 3 | 2.71429 | 1 |
| 27 | 2.28571 | 1 | 2.00000 | 8 |
| 28 | 2.00000 | 5 | 2.57143 | 2.5 |
| 29 | 2.14286 | 3 | 2.57143 | 2.5 |
| 30 | 1.85714 | 6 | 1.85714 | 14.5 |

**Highest:High School A** nA=4 nB=3

r Del-NA/Del-NB=.73100 (p=.0001)

| Qst # | DelN Value A | Rank A | DelN Value B | Rank B |
|---|---|---|---|---|
| 1 | 0.22898 | 18 | 0.23910 | 13 |
| 2 | 0.07835 | 29 | 0.09707 | 24.5 |
| 3 | 0.08393 | 28 | 0.15655 | 21 |
| 4 | 0.42370 | 5 | 0.34932 | 7 |
| 5 | 0.17145 | 23 | 0.27262 | 9 |
| 6 | 0.17145 | 23 | 0.19007 | 15 |
| 7 | 0.21675 | 19 | 0.17218 | 19.5 |
| 8 | 0.37960 | 7 | 0.24956 | 12 |
| 9 | 0.28650 | 13 | 0.19007 | 15 |
| 10 | 0.07831 | 30 | 0.17218 | 19.5 |
| 11 | 0.27985 | 14 | 0.18436 | 17 |
| 12 | 0.20452 | 20 | 0.12198 | 23 |
| 13 | 016212 | 25 | 0.17280 | 18 |
| 14 | 0.35689 | 8 | 0.35580 | 6 |
| 15 | 0.30427 | 11 | 0.33211 | 8 |
| 16 | 0.17998 | 21 | -0.00337 | 28 |
| 17 | 0.15922 | 26 | -0.00337 | 28 |
| 18 | 0.15918 | 27 | 0.09707 | 24.5 |
| 19 | 0.35395 | 9 | -0.00337 | 28 |
| 20 | 0.23452 | 17 | 0.19007 | 15 |
| 21 | 0.27866 | 15 | 0.14911 | 22 |
| 22 | 0.24189 | 16 | 0.03622 | 26 |
| 23 | 0.33618 | 10 | 0.25694 | 10.5 |
| 24 | 0.29204 | 12 | 0.25694 | 10.5 |
| 25 | 0.17145 | 23 | -0.03689 | 30 |
| 26 | 0.39737 | 6 | 0.57390 | 5 |
| 27 | 0.69866 | 1 | 0.75752 | 1 |
| 28 | 0.63628 | 2 | 0.57453 | 3.5 |
| 29 | 0.59214 | 3 | 0.63339 | 2 |
| 30 | 0.47266 | 4 | 0.57453 | 3.5 |

Table 11

Index Values and Associated Ranks for Questions 1 to 30 at 1993-94 Mathematics Schools Having the Lowest and Highest Subsample Correlations

**Lowest: Middle School B** nA=5 nB=4

r WNIA/WNIB=.19657 (p=.2978)

| Qst # | WNI Value A | Rank A | WNI Value B | Rank B |
|---|---|---|---|---|
| 1 | 1.6 | 4.5 | 2.25 | 7 |
| 2 | 1.4 | 7.5 | 1.25 | 25.5 |
| 3 | 1.0 | 13.5 | 0.75 | 30 |
| 4 | 0.6 | 24.5 | 1.50 | 21.5 |
| 5 | 2.2 | 1 | 2.00 | 11 |
| 6 | 1.4 | 7.5 | 1.75 | 16.5 |
| 7 | 2.0 | 2.5 | 1.75 | 16.5 |
| 8 | 0.6 | 24.5 | 1.00 | 28.5 |
| 9 | 0.8 | 18.5 | 1.50 | 21.5 |
| 10 | 1.0 | 13.5 | 1.00 | 28.5 |
| 11 | 0.4 | 28.5 | 1.75 | 16.5 |
| 12 | 1.0 | 13.5 | 1.75 | 16.5 |
| 13 | 1.2 | 10.5 | 2.25 | 7 |
| 14 | 0.8 | 18.5 | 2.50 | 3.5 |
| 15 | 0.6 | 24.5 | 2.00 | 11 |
| 16 | 0.6 | 24.5 | 1.25 | 25.5 |
| 17 | 1.2 | 10.5 | 1.50 | 21.5 |
| 18 | 1.0 | 13.5 | 2.50 | 3.5 |
| 19 | 0.4 | 28.5 | 2.00 | 11 |
| 20 | 0.8 | 18.5 | 1.75 | 16.5 |
| 21 | 0.8 | 18.5 | 1.50 | 21.5 |
| 22 | 0.8 | 18.5 | 2.25 | 7 |
| 23 | 0.2 | 30 | 1.25 | 25.5 |
| 24 | 0.6 | 24.5 | 1.75 | 16.5 |
| 25 | 0.8 | 18.5 | 2.00 | 11 |
| 26 | 0.6 | 24.5 | 2.50 | 3.5 |
| 27 | 2.0 | 2.5 | 3.25 | 1 |
| 28 | 1.4 | 7.5 | 2.00 | 11 |
| 29 | 1.4 | 7.5 | 2.50 | 3.5 |
| 30 | 1.6 | 4.5 | 1.25 | 25.5 |

**Highest:Elementary School F** nA=11 nB=10

r Del-NA/Del-NB=.61464 (p=.0003)

| Qst # | DelN Value A | Rank A | DelN Value B | Rank B |
|---|---|---|---|---|
| 1 | 0.41262 | 7 | 0.33125 | 1 |
| 2 | 0.44887 | 5 | 0.24875 | 8 |
| 3 | 0.31351 | 20 | 0.12621 | 28 |
| 4 | 0.34864 | 14 | 0.22650 | 13 |
| 5 | 0.45792 | 4 | 0.24836 | 9 |
| 6 | 0.50973 | 1 | 0.26977 | 5 |
| 7 | 0.36935 | 12 | 0.23371 | 10 |
| 8 | 0.29068 | 22 | 0.10809 | 29 |
| 9 | 0.30435 | 21 | 0.14892 | 25 |
| 10 | 0.48103 | 2 | 0.31286 | 2 |
| 11 | 0.42253 | 6 | 0.21547 | 15 |
| 12 | 0.39124 | 9 | 0.19833 | 17 |
| 13 | 0.31638 | 19 | 0.21586 | 14 |
| 14 | 0.37784 | 11 | 0.25966 | 7 |
| 15 | 0.35658 | 13 | 0.23022 | 12 |
| 16 | 0.27072 | 25 | 0.15847 | 23 |
| 17 | 0.37919 | 10 | 0.14376 | 27 |
| 18 | 0.25674 | 27 | 0.23120 | 11 |
| 19 | 0.27612 | 23 | 0.10804 | 30 |
| 20 | 0.24604 | 28 | 0.17283 | 21 |
| 21 | 0.26199 | 26 | 0.17697 | 19 |
| 22 | 0.31729 | 18 | 0.27011 | 4 |
| 23 | 0.21527 | 30 | 0.14471 | 26 |
| 24 | 0.24095 | 29 | 0.17442 | 20 |
| 25 | 0.27244 | 24 | 0.15569 | 24 |
| 26 | 0.46981 | 3 | 0.26312 | 6 |
| 27 | 0.34424 | 15 | 0.16585 | 22 |
| 28 | 0.39898 | 8 | 0.19134 | 18 |
| 29 | 0.33950 | 16 | 0.28413 | 3 |
| 30 | 0.33267 | 17 | 0.20157 | 16 |

Table 12

Index Values and Associated Ranks for Questions 1 to 30 at 1993-94 Science Schools Having the Lowest and Highest Subsample Correlations

**Lowest: High School B** nA=3 nB=2

r Del-NA/Del-NB=.13291 (p=.4838)

| Qst # | DelN Value A | Rank A | Del N Value B | Rank B |
|---|---|---|---|---|
| 1 | 0.34995 | 10.5 | 0.33503 | 18 |
| 2 | 0.09571 | 29 | 0.27257 | 19.5 |
| 3 | 0.19007 | 26.5 | 0.24674 | 25.5 |
| 4 | 0.26677 | 19.5 | 0.54800 | 4.5 |
| 5 | 0.24956 | 23 | 0.39741 | 7.5 |
| 6 | 0.29046 | 15.5 | 0.39733 | 12.5 |
| 7 | 0.26677 | 19.5 | 0.37295 | 17 |
| 8 | 0.23325 | 25 | 0.27257 | 19.5 |
| 9 | 0.34995 | 10.5 | 0.39741 | 7.5 |
| 10 | 0.31580 | 13 | 0.24674 | 25.5 |
| 11 | 0.24956 | 23 | 0.24674 | 25.5 |
| 12 | 0.26677 | 19.5 | 0.39733 | 12.5 |
| 13 | 0.18024 | 28 | 0.39733 | 12.5 |
| 14 | 0.29046 | 15.5 | 0.54800 | 4.5 |
| 15 | 0.19007 | 26.5 | 0.54800 | 4.5 |
| 16 | 0.40880 | 5 | 0.24674 | 25.5 |
| 17 | 0.37301 | 7 | 0.24674 | 25.5 |
| 18 | 0.24956 | 23 | 0.24674 | 25.5 |
| 19 | 0.26677 | 19.5 | 0.39733 | 12.5 |
| 20 | 0.29046 | 15.5 | 0.39733 | 12.5 |
| 21 | 0.29046 | 15.5 | 0.39733 | 12.5 |
| 22 | 0.32625 | 12 | 0.39733 | 12.5 |
| 23 | 0.35739 | 8.5 | 0.24674 | 25.5 |
| 24 | 0.35739 | 8.5 | 0.39733 | 12.5 |
| 25 | 0.05611 | 30 | 0.24674 | 25.5 |
| 26 | 0.67497 | 3 | 0.24674 | 25.5 |
| 27 | 0.42323 | 4 | 0.54800 | 4.5 |
| 28 | 0.65708 | 2 | 0.69866 | 1.5 |
| 29 | 0.67497 | 1 | 0.69866 | 1.5 |
| 30 | 0.37369 | 6 | 0.24674 | 25.5 |

**Highest: Elementary School M** nA=19 nB=19

r Del-NA/Del-NB=.89499 (p=.0001)

| Qst # | DelN Value A | Rank A | DelN Value B | Rank B |
|---|---|---|---|---|
| 1 | 0.29644 | 21 | 0.26334 | 18 |
| 2 | 0.28278 | 24 | 0.25631 | 19 |
| 3 | 0.31706 | 18 | 0.21177 | 24 |
| 4 | 0.35755 | 13 | 0.34730 | 9 |
| 5 | 0.37973 | 8 | 0.31222 | 13 |
| 6 | 0.39421 | 6 | 0.38994 | 7 |
| 7 | 0.34437 | 15 | 0.38630 | 8 |
| 8 | 0.37754 | 10 | 0.31233 | 12 |
| 9 | 0.27364 | 26 | 0.16548 | 27 |
| 10 | 0.28421 | 23 | 0.16959 | 26 |
| 11 | 0.34428 | 16 | 0.29747 | 15 |
| 12 | 0.37886 | 9 | 0.34043 | 10 |
| 13 | 0.34777 | 14 | 0.32451 | 11 |
| 14 | 0.43643 | 5 | 0.47676 | 4 |
| 15 | 0.26309 | 27 | 0.24894 | 22.5 |
| 16 | 0.27888 | 25 | 0.15712 | 28 |
| 17 | 0.20709 | 30 | 0.12422 | 30 |
| 18 | 0.22967 | 29 | 0.14126 | 29 |
| 19 | 0.30585 | 20 | 0.26475 | 17 |
| 20 | 0.38707 | 7 | 0.27813 | 16 |
| 21 | 0.31062 | 19 | 0.30035 | 14 |
| 22 | 0.28678 | 22 | 0.24824 | 22.5 |
| 23 | 0.32122 | 17 | 0.25031 | 21 |
| 24 | 0.24334 | 28 | 0.20591 | 25 |
| 25 | 0.37022 | 12 | 0.25585 | 20 |
| 26 | 0.45496 | 4 | 0.44809 | 6 |
| 27 | 0.54425 | 1 | 0.59065 | 2 |
| 28 | 0.48792 | 2 | 0.53591 | 3 |
| 29 | 0.46841 | 3 | 0.60046 | 1 |
| 30 | 0.37392 | 11 | 0.44972 | 5 |

Judging from Tables 9 through 12, it is difficult to determine the exact effect that subsample size had on the values of the correlation coefficients. In Tables 9, 11, and 12, the schools with the highest subsample sizes did have the highest within method correlations: Elementary School B in Table 9 (nA=17, nB=16, rDelN A/B = .78376), Elementary School F in Table 11 (nA=11, nB=10, rDel-N A/B = .61464), and Elementary School M, Table 12 (nA=19, nB=19, rDelN A/B = .89499). But High School A in Table 10, with only 4 teachers in subsample A and 3 in subsample B, had a Del-N A/B correlation coefficient of .73100.

To depict the relationship between subsample size and coefficient values, a scatterplot of subsample correlation coefficients versus average subsample sizes is presented in Figure 16. At the upper left of the plot near .70 on the Y axis is an "A" for the .73100 Del-N A/B correlation for High School A. The two other observations in this location are the coefficients of .70098 and .71629 for WNI A/B and mean difference A/B at this school, which had an average subsample size of 3.5. Apart from these three discrepant observations, the plot portrays a positive linear relationship between coefficient values and average subsample size. In terms of the influence of these findings on the subsequent analyses, the exact effect of subsample size was inconclusive, with evidence that larger subsample sizes were associated with higher correlation coefficients (Figure 16).

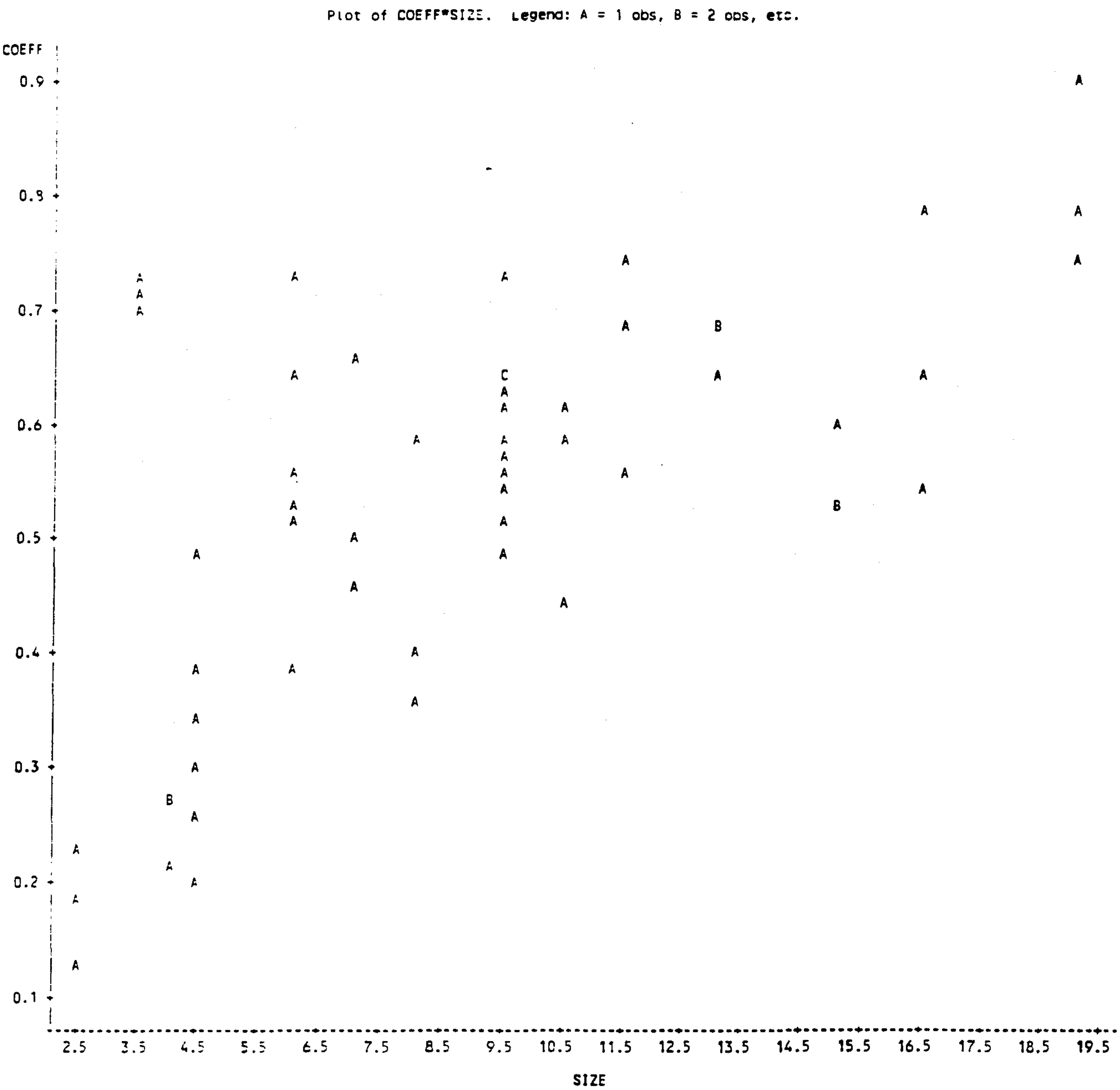


Figure 16.

Plot of Subsample Correlation Coefficients Versus Average Subsample Size

It was anticipated that sample size would be less of a factor in the main analysis, since sizes of the main samples were approximately twice that of the subsamples. It did seem clear that tied ranks in the subsample analysis affected the magnitude of the rank order correlation coefficients; thus, it was necessary assess the effect of ties on the rank order correlations calculated in the main analysis.

**Comparability of Mean Difference, WNI, and Del-N Scores**

The initial step in assessing the comparability of the mean difference, Del-N, and weighted needs index methods of scoring dual-response needs assessment surveys was to use each method to calculate scores for 30 items on the mathematics and science needs assessment surveys administered at the 19 schools in this study. For each participating school, the 30 survey items were then rank ordered based on each of the indices. Tables of the index values and associated item ranks for all three scoring methods were compiled by school and are included in Appendix B.

<u>Tabulation of Rank Orderings Based on the Three Scoring Methods</u>

The tables of the rank orderings for each method (Appendix B) allow visual assessment of their relative comparability. Two examples are provided in Tables 13 and 14 below, which present ranks of the 30 items for an elementary school that used the mathematics needs assessment in 1992-93 (Elementary School B, n = 33) and one that used the science assessment in 1993-94 (Elementary School K, n = 12). These two tables were selected for discussion here because they are representative of the general tendency at all 19 schools for the 30 items to be ranked similarly with all three methods.

Table 13 contains rankings on the mathematics assessment items for Elementary School B. Question 1 is ranked 13.5 with the mean difference, 12 with WNI, and 11 with Del-N. Question 2 received rankings of 11.5, 10, and 9 on mean difference, WNI, and Del-N, respectively. This basic pattern of similar rankings appears to hold throughout the table. The most discrepant rankings were for Question 8, which had ranks of 21 and 23 with mean difference and WNI, and a rank of 14.5 with Del-N; and for Question 22, which was ranked 11.5 and 11 on mean difference and WNI, but 19 with Del-N.

Table 14 includes questions on the science needs assessment at Elementary School K in 1993-94. Question 1 is ranked 5, 4, and 6. The rankings for Question 2 (16, 15, and 10) are not as similar. But similar rankings occur for Question 3: 25.5 with mean difference, 24 with WNI, and 22 with Del-N. Generally, the pattern of similar rankings holds throughout the table; however, there are discrepancies of 5 to 8.5 points between 11 of the rankings for Elementary School K. For example, Question 8 has ranks of 22 and 24 with the first two indices, but a rank of 19 with Del-N. And for Question 19, the WNI rank is 11.5, but the Del-N rank is 18, a discrepancy of 6.5 points. The largest discrepancy in Table 14 is for Question 25, where the WNI rank is 13.5 and the Del-N rank is 5 (a difference of 8.5).

Inspection of the tables of ranks for the remainder of the schools (Appendix B) indicates that this pattern of similar rankings for the majority of questions, with a minority having discrepant ranks, holds across schools for both the mathematics and the science needs assessments.

Table 13

Mean Difference, WNI, and Del-N Values with their Associated Ranks for Questions 1 to 30 at Elementary School B (n = 33)

| Question Number | Mean Diff Value | Mean Diff Rank | WNI Value | WNI Rank | Del-N Value | Del-N Rank |
|---|---|---|---|---|---|---|
| 1 | 0.90909 | 13.5 | 1.00000 | 12 | 0.17535 | 11 |
| 2 | 0.93939 | 11.5 | 1.06250 | 10 | 0.20545 | 9 |
| 3 | 0.72727 | 24.5 | 0.78788 | 20.5 | 0.12903 | 17 |
| 4 | 0.84848 | 17.5 | 0.87879 | 17 | 0.16961 | 12 |
| 5 | 0.84848 | 17.5 | 0.90909 | 16 | 0.10827 | 22 |
| 6 | 1.15152 | 8 | 1.18182 | 9 | 0.22794 | 8 |
| 7 | 0.75758 | 23 | 0.54545 | 26 | 0.06574 | 25 |
| 8 | 0.81818 | 21 | 0.66667 | 23 | 0.15253 | 14.5 |
| 9 | 0.69697 | 26 | 0.69697 | 22 | 0.11727 | 20 |
| 10 | 1.21212 | 6.5 | 1.37500 | 6 | 0.30634 | 3 |
| 11 | 0.96970 | 10 | 0.96875 | 13 | 0.15275 | 13 |
| 12 | 0.90909 | 13.5 | 0.93939 | 14.5 | 0.13129 | 16 |
| 13 | 0.81818 | 21 | 0.63636 | 24.5 | 0.08521 | 23 |
| 14 | 1.21212 | 6.5 | 1.36364 | 7 | 0.25805 | 6 |
| 15 | 0.87879 | 15 | 0.78788 | 20.5 | 0.14253 | 14.5 |
| 16 | 0.72727 | 24.5 | 0.63636 | 24.5 | 0.04319 | 26 |
| 17 | 0.81818 | 21 | 0.84848 | 18 | 0.07897 | 24 |
| 18 | 0.51515 | 27 | 0.43750 | 28 | -0.00691 | 27 |
| 19 | 0.48485 | 28.5 | 0.42424 | 29.5 | -0.01590 | 29 |
| 20 | 0.45455 | 30 | 0.42424 | 29.5 | -0.03363 | 30 |
| 21 | 0.48485 | 28.5 | 0.48485 | 27 | -0.01035 | 28 |
| 22 | 0.93939 | 11.5 | 1.06061 | 11 | 0.11913 | 19 |
| 23 | 0.84848 | 17.5 | 0.81818 | 19 | 0.11046 | 21 |
| 24 | 0.84848 | 17.5 | 0.93939 | 14.5 | 0.12269 | 18 |
| 25 | 1.03030 | 9 | 1.21212 | 8 | 0.17788 | 10 |
| 26 | 1.93939 | 1 | 2.30303 | 2 | 0.42740 | 2 |
| 27 | 1.30303 | 4 | 1.42424 | 5 | 0.23040 | 7 |
| 28 | 1.27273 | 5 | 1.45455 | 4 | 0.28274 | 4.5 |
| 29 | 1.84848 | 2 | 2.33333 | 1 | 0.44354 | 1 |
| 30 | 1.42424 | 3 | 1.71875 | 3 | 0.28894 | 4.5 |

Table 14

Mean Difference, WNI, and Del-N Values with their Associated Ranks for Questions 1 to 30 at Elementary School K (n = 12)

| Question Number | Mean Diff Value | Mean Diff Rank | WNI Value | WNI Rank | Del-N Value | Del-N Rank |
|---|---|---|---|---|---|---|
| 1 | 1.66667 | 5 | 2.45455 | 4 | 0.38645 | 6 |
| 2 | 1.25000 | 16 | 1.63636 | 15 | 0.33727 | 10 |
| 3 | 0.83333 | 25.5 | 0.91667 | 24 | 0.20377 | 22 |
| 4 | 0.08333 | 30 | 0.16667 | 30 | 0.13866 | 25 |
| 5 | 1.00000 | 22 | 1.08333 | 20.5 | 0.21861 | 21 |
| 6 | 1.50000 | 10 | 1.91667 | 10 | 0.32716 | 11 |
| 7 | 1.50000 | 10 | 1.83333 | 11.5 | 0.36105 | 8 |
| 8 | 1.00000 | 22 | 0.91667 | 24 | 0.29049 | 19 |
| 9 | 1.50000 | 10 | 2.00000 | 8.5 | 0.31188 | 13 |
| 10 | 083333 | 25.5 | 0.83333 | 26.5 | 0.11738 | 29 |
| 11 | 1.58333 | 6.5 | 2.16667 | 6 | 0.36882 | 7 |
| 12 | 1.00000 | 22 | 0.91667 | 24 | 0.20225 | 23 |
| 13 | 0.83333 | 25.5 | 0.75000 | 28 | 0.13308 | 26 |
| 14 | 1.91667 | 3 | 2.41667 | 5 | 0.45847 | 4 |
| 15 | 0.66667 | 29 | 0.83333 | 26.5 | 0.08001 | 30 |
| 16 | 1.08333 | 19.5 | 1.25000 | 19 | 0.18060 | 24 |
| 17 | 0.75000 | 28 | 0.58333 | 29 | 0.08204 | 29 |
| 18 | 0.83333 | 25.5 | 1.00000 | 22 | 0.10267 | 28 |
| 19 | 1.25000 | 16 | 1.83333 | 11.5 | 0.29302 | 18 |
| 20 | 1.33333 | 13.5 | 1.58333 | 16.5 | 0.30190 | 16 |
| 21 | 1.50000 | 10 | 2.08333 | 7 | 0.32454 | 12 |
| 22 | 1.08333 | 19.5 | 1.08333 | 20.5 | 0.26252 | 20 |
| 23 | 1.25000 | 16 | 1.58333 | 16.5 | 0.30043 | 17 |
| 24 | 1.16667 | 18 | 1.50000 | 18 | 0.30289 | 15 |
| 25 | 1.50000 | 10 | 1.75000 | 13.5 | 0.43666 | 5 |
| 26 | 1.58333 | 6.5 | 2.00000 | 8.5 | 0.34333 | 9 |
| 27 | 1.83333 | 4 | 2.66667 | 2 | 0.46539 | 2 |
| 28 | 2.25000 | 1 | 2.91667 | 1 | 0.49374 | 1 |
| 29 | 1.33333 | 13.5 | 1.75000 | 13.5 | 0.30451 | 14 |
| 30 | 2.00000 | 2 | 2.50000 | 3 | 0.46069 | 3 |

Calculating Difference Scores to Categorize Rank Similarities

To clarify the pattern of similarities and differences of rankings across methods, the various ranks generated for each method at every school (Appendix B) were compared with each other. For each school, the rankings for the mean difference method were compared with those from Del-N and with those from the weighted needs index. And the ranks from WNI were compared with those from Del-N. For each pairing (mean diff/Del-N, mean diff/WNI, and Del-N/WNI), a rank difference (D) was calculated by subtracting the rank of one index from the rank of another. If one method were labeled I and one method labeled II, the formula would be:

D = rank Ii - rank IIi

The absolute values of D were then used to categorize the similarity or dissimilarity between ranks for each of the 30 items. If the absolute value of the difference calculated between a pair of ranks was less than or equal to 2.5, it was categorized as *Similar* for that item. If D was between 3 and 4 ($3 \leq D \leq 4$), the item was categorized as *Moderately Similar*; and if D was greater than 4, it was categorized as *Dissimilar*. (Note: The numeric demarcations used in this study to differentiate the three categories were chosen because this investigator deemed differences in ranks of 0 to 2.5 across 30 items to be a reasonable degree of similarity, differences between 3 and 4 to be moderately similar, etc. Other investigators might select different boundaries, based on their own interpretation of similarity as well as on the number of items comprising the needs assessment being studied.)

For each of the pairings of ranks, i.e., mean diff/Del-N, mean diff/WNI, and Del-N/WNI, the number of items falling into each of the categories was counted and entered into the appropriate cell of Tables 15 through 18. These tables are divided by school and discipline. Tables 15 and 16 present the rank difference categorizations for 1992-93 mathematics schools (Table 15) and science schools (Table 16). Information for 1993-94 participating schools is included in Table 17 (mathematics) and Table 18 (science).

For 1992-93 schools, Elementary School A (Table 15) had 13 items categorized as *Similar* for rank differences between mean difference and Del-N. It had 17 items in the *Similar* Category for mean difference and WNI, and 12 *Similar* items for the rank differences between Del-N and WNI. Also at this school, 11, 8, and 6 items were categorized as *Moderately Similar* for mean difference/Del-N, mean difference/WNI, and Del-N/WNI, respectively. In the *Dissimilar* category, the numbers of items were 6, 5, and 12 across the three comparisons. A perusal of the other rank differences categorized in Table 15 reinforces the earlier observation that the rankings of items across the three indices tended to be similar. As they did with Elementary School A, the majority of rank differences in this table fall under the *Similar* category: 19, 22, and 21 items for Elementary School B and 24, 22, and 18 items for Middle School A.

Table 15

Similarities of Rankings for 1992-93 Schools that Used the Mathematics Needs Assessment (abbreviations in table: mdf=mean difference; del=Del-N; wni=weighted needs index)

| | Similar ± 2.5 | | | Mod. Sim. 3-4 | | | Dissimilar >4 | | | ΣD2 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **School** | **mdf del** | **mdf wni** | **del wni** | **mdf del** | **mdf wni** | **del wni** | **mdf del** | **mdf wni** | **del wni** | **mdf del** | **mdf wni** | **del wni** |
| Elem. School A | 13 | 17 | 12 | 11 | 8 | 6 | 6 | 5 | 12 | 480.5 | 413.5 | 662.0 |
| Elem. School B | 19 | 22 | 21 | 5 | 7 | 3 | 6 | 1 | 6 | 328.5 | 136.0 | 335.5 |
| Midd. School A | 24 | 22 | 18 | 6 | 5 | 9 | 0 | 3 | 3 | 111.0 | 182.5 | 235.0 |

This pattern of more rank differences in the *Similar* versus *Moderate* or *Dissimilar* categories holds throughout Tables 16, 17, and 18. In every case, the preponderance of items had rank differences with absolute values less than or equal to 2.5 and were classified as *Similar* as opposed to *Moderately Similar* or *Dissimilar*.

The *Similar* categorization of 24, 22, and 18 of the items from Middle School A (Table 15) was mentioned above. For this school, only 6, 5, and 9 items were in the *Moderate Similarity* category, and only 0, 3, and 3 were in the *Dissimilar* category. Middle School A exemplifies the most pronounced instance of items in the *Similar* category outnumbering those in the other two categories. One of the schools where this pattern is evident but less pronounced is Elementary School A, also in Table 15, where the dispersion across categories is more balanced.

One additional approach was employed to evaluate the similarity and dissimilarity of ranks. An overall difference index was calculated for each of the three method pairs (mean difference/Del-N, mean difference/WNI, and Del-N/WNI) at each school. For each method pair, the value of D on each of the 30 items was squared (thus eliminating negative values) and summed to calculate a value of $\Sigma D^2$ for that pairing. The quantity $\Sigma D^2$ represents the overall difference between the ranks assigned with one method and those assigned with another. The more ranks differ, the larger D and $D^2$ are; thus, larger values of $\Sigma D^2$ indicate less overall similarity between ranks. Values of $\Sigma D^2$ are included in Tables 15 through 18. Schools with larger values of $\Sigma D^2$ between two methods can be considered to have less similarity of rankings than schools with smaller values of $\Sigma D^2$ for that method.

For example, between the mean difference and Del-N ranks for Elementary School A (Table 15), the value of $\Sigma D^2$ is 480.5, compared to Middle School A's 111.0 $\Sigma D^2$ value. These values indicate that the ranks generated for the 30 items by mean difference and Del-N tended to be more similar for Middle School A than were the ranks on these two methods for Elementary School A. And that, for all three of the schools in this table, the ranks for Del-N and WNI tended to be more dissimilar than the ranks for mean difference and Del-N and the ranks for mean difference and WNI.

Table 16
Similarities of Rankings for 1992-93 Schools that Used the Science Needs Assessment (abbreviations in table: mdf=mean difference; del=Del-N; wni=weighted needs index)

| | Similar ± 2.5 | | | Mod. Sim. 3-4 | | | Dissimilar >4 | | | ΣD2 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **School** | **mdf del** | **mdf wni** | **del wni** | **mdf del** | **mdf wni** | **del wni** | **mdf del** | **mdf wni** | **del wni** | **mdf del** | **mdf wni** | **del wni** |
| Elem. School C | 19 | 17 | 20 | 4 | 5 | 3 | 7 | 8 | 7 | 516.0 | 389.5 | 471.0 |
| Elem. School D | 18 | 27 | 16 | 3 | 1 | 6 | 9 | 2 | 8 | 694.0 | 103.0 | 613.0 |
| Elem. School E | 23 | 22 | 18 | 4 | 6 | 2 | 3 | 2 | 10 | 274.0 | 214.5 | 365.5 |
| High School A | 22 | 13 | 17 | 3 | 7 | 6 | 5 | 10 | 7 | 295.9 | 817.0 | 562.0 |

In Table 16, the values of $\Sigma D^2$ calculated for the rank differences between mean difference and WNI range from a high of 817.0 for High School A to a low of 103.0 for Elementary School D. Thus, the ranks obtained with these two methods tended to be more similar at Elementary School D than they were at High School A. For the difference in ranks between Del-N and WNI, the value of $\Sigma D^2$ at Elementary School F (Table 17) is 912.5, because the ranks between these two methods tended to be dissimilar. In fact, only 12 of the rank differences between Del-N and WNI could be categorized as *Similar*; whereas, 7 were categorized as *Moderately Similar* and 11 were in the *Dissimilar* category.

Table 17
Similarities of Rankings for 1993-94 Schools that Used the Mathematics Needs Assessment (abbreviations in table: mdf=mean difference; del=Del-N; wni=weighted needs index)

| | Similar ± 2.5 | | | Mod. Sim. 3-4 | | | Dissimilar >4 | | | ΣD2 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **School** | **mdf del** | **mdf wni** | **del wni** | **mdf del** | **mdf wni** | **del wni** | **mdf del** | **mdf wni** | **del wni** | **mdf del** | **mdf wni** | **del wni** |
| Elem. School F | 16 | 16 | 12 | 4 | 8 | 7 | 10 | 6 | 11 | 846.0 | 253.0 | 912.5 |
| Elem. School G | 15 | 19 | 12 | 6 | 2 | 6 | 9 | 9 | 12 | 479.5 | 640.5 | 670.0 |
| Midd. School B | 21 | 22 | 18 | 4 | 2 | 4 | 5 | 6 | 8 | 225.5 | 207.5 | 451.5 |

In Table 18, the $\Sigma D^2$ value of 86.0 between the mean difference and WNI rankings at Elementary School J is the lowest in this table and in the preceding three tables. It strongly suggests a high degree of overall similarity between the rankings with these two methods. This is borne out by the fact that 28 rank differences were classified as *Similar* versus two categorized as *Moderately* Similar and none in the *Dissimilar* category.

Table 18
Similarities of Rankings for 1993-94 Schools that Used the Science Needs Assessment (abbreviations in table: mdf=mean difference; del=Del-N; wni=weighted needs index)

| | Similar ± 2.5 | | | Mod. Sim. 3-4 | | | Dissimilar >4 | | | ΣD2 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **School** | **mdf del** | **mdf wni** | **del wni** | **mdf del** | **mdf wni** | **del wni** | **mdf del** | **mdf wni** | **del wni** | **mdf del** | **mdf wni** | **del wni** |
| Elem. School H | 13 | 20 | 17 | 2 | 3 | 4 | 15 | 7 | 9 | 709.5 | 512.3 | 387.3 |
| Elem. School I | 21 | 21 | 22 | 3 | 4 | 2 | 6 | 5 | 6 | 355.5 | 254.5 | 322.0 |
| Elem. School J | 17 | 28 | 19 | 6 | 2 | 3 | 7 | 0 | 8 | 764.0 | 86.0 | 700.0 |
| Elem. School K | 21 | 25 | 18 | 5 | 4 | 3 | 4 | 1 | 9 | 202.5 | 111.0 | 353.0 |
| Elem. School L | 19 | 19 | 19 | 4 | 6 | 5 | 7 | 5 | 6 | 597.0 | 389.5 | 488.5 |
| Elem. School M | 20 | 26 | 20 | 3 | 1 | 1 | 7 | 3 | 9 | 518.5 | 197.5 | 535.0 |
| Midd. School C | 20 | 25 | 17 | 2 | 5 | 9 | 8 | 0 | 4 | 343.5 | 106.5 | 276.5 |
| Midd. School D | 19 | 22 | 20 | 4 | 2 | 4 | 7 | 6 | 6 | 392.0 | 352.5 | 315.0 |
| High School B | 16 | 14 | 20 | 5 | 6 | 2 | 9 | 10 | 8 | 533.5 | 566.0 | 565.5 |

A look at the formula for the Spearman rank order correlation coefficient given below will demonstrate how this use of $\Sigma D^2$ to assess the similarities of rankings relates to the next sections of this chapter, where results are reported for the rank order correlations calculated between all three pairings of methods for each of the 19 schools.

$$r\ ranks = 1 - \frac{6\sum_{i=1}^{n} D^2}{n(n^2-1)}$$

The quantity $\Sigma D^2$ appears in the numerator of the formula for r ranks. Not surprisingly, those schools which had the very highest (912.5, Elementary School F, Table 17) and lowest (86.0, Elementary School J, Table 18) values of $\Sigma D^2$ had the lowest (Elementary School F) and highest (Elementary School J) Spearman rank order correlation coefficients. (Note: R ranks is a special case of the Pearson product moment correlation and, if there are no tied ranks, the two formulas will give identical values when the ranks of the variables to be correlated are used. When there are tied ranks, the two formulas are not equivalent but will differ trivially (Glass & Hopkins, 1984).)

Spearman Rank Order Correlations Between Methods

Another method for assessing the relationship between the three approaches is to correlate the ranks from each index with rankings from each of the other indices. In Chapter III it was stated that if there is comparability between the indices, the value of the correlation coefficient computed between the rankings for any two methods would indicate a strong positive relationship; specifically, that Rho would equal or exceed .80.

Tables 19 through 22 present sample values of the Spearman rank order correlation coefficients for mathematics-focused schools and then for science-focused schools for the 1992-93 school year followed by tables for mathematics and science schools in the 1993-94 school year. The high and low sample values in each table are identified and discussed. Additionally, 95% confidence intervals (CI) using the low and high sample values in each table are constructed to provide an estimate of population parameters. Fisher's Z transformation was used. Because it is a large-sample procedure (n ≥30), unusually large intervals resulted for schools with small sample sizes.

Table 19 contains the Spearman rank order correlation coefficients between all three methods for schools that used the mathematics needs assessment in school year 1992-93. All correlation coefficients in the table exceed .85. The lowest, .85377, is between Del-N and WNI at Elementary School A. The highest, .97524, is between Middle School A's mean difference rankings and its Del-N rankings. A 95% confidence interval on the sample value .85377 is from .71272 to .92846. A 95% CI on .97524 is between .93536 and .99063. In both cases the research hypothesis of a population correaltion coefficient equaling or exceeding .80 is supported.

Table 19

Spearman Rank Order Correlation Coefficients for 1992-93 Schools Using the Mathematics Needs Assessment*

| School | r mean diff/del-n | r mean diff/wni | r del-n/wni | Number of teachers |
|---|---|---|---|---|
| Elementary School A | .88513 | .91232 | .85377 | 30 |
| Elementary School B | .92565 | .96967 | .92477 | 33 |
| Middle School A | .97524 | .95921 | .94763 | 19 |

*p-values (Ho:$\rho = 0$) for all correlation coefficients in this table $\leq .0001$

Correlation coefficients for 1992-93 schools using the science assessment are contained in Table 20. The lowest correlation coefficient in the table is .81647, between the mean difference and WNI methods at High School A. The highest coefficient is .97689 between the mean difference method and WNI at Elementary School D. The 95% CI for .81647 ranges from .16459 to .97193. (The sample size of only 7 for High School A affected the spread of this interval.) For the sample correlation of .97689 at Elementary School D, the 95% CI is between .93959 and .99126. In both cases, the hypothesized population correlation equal to or greater than .80 is supported.

Table 20

Spearman Rank Order Correlation Coefficients for 1992-93 Schools Using the Science Needs Assessment*

| School | r mean diff/del-n | r mean diff/wni | r del-n/wni | Number of teachers |
|---|---|---|---|---|
| Elementary School C | .90896 | .92820 | .89501 | 14 |
| Elementary School D | .84466 | .97689 | .86326 | 19 |
| Elementary School E | .93874 | .95197 | .91857 | 19 |
| High School A | .93387 | .81647 | .87450 | 07 |

*p-values (Ho:$\rho = 0$) for all correlation coefficients in this table $\leq .0001$

The following two tables present correlation coefficients for schools that used the needs assessment at the beginning of the 1993-94 school year. Coefficients for mathematics focused schools are included in Table 21. The coefficient of .79492 for the correlation between Del-N and WNI at Elementary School F is the lowest one in this table as well as the lowest value calculated for any of the comparisons across all 19 schools. A 95% CI on this sample value extends from a low of .55302 to a high of .91324. Middle School B's .95325 correlation coefficient between the mean difference method and WNI was the highest in this table. A 95% CI on this coefficient runs from .78796 to .99038. The confidence intervals for both the low and high values in this table support the hypothesis of a population correlation coefficient of .80 or greater.

Table 21

Spearman Rank Order Correlation Coefficients for 1993-94 Schools Using the Mathematics Needs Assessment*

| **School** | **r mean diff/del-n** | **r mean diff/wni** | **r del-n/wni** | **Number of teachers** |
|---|---|---|---|---|
| Elementary School F | .81071 | .94269 | .79492 | 21 |
| Elementary School G | .89208 | .85513 | .85025 | 08 |
| Middle School B | .94944 | .95325 | .89913 | 09 |

*p-values (Ho:$\rho$ = 0) for all correlation coefficients in this table $\leq$ .0001

Tabled values (Table 22) for the nine schools that focused on science in 1993-94 ranged from a low of .83988 (Elementary School H, mean diff/Del-N) to a high of .98350 (Elementary School J, mean diff/WNI). A 95% CI on Elementary School H's sample correlation of .83988 ranges from .58969 to .94299. For Elementary School J, .96302 and .99268, represent the 95% CI. In both instances, a hypothesized population correlation coefficient of .80 or greater is supported.

Table 22
Spearman Rank Order Correlation Coefficients for 1993-94 Schools Using the Science Needs Assessment*

| School | r mean diff/del-n | r mean diff/wni | r del-n/wni | Number of teachers |
|---|---|---|---|---|
| Elementary School H | .83988 | .88749 | .91465 | 16 |
| Elementary School I | .92064 | .94310 | .92825 | 19 |
| Elementary School J | .91888 | .98350 | .93143 | 26 |
| Elementary School K | .95699 | .97517 | .92272 | 12 |
| Elementary School L | .86680 | .91291 | .89110 | 23 |
| Elementary School M | .91124 | .95598 | .89203 | 38 |
| Middle School C | .92324 | .97616 | .93839 | 12 |
| Middle School D | .91219 | .92083 | .92974 | 09 |
| High School B | .87741 | .86885 | .87321 | 05 |

*p-values (Ho:$\rho = 0$) for all correlation coefficients in this table $\leq .0001$

In addition to hypothesizing that the correlation coefficients between the three scoring methods would equal or exceed .80, it was also hypothesized that the correlation coefficients would follow the pattern found by Cummings (1985). The hypothesized pattern was:

$$\rho\text{mean diff/Del-N} < \rho\text{mean diff/WNI} < \rho\text{Del-N/WNI}$$

In the tables below, the correlation coefficients for each method at every school are reported by year and content focus, just as in the preceding four tables. However, in the following tables, each school's correlation is classified as being either low (L), medium (M), or high (H) in relation to other correlations for that school. If the predicted pattern holds, the classifications for most of the schools should progress from L in the left-hand column containing mean difference/Del-N correlations to M in the middle column of correlations between the mean difference and WNI methods to H in the right-hand column of Del-N/WNI correlations

The expected pattern of correlations did not emerge for any of the schools participating in 1992-93. For all mathematics schools in that year, the correlations between Del-N and WNI, which were hypothesized to be the highest, were the lowest. For the science schools in 1992-93, two of the Del-N/WNI correlations were classified as low, and two were classified as medium.

Table 23

Classification of Spearman Rank Order Correlation Coefficients for 1992-93 Mathematics Schools: Hypothesized Pattern L M H

| School | r mean diff/del-n and classification | r mean diff/wni | r del-n/wni | Number of teachers |
|---|---|---|---|---|
| Elementary School A | .88513 H | .91232 M | .85377 L | 30 |
| Elementary School B | .92565 M | .96967 H | .92477 L | 33 |
| Middle School A | .97524 H | .95921 M | .94763 L | 19 |

Table 24

Classification of Spearman Rank Order Correlation Coefficients for 1992-93 Science Schools: Hypothesized Pattern L M H

| School | r mean diff/del-n and classification | r mean diff/wni and classification | r del-n/wni and classification | Number of teachers |
|---|---|---|---|---|
| Elementary School C | .90896 M | .92820 H | .89501 L | 14 |
| Elementary School D | .84466 L | .97689 H | .86326 M | 19 |
| Elementary School E | .93874 M | .95197 H | .91857 L | 19 |
| High School A | .93387 H | .81647 L | .87450 M | 07 |

Inspection of the following table shows that the correlation coefficient for the 1993-94 mathematics schools did not conform to the predicted pattern; in fact, the correlation between Del-N and WNI was the lowest rather than the highest in all cases.

Table 25
Classification of Spearman Rank Order Correlation Coefficients for 1993-94 Mathematics: Hypothesized Pattern L M H

| School | r mean diff/del-n and classification | | r mean diff/wni and classification | | r del-n/wni and classification | | Number of teachers |
|---|---|---|---|---|---|---|---|
| Elementary School F | .81071 | M | .94269 | H | .79492 | L | 21 |
| Elementary School G | .89208 | H | .85513 | M | .85025 | L | 08 |
| Middle School B | .94944 | M | .95325 | H | .89913 | L | 09 |

Among the 1993-94 schools that focused on science, the hypothesized pattern was in evidence in two instances, for Elementary School H and for Middle School D. But these were the only two places in the table where the hypothesized high classification of coefficients for the correlation between Del-N and WNI occurred.

Table 26
Classification of Spearman Rank Order Correlation Coefficients for 1993-94 Science Schools: Hypothesized Pattern L M H

| School | r mean diff/del-n and classification | | r mean diff/wni and classification | | r del-n/wni and classification | | Number of teachers |
|---|---|---|---|---|---|---|---|
| Elementary School H | .83988 | L | .88749 | M | .91465 | H | 16 |
| Elementary School I | .92064 | L | .94310 | H | .92825 | M | 19 |
| Elementary School J | .91888 | L | .98350 | H | .93143 | M | 26 |
| Elementary School K | .95699 | M | .97517 | H | .92272 | L | 12 |
| Elementary School L | .86680 | L | .91291 | H | .89110 | M | 23 |
| Elementary School M | .91124 | M | .95598 | H | .89203 | L | 38 |
| Middle School C | .92324 | L | .97616 | H | .93839 | M | 12 |
| Middle School D | .91219 | L | .92083 | M | .92974 | H | 09 |
| High School B | .87741 | H | .86885 | L | .87321 | M | 05 |

**Occurrences of Ties in the Rank Orderings Based on the Three Methods**

Tabulations of schools' rank orderings of needs assessment items based on the three scoring methods (Appendix B) were summarized in Tables 15 through 18 earlier in this chapter and used to explicate the general pattern of similarities of rankings among the three methods. Ranks, specifically tied ranks, will again be used, this time to illustrate some of the dissimilarities. Two tables from Appendix B are reproduced below. Table 27 presents indices and associated ranks for Elementary School F, which had the lowest between-method correlation coefficient (rDel-n/WNI = .79492) and the highest value of $\Sigma D^2$ (912.5, Del-N/WNI). The following discussion will contrast ties in these rankings with tied ranks from Elementary School J (Table 28), which had the highest between-method correlation coefficient (r mean diff/WNI = .98350; $\Sigma D^2$ mean diff/WNI =86.0).

Table 27

Mean Difference, WNI, and Del-N Values with their Associated Ranks for Questions 1 to 30 at Elementary School F (n = 21)

| Question Number | Mean Diff Value | Mean Diff Rank | WNI Value | WNI Rank | Del-N Value | Del-N Rank |
|---|---|---|---|---|---|---|
| 1 | 1.57143 | 4 | 2.04762 | 1 | 0.38549 | 5 |
| 2 | 1.38095 | 8.5 | 1.57143 | 9 | 0.38217 | 6 |
| 3 | 1.09524 | 18 | 1.42857 | 15.5 | 0.25107 | 21 |
| 4 | 0.95238 | 28 | 1.23810 | 23 | 0.30793 | 14 |
| 5 | 1.57143 | 4 | 1.76190 | 7 | 0.38807 | 4 |
| 6 | 1.61905 | 1.5 | 1.95238 | 4 | 0.42974 | 1 |
| 7 | 1.42857 | 7 | 1.95238 | 4 | 0.32414 | 11 |
| 8 | 1.00000 | 24.5 | 1.28571 | 21.5 | 0.22982 | 26 |
| 9 | 0.85714 | 29 | 1.04762 | 28 | 0.25254 | 20 |
| 10 | 1.57143 | 4 | 1.95238 | 4 | 0.42497 | 2 |
| 11 | 1.47619 | 6 | 1.85714 | 6 | 0.35351 | 7 |
| 12 | 1.38095 | 8.5 | 1.71429 | 8 | 0.32694 | 10 |
| 13 | 1.09524 | 18 | 1.42857 | 15.5 | 0.28287 | 19 |
| 14 | 1.04762 | 20.5 | 1.19048 | 25 | 0.33844 | 8 |
| 15 | 1.14286 | 15 | 1.47619 | 11 | 0.31446 | 13 |
| 16 | 1.04762 | 20.5 | 1.42857 | 15.5 | 0.23330 | 25 |
| 17 | 1.23810 | 10.5 | 1.52381 | 10 | 0.30071 | 16 |
| 18 | 1.00000 | 24.5 | 1.19048 | 25 | 0.24823 | 22 |
| 19 | 1.14286 | 15 | 1.38095 | 20 | 0.22010 | 28 |
| 20 | 1.00000 | 24.5 | 1.19048 | 25 | 0.22164 | 27 |
| 21 | 1.00000 | 24.5 | 1.28571 | 21.5 | 0.23365 | 23 |
| 22 | 1.23810 | 10.5 | 1.42857 | 15.5 | 0.30157 | 15 |
| 23 | 1.00000 | 24.5 | 0.95238 | 29 | 0.19175 | 30 |
| 24 | 1.00000 | 24.5 | 1.14286 | 27 | 0.21877 | 29 |
| 25 | 0.76190 | 30 | 0.85714 | 30 | 0.23353 | 24 |
| 26 | 1.61905 | 1.5 | 2.00000 | 2 | 0.40091 | 3 |
| 27 | 1.14286 | 15 | 1.42857 | 15.5 | 0.28477 | 18 |
| 28 | 1.19048 | 12.5 | 1.42857 | 15.5 | 0.32977 | 9 |
| 29 | 1.19048 | 12.5 | 1.42857 | 15.5 | 0.32104 | 12 |
| 30 | 1.09524 | 18 | 1.42857 | 15.5 | 0.28897 | 17 |

Table 28

Mean Difference, WNI, and Del-N Values with their Associated Ranks for Questions 1 to 30 at Elementary School J (n = 26)

| Question Number | Mean Diff Value | Mean Diff Rank | WNI Value | WNI Rank | Del-N Value | Del-N Rank |
|---|---|---|---|---|---|---|
| 1 | 1.03846 | 13 | 1.15385 | 13 | 0.20549 | 15 |
| 2 | 0.69231 | 28 | 0.65385 | 26.5 | 0.13006 | 22 |
| 3 | 0.76923 | 24 | 0.69231 | 24.5 | 0.08879 | 26 |
| 4 | 0.88462 | 18 | 0.96154 | 18 | 0.25005 | 11 |
| 5 | 0.88462 | 18 | 0.88462 | 20 | 0.12940 | 23 |
| 6 | 1.11538 | 9.5 | 1.23077 | 10.5 | 0.22094 | 13 |
| 7 | 0.96154 | 15 | 1.11538 | 14.5 | 0.18164 | 18 |
| 8 | 1.07692 | 11 | 1.26923 | 9 | 0.27498 | 9 |
| 9 | 0.84615 | 20 | 0.76923 | 21.5 | 0.12580 | 24 |
| 10 | 0.73077 | 26.5 | 0.69231 | 24.5 | 0.07782 | 28 |
| 11 | 1.26923 | 6.5 | 1.34615 | 7.5 | 0.27811 | 8 |
| 12 | 1.11538 | 9.5 | 1.19231 | 12 | 0.28013 | 7 |
| 13 | 1.03846 | 13 | 1.11538 | 14.5 | 0.17232 | 19 |
| 14 | 1.50000 | 4 | 1.73077 | 5 | 0.32434 | 5 |
| 15 | 0.76923 | 24 | 0.76923 | 21.5 | 0.16604 | 20 |
| 16 | 0.76923 | 24 | 0..57692 | 28 | 0.07935 | 27 |
| 17 | 0.53846 | 29 | 0.26923 | 29 | 0.01446 | 29 |
| 18 | 0.46154 | 30 | 0.23077 | 30 | -0.03312 | 10 |
| 19 | 0.73077 | 26.5 | 0.65385 | 26.5 | 0.12017 | 25 |
| 20 | 0.88462 | 18 | 1.07692 | 16 | 0.13437 | 21 |
| 21 | 1.26923 | 6.5 | 1.56000 | 6 | 0.30182 | 6 |
| 22 | 0.80769 | 21.5 | 0.96000 | 19 | 0.22878 | 12 |
| 23 | 0.92308 | 16 | 1.00000 | 17 | 0.20175 | 16 |
| 24 | 1.19231 | 8 | 1.34615 | 7.5 | 0.25871 | 10 |
| 25 | 0.80769 | 21.5 | 0.73077 | 23 | 0.19886 | 17 |
| 26 | 1.61538 | 3 | 1.96154 | 2 | 0.34965 | 4 |
| 27 | 2.11538 | 1 | 2.84615 | 1 | 0.49762 | 1 |
| 28 | 1.69231 | 2 | 1.92308 | 3 | 0.43333 | 2 |
| 29 | 1.46154 | 5 | 1.76923 | 4 | 0.35933 | 3 |
| 30 | 1.03846 | 13 | 1.23077 | 10.5 | 0.21931 | 14 |

Twenty-one teachers at Elementary School F took the needs assessment, and 26 took it at Elementary School J. Sample size was greater than 20 at each school and so does not seem to account for School F having the lowest overall correlation of ranks versus School J's having the highest. Looking at Table 27 to assess the pattern of rankings for WNI compared to those for Del-N, there are numerous tied ranks for WNI as opposed to no ties for Del-N. Using WNI to rank the 30 questions, there is 1 two-way tie (Questions 8 and 21 ranked 21.5), there are 2 three-way ties (Questions 6, 7, and 10 ranked 4 and Questions 14, 18, and 20 ranked 25), and there is 1 eight-way tie (Questions 3, 13, 16, 22, 27, 28, 29, and 30 ranked 15.5). Thus, when ranks on the two methods were correlated, the resulting coefficient was affected because there were 30 different rank numbers possible for Del-N but, due to the ties, only 18 different rank numbers possible for WNI. Del-N had possible rank numbers ranging from 1 to 30, but WNI only had rank numbers 1, 2, 4 (three-way tie), 6, 7, 8, 9, 10, 11, 15.5 (eight-way tie), 20, 21.5 (two-way tie), 23, 25 (three-way tie), 27, 28, 29, and 30.

In examining the mean difference and WNI rankings in Table 28 for patterns of ties that might be related to the this school's highest overall between method correlation coefficient (r mean diff/WNI = .98350), there are tied ranks for both mean difference and WNI. They tend to be one- to three-way ties, evenly dispersed across the 30 items for both indices. This pattern of ties does not appear to have negatively affected the strength of the relationship between the ranks. For the mean difference rankings, there are 4 two-way ties and 3 three-way ties in the mean difference rankings, and 6 two-way ties for WNI. Specifically, the mean difference ties are Questions 11 and 21, ranked 6.5; Questions 6 and 12, ranked 9.5; Questions 1, 13, and 30, ranked 13; Questions 4, 5, and 20, ranked 18;

Questions 22 and 25, ranked 21.5; Questions 3, 15, and 16, ranked 24; and Questions 10 and 19, ranked 26.5. The ties for WNI include Questions 11 and 24, ranked 7.5; Questions 6 and 30, ranked 10.5; Questions 7 and 13, ranked 14.5; Questions 9 and 15, ranked 21.5; Questions 3 and 10, ranked 24.5; and Questions 2 and 19, ranked 26.5. With the tied rankings, there were 20 different numeric ranks possible for mean difference method; and 24 possible numeric ranks for WNI.

The primary difference between the pattern of ties for Elementary School J, with its highest overall correlation, and Elementary School F, with its lowest overall correlation, is that School J had lower-way ties evenly spread throughout the ranks on both indices in the correlation (mean difference and WNI); whereas, School F had no tied ranks on one of the indices in the correlation (Del-N) and an eight-way tie on the other (WNI).

The tables below were developed to summarize occurrences of tied ranks for all 19 schools in the study. As in the preceding sections, data are tabulated separately by school year and subject matter focus. In Tables 29-32, ties occurring with each method are classified as two-way ties, three-way ties, or four- or higher-way ties. A ties index has also been computed for every method at each school. The number of two-way ties with a given method was multiplied by 2; the number of three-way ties was multiplied by 3; and each higher-way tie was multiplied by its number of ties (4 or greater). With this latter approach for higher-way ties, the index of a school like School F, with its eight-way tie, was weighted accordingly.

Because the ties index does not figure directly into the rank order correlation as does $\Sigma D^2$, there is not a direct formulaic link between the index and the various high and low correlation coefficients computed. Certain patterns regarding ties, however, are apparent in Tables 29-31. Review of columns in each of these tables where the numbers of ties on each index is classified as *Two-Way*, *Three-Way* or *Higher-Way*, shows that two-way ties tend to occur more often than three-way ties, and three-way ties are more frequent than higher-way ties.

Table 29
Classifications of Tied Ranks for 1992-93 Schools that Used the Mathematics Needs Assessment

| | Two-Way | | | Three-Way | | | Higher-Way | | | Ties Index | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **School** | **mdf** | **wni** | **del** | **mdf** | **wni** | **del** | **mdf** | **wni** | **del** | **mdf** | **wni** | **del** |
| Elem. School A | 3 | 6 | 0 | 3 | 2 | 0 | 0 | 0 | 0 | 15 | 18 | 0 |
| Elem. School B | 5 | 3 | 2 | 1 | 0 | 0 | 1 | 0 | 0 | 17 | 6 | 4 |
| Midd. School A | 4 | 4 | 0 | 3 | 3 | 0 | 1 | 0 | 0 | 21 | 17 | 0 |
| | | | | | | | | | | Σ53 | Σ41 | Σ4 |

Table 30
Classifications of Tied Ranks for 1992-93 Schools that Used the Science Needs Assessment

| | Two-Way | | | Three-Way | | | Higher-Way | | | Ties Index | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **School** | **mdf** | **wni** | **del** | **mdf** | **wni** | **del** | **mdf** | **wni** | **del** | **mdf** | **wni** | **del** |
| Elem. School C | 4 | 4 | 0 | 1 | 1 | 0 | 2 | 1 | 0 | 26 | 15 | 0 |
| Elem. School D | 3 | 2 | 0 | 2 | 3 | 0 | 2 | 1 | 0 | 22 | 17 | 0 |
| Elem. School E | 7 | 5 | 0 | 1 | 2 | 0 | 1 | 0 | 0 | 23 | 16 | 0 |
| High School A | 2 | 5 | 0 | 3 | 2 | 0 | 3 | 1 | 0 | 26 | 21 | 0 |
| | | | | | | | | | | Σ97 | Σ69 | Σ0 |

Table 31

Classifications of Tied Ranks for 1993-94 Schools that Used the Mathematics Needs Assessment

| | Two-Way | | | Three-Way | | | Higher-Way | | | Ties Index | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **School** | **mdf** | **wni** | **del** | **mdf** | **wni** | **del** | **mdf** | **wni** | **del** | **mdf** | **wni** | **del** |
| Elem. School F | 5 | 1 | 0 | 3 | 2 | 0 | 1 | 1 | 0 | 25 | 16 | 0 |
| Elem. School G | 2 | 3 | 1 | 0 | 2 | 0 | 4 | 2 | 0 | 25 | 21 | 2 |
| Midd. School B | 2 | 3 | 0 | 2 | 4 | 0 | 3 | 2 | 0 | 25 | 26 | 0 |
| | | | | | | | | | | Σ75 | Σ63 | Σ2 |

Table 32

Classifications of Tied Ranks for 1993-94 Schools that Used the Science Needs Assessment

| | Two-Way | | | Three-Way | | | Higher-Way | | | Ties Index | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **School** | **mdf** | **wni** | **del** | **mdf** | **wni** | **del** | **mdf** | **wni** | **del** | **mdf** | **wni** | **del** |
| Elem. School H | 5 | 6 | 0 | 1 | 2 | 0 | 1 | 1 | 0 | 22 | 22 | 0 |
| Elem. School I | 3 | 4 | 0 | 2 | 1 | 0 | 2 | 1 | 0 | 20 | 21 | 0 |
| Elem. School J | 4 | 6 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 17 | 12 | 0 |
| Elem. School K | 3 | 6 | 0 | 2 | 1 | 0 | 2 | 0 | 0 | 21 | 15 | 0 |
| Elem. School L | 4 | 3 | 0 | 3 | 4 | 0 | 1 | 0 | 0 | 21 | 18 | 0 |
| Elem. School M | 3 | 6 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 12 | 12 | 0 |
| Midd. School C | 3 | 7 | 0 | 2 | 2 | 0 | 3 | 0 | 0 | 24 | 20 | 0 |
| Midd. School D | 4 | 5 | 1 | 1 | 2 | 0 | 3 | 1 | 0 | 27 | 20 | 2 |
| High School B | 4 | 3 | 3 | 0 | 4 | 1 | 3 | 2 | 0 | 29 | 28 | 9 |
| | | | | | | | | | | Σ193 | Σ159 | Σ11 |

Among all four of these tables, there were few occurrences of tied ranks when Del-N was used. There were 2 two-way ties at Elementary School B with Del-N (Table 29), and there was 1 two-way Del-N rank tie at Elementary School G (Table 31). Middle School D had a single two-way tie with Del-N, and High School B had 3 two-way ties with this index (Table 32).

When the index of ties is summed by method for each table (see summation row under the Ties Index section of Tables 29-32), the summation is highest for the mean difference method in every table: 53 in Table 29, 97 in Table 30, 75 in

Table 31, and 193 in Table 32. In every table, Del-N had the lowest index sum: 4 in Table 29, 0 in Table 30, 2 in Table 31, and 11 in Table 32. Sums for the weighted needs fell between the high values on mean difference and the low values on Del-N. Specifically, the WNI sums on the ties index were 41 in Table 29, 69 in Table 30, 63 in Table 31, and 159 in Table 32.

Few if any ties were found in Cummings (1985) study; however, there were numerous instances of ties in this study. The implications of tied ranks for prioritizing areas of need and for choosing among the three scoring methods will be discussed in Chapter V.

# CHAPTER V
# DISCUSSION

In the preceding chapters of this dissertation, an overview was given of the use of needs assessment in educational evaluation, and various data gathering approaches were described. Typical formats for dual-response needs assessment surveys were reviewed along with three methods (mean difference, Weighted Needs Index, and Del-N) commonly used for scoring such surveys. Cummings' 1985 investigation found the three methods to be comparable for ranking items on a needs assessment in a business setting. This study was undertaken to evaluate their comparability in 19 public schools in North Carolina. The results of that investigation, presented in Chapter IV, are discussed in this chapter. The initial section focuses on limitations of the study. In the following sections, results of the stability and subsample analyses are discussed. The penultimate section reviews evidence found in support of the research hypotheses, and the final section outlines applications of the findings for scoring needs assessments in educational settings and discusses implications for further study.

## Limitations of the Study

Data from a mathematics or a science needs assessment administered at 19 North Carolina schools during 1992-93 and 1993-94 were used in this study. The schools were chosen purposefully, rather than randomly. System administrators in several school districts in the central part of the state were invited to select schools in their district to participate in a planning process which included administration of the needs assessment. They were instructed to focus on schools with a high percentage of minority students or students in poverty, or on schools in rural areas. Hence, the findings of this study may not be generalizable to affluent schools or to schools in urban areas.

The two needs assessment instruments administered in this study related to mathematics and science. Both were based on standards of exemplary practice in their respective fields. If needs assessments developed in other content areas are also grounded in the accepted practice standards of their disciplines, there is reason to believe the comparability of the scoring methods will carry over. However, caution should be exercised in generalizing the findings of this study to the scoring of needs assessments in other content areas. Ideally, pilot studies should be conducted to assess evidence of comparability across disciplines.

The numbers of respondents at the 19 participating schools ranged from 5 to 38. Including the school with five respondents, a total of eight schools in the sample had less than 15 respondents. Sample sizes at the other schools were 15 or more; however, the sample sizes at these schools could also have affected the results. Additionally, small sample sizes were a factor in the subsample analysis. The needs assessment responses of teachers at each school in the sample were randomly divided into two subsamples in order to conduct a within method analysis of the three scoring methods. Ten of the 38 subsamples had five respondents or less, including one subsample that contained only two respondents. Correlation coefficients calculated between the subsamples ranged from a low of .13 at a school with 2 and 3 teachers in the subsamples to a high of .89 at a school with both subsamples containing 19 teachers. A more effective subsample study would result if sample sizes in the schools were large enough to yield subsamples of at least 10 teachers; this would limit the study to schools with 20 or more teachers.

In most of the analyses in this study, the ranks associated with various values of the mean difference, Del-N, and WNI scoring methods were used, rather than the actual numeric values of the indices. Thus, when any one of the indices was used to prioritize needs at different schools, different ranks might be assigned to items for which the actual magnitude of index values differed greatly at one school and trivially at another. Illustrative Del-N data from hypothetical Schools Y and Z will be used to discuss this point (Table 33). At School Y, hypothetical Del-N index values of 1 for Item 1, 5 for Item 2, and 3 for Item 3 would have resulted in a rank of 1 for Item 2 (recall, higher index values indicate higher need and thus a rank priority of 1), a rank of 2 for Item 3, and a rank of 3 for Item 1. At School Z, hypothetical Del-N index values of 1.1 for Item 1, 1.3 for Item 2, and 1.2 for Item 3, would have resulted in item ranks identical to those for School Y. Item 2, which was prioritized as 1 at both schools, differed by 4 and 2 index points, respectively, from Items 1 and 3 at School Y; but it differed by only .1 of an index value point from Items 1 and 3 at School Z.

Table 33
Illustrative Data on Index Values and Ranks for Hypothetical Schools Y and Z

| School Y | | | School Z | | |
|---|---|---|---|---|---|
| Item # | Index Value | Rank | Item # | Index Value | Rank |
| 1 | 1 | 3 | 1 | 1.1 | 3 |
| 2 | 5 | 1 | 2 | 1.3 | 1 |
| 3 | 3 | 2 | 3 | 1.2 | 2 |

At School Z, the index value difference between the top ranked item and items ranked below it was very small, only one-tenth of a point; whereas at School Y, the difference between the top-ranked item and those following it was two index value points or more. In a study such as this, which makes extensive use of ranks, certain issues of numeric magnitude may be obscured.

**The Stability Analysis**

In the stability analysis for the Weighted Needs Index (WNI), four cell weighting schemes were used to vary the basic formula, and then the variants were correlated with the basic formula. Rank order correlation coefficients calculated for the stability analysis ranged from a low of .80 to a high of .95, indicating adequate levels of stability under different weighting schemes. The two variants which, like WNI itself, had a weight of zero for the 3-3 cell of the *Importance/Achievement* matrix correlated more closely with the basic index than did the forms with whole number or unit weights in the 3-3 cell. Of these, WNIb correlated most closely with the basic index ($r = .95$), indicating that WNI would remain most stable under weighting scheme variations based on graduated whole numbers with a zero weight in the 3-3 cell. Conversely, the study results revealed no reason to use a variant, as opposed to the weighting scheme specified in the basic WNI formula.

To assess the stability of Del-N, the basic formula was compared to two weighting scheme variations and two variations in the expected marginal probabilities. When cell weights were based on a symmetric matrix of whole numbers from 9 to 1, the rank order correlation with the original index was .92 at one elementary school used in the stability analysis and .91 at a second. This indicates an acceptable level of stability. When a matrix of unit weights was used, no rank order correlation could be calculated between the basic index and this variant. The index values calculated under unit weighting were the same for all 30 questions; thus, the questions could not be rank ordered. The aim of using any one of the indices investigated in this study is to rank order items on a needs assessment. The outcome of the Del-N stability analysis using unit weights suggests that unit weighting is not an appropriate variant for prioritizing needs with Del-N.

When sets of expected marginal probabilities postulating a normal and a uniform distribution for Del-N were used, the ranks obtained with these variants were identical to those obtained with the basic index and, thus, correlated perfectly with it. If the rank orderings are the same with one of these variants, why employ it versus using the basic formula? The values of the indices under the postulated normal and uniform distributions do vary, suggesting an area for further study.

**Subsample Analyses**

Generally, the pattern of correlations obtained for the within method comparisons of the rankings for each of the indices in Subsamples A and B at each school was not strong. All coefficients were positive; but, with few exceptions, they tended to be moderate to low. As mentioned earlier, the small subsample sizes at certain of the schools were associated with lower correlations. For example, the Del-N subsample rank order correlation for High School B, which had 3 teachers in Subsample A and 2 teachers in Subsample B, was .13 (Table 8). On the other hand, High School A (Table 6), which had 4 and 3 teachers in its subsamples, had subsample correlation coefficients above .70 for all three of the indices. In Chapter IV, Table 10 includes rankings for High School A and Table 11 includes selected rankings for High School B. Discussion related to these tables notes the presence of multiple tied ranks for High School B compared to fewer ties for High School A. This pattern of ties affecting values of the correlation coefficients appears throughout the within method subsample comparisons as well as in the between method comparisons with the main data set. Within the subsample analysis, one way to differentiate effects due to small sample sizes versus effects due to ties would be to have, as suggested above, school sizes large enough in the main sample to allow for subsample sizes of at least 10.

**Support for the Research Hypotheses**

In this study, the mean difference, WNI, and Del-N methods were used to score dual-response mathematics or science needs assessments administered to teachers at 19 schools. For each school, the 30 needs assessment items were then rank ordered based on each index; and rank order correlation coefficients were calculated between index pairs.

It was hypothesized that if the indices were comparable, the correlation coefficients computed would equal or exceed .80. To compare three indices with each other across 19 schools, a total of 57 correlation coefficients were calculated. All of these (Tables 19 through 22) except one exceeded .80. The exception was the correlation coefficient of .79 calculated between Del-N and WNI at Elementary School F. Tables 19 through 22 report the various correlations by school year and by subject, either mathematics or science. The pattern of sample correlation coefficients exceeding .80 held across tables, with no obvious higher or lower values associated with any one school year or subject area. The sample values indicated strong support for the research hypothesis as stated. And the 95%

confidence intervals constructed for the low and high sample values in each table confirmed this support.

A further assumption, with the hypothesis of comparability of methods supported, would be a relative interchangeability of methods, since any of the three methods could be expected to yield reasonably similar patterns of rankings for needs assessment items. However, other factors should be considered when selecting one or the other of the methods for scoring a needs assessment. Prior to discussing these, the support of lack of support for the second research hypothesis of this study will be evaluated.

The second research hypothesis postulated an expected pattern of lower values of the rank order correlation coefficients between less computationally similar methods and higher values between methods that were more computationally similar. Specifically, it was hypothesized that the correlation between the mean difference and Del-N methods would be lower than the correlation between the mean difference method and WNI, and that the correlation between Del-N and WNI would be higher than that between either of the other two methods. To assess support for this hypothesis, the sample correlation coefficients calculated for each school were arranged by year and subject in Tables 23 through 26 in the hypothesized order, i.e., beginning with mean difference and Del-N, then mean difference and WNI, and ending with Del-N and WNI. Within each school, the tabled values of the sample coefficients were then classified as either low (L), medium (M), or high (H); and these classifications were entered into the tables. In only 2 out of 19 cases, both in the table for 1993-94 science schools (Elementary School H and Middle School D), did the hypothesized pattern emerge among the sample values. In most cases the pattern was the opposite of that expected, with the Del-N/WNI correlation being the lowest. The research hypothesis about the expected pattern of correlation coefficients was not supported by the sample data.

**Implications for Scoring Needs Assessments in Educational Settings**

The introduction to this paper stated that, because important programmatic decisions are often based on needs assessment outcomes, accuracy in the assessment of need is vital. If a needs assessment survey is used, the accuracy of the need assessed will be influenced by the method used in scoring the assessment. The three scoring methods investigated in this study appear to be comparable, but they should not be considered interchangeable. There are numerous factors to consider when selecting one or the other of these methods.

If a numeric assessment of need and the prioritization that can be generated with numbers are needed, all of the methods in this study would be potential candidates. The needs assessor, the needs assessment clients, and/or the needs assessment participants might want numeric measures for several reasons. One reason would be to allow comparisons of levels of need at the beginning of the planning process and again at the end, after programs have been implemented to meet identified needs. Either the mean difference, WNI, or Del-N methods would be useful for a before and after assessment in order to compare levels of need.

Numeric indices are also appropriate in situations where resources are limited and only the most urgent needs can be addressed. In such a case, numeric indices of need are necessary. A method that generates a strict prioritization of need should be used, and methods that are subject to ties should not be used. Tied ranks occurred with all of the methods included in this study, but Del-N was much less prone to ties than the mean difference and WNI methods (Tables 29 through

32). There were ties with the Del-N method at only 4 of the 19 schools in the study; whereas, there were ties with the mean difference and WNI methods at all 19 schools. Based on this information, Del-N would be the method of choice if the objective is strict prioritization of needs, so that limited resources can be directed to the areas of greatest need.

The computational complexity of Del-N was mentioned earlier in this paper. Customized computer programs must be developed to run it. Special programming also has to be written to use WNI. The mean difference method can be calculated with most of the commercially available statistical analysis packages, making it the method of choice in situations where computer programming support is not available. In a university setting, support may be readily available for writing specialized computer programs, but it is typically less so at the school system and school building level.

When Del-N is used to score a needs assessment, an area of need is identified for any co-occurrence of *Importance* and *Achievement* ratings where the rating for *Importance* exceeds the rating for *Achievement*. With Del-N, if an area rated as being of *Low Importance* is also rated as having *No Achievement*, a need will be identified. In some cases clients or needs assessors may not want to expend any resources in an area where there is *No Achievement* in an area of *Low Importance*. With his system of zero weightings in certain of the cells in the *Importance/Achievement* matrix, Cummings (1985) designed WNI to provide a threshold on *Importance* ratings below which needs could not be identified. Therefore, if needs assessors, clients, or participants do not want needs to be identified in areas rated low on *Importance*, WNI should be used.

In an earlier section of this chapter dealing with limitations of the study, illustrative data were used to discuss the issue of magnitude of index values versus the actual ranks assigned to items (Table 33). This issue is also relevant to the application of Del-N, or the other two indices studied, to actual needs assessment situations. Once again, hypothetical data (Table 33) will be used to illustrate a point. If both School Y and School Z (Table 33) could only direct resources to meet two identified needs in one year, the needs assessor should consider magnitude issues as well as rank prioritizations before making recommendations. She or he could feel fairly confident in advising School Y to address the number one and two ranked needs (Items 2 and 3), which differ by four and two index value points, respectively, from the third ranked need (Item 1). However, the decision to address only the number one and two (Item 2 and Item 3) ranked needs and to leave out the third ranked need (Item 1) at School Z, where the rankings are based on index value differences of only one-tenth of a point, would be much less clear-cut. Thus, in addition to relying on the rankings in helping clients identify needs to be addressed, the evaluator must also take into account the actual values of the indices and the magnitudes of the numeric differences between them.

Several implications for further study are suggested by this investigation. The sample statistics and selected hypothesis tests confirm Cummings' (1985) findings of comparability among the three needs assessment scoring methods that were studied; however, further research with groups of needs assessment clients should be undertaken to investigate other of his assertions. He mentions the difficulty of explaining the Del-N method to clients because of its computational complexity. To address the issue of its understandability to client groups, Del-N could be used along with the other two methods with different client groups. And their understanding of the needs assessment process and its results could be evaluated.

Cummings (1985) found a pattern of higher rank order correlations between scoring methods that he deemed to be computationally similar. In his results, the correlation between the mean difference and Del-N methods was lowest, it was higher between mean difference and the weighted needs index, and the highest correlation was between Del-N and weighted needs. In this dissertation, that pattern occurred among the sample correlation coefficients at only 2 of the 19 schools studied. In most cases (12 out of 19 schools), the highest sample correlations were between the mean difference and weighted needs index methods. Further research should be undertaken to determine why the pattern of between method correlations demonstrated in this study differed from those in the Cummings study.

At most of the schools in this study, the sample sizes were inadequate to address properly the issue of the comparability of each individual method for two randomly drawn subsamples of teachers within a school. As mentioned earlier in the discussion of limitations of the study, an investigation that includes schools with 20 or more teachers should be planned. This would allow for subsample sizes of 10 or more teachers at each school and for more effective subsample comparisons.

In the analysis to assess the stability of Del-N, the index variations that postulated uniform and approximately normal probability schemes for the expected marginals both correlated perfectly with the original index. The variation that used unit weighting could not be correlated with Del-N, because identical indices were calculated for every item, precluding prioritization of the items. In future, a researcher might wish to employ other weighting schemes or to utilize other expected marginals for additional analysis of the stability of Del-N.

In conclusion, this study found support for the hypothesis of the comparability of the mean difference, WNI, and Del-N methods for scoring dual-response needs assessments in an educational setting. The postulated pattern of higher correlations among methods deemed to be more computationally similar and lower correlations for less similar methods was not supported. Regardless of any findings about comparability, the choice of a scoring method must ultimately be based on the objectives of the needs assessment as understood by the needs assessor, clients, and participants.

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# APPENDIX A

**Univeristy of North Carolina at Chapel Hill**
**Mathematics and Science Education Network**
**MATHEMATICS Needs Assessment**

Listed below are thirty statements that could characterize effective elementary mathematics programs. The statements focus on content (#1-11), instructional practices (#12-21), student assessment (#22-24), and school mathematics environment (#25-30). For each statement, indicate:

1) its importance for your school; and
2) the extent to which this characteristic is achieved in your school.

Use the following scales to rate **Importance** and **Achievement**. First circle a number to indicate the level of **Importance**. Then circle a number to indicate the level of **Achievement**.

| No Importance | Low Importance | Average Importance | Above Average Importance | High Importance |
|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 |

| No Achievement | Low Achievement | Average Achievement | Above Average Achievement | High Achievement |
|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 |

Read each of the following statements carefully and circle a number on the first scale to indicate the level of **Importance**. Then circle a number on the second scale to indicate the level of **Achievement**.

1. **The mathematics curriculum includes a balanced treatment of all seven topics included in the NC Standard Course of Study--numeration, geometry, patterns, measurement, problem solving, data analysis, and computation.**

| No Importance | Low Importance | Average Importance | Above Average Importance | High Importance |
|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 |

| No Achievement | Low Achievement | Average Achievement | Above Average Achievement | High Achievement |
|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 |

2. **Mathematics is presented as a subject to be explored in "what if" situations, rather than a series of facts and algorithms to be memorized.**

| No Importance | Low Importance | Average Importance | Above Average Importance | High Importance |
|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 |

| No Achievement | Low Achievement | Average Achievement | Above Average Achievement | High Achievement |
|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 |

3. **The mathematics curriculum includes experiences with data analysis and probability; students collect, graph, and interpret data.**

| No Importance | Low Importance | Average Importance | Above Average Importance | High Importance |
|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 |

| No Achievement | Low Achievement | Average Achievement | Above Average Achievement | High Achievement |
|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 |

4. **Students explore geometric figures and develop spatial sense.**

| No Importance | Low Importance | Average Importance | Above Average Importance | High Importance |
|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 |

| No Achievement | Low Achievement | Average Achievement | Above Average Achievement | High Achievement |
|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 |

5. **The mathematics curriculum emphasizes problem solving; students formulate and solve problems using a variety of strategies.**

| No Importance | Low Importance | Average Importance | Above Average Importance | High Importance |
|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 |

| No Achievement | Low Achievement | Average Achievement | Above Average Achievement | High Achievement |
|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 |

6. **Students learn to reason mathematically; they use models, known facts, properties, and relationships to explain their thinking.**

| No Importance | Low Importance | Average Importance | Above Average Importance | High Importance |
|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 |

| No Achievement | Low Achievement | Average Achievement | Above Average Achievement | High Achievement |
|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 |

7. **The mathematics curriculum helps students understand how mathematics applies to their everyday lives.**

| No Importance | Low Importance | Average Importance | Above Average Importance | High Importance |
|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 |

| No Achievement | Low Achievement | Average Achievement | Above Average Achievement | High Achievement |
|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 |

8. **Students develop skill in estimating and learn to recognize when using estimation is appropriate.**

| No Importance | Low Importance | Average Importance | Above Average Importance | High Importance |
|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 |

| No Achievement | Low Achievement | Average Achievement | Above Average Achievement | High Achievement |
|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 |

9. **The mathematics curriculum includes patterns and relationships; students learn to represent and describe mathematical relationships in a variety of ways.**

| No Importance | Low Importance | Average Importance | Above Average Importance | High Importance |
|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 |

| No Achievement | Low Achievement | Average Achievement | Above Average Achievement | High Achievement |
|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 |

**10. The mathematics curriculum emphasizes connections and relationships within mathematics; for example, students understand the relationship between fractions and decimals, between multiplication and finding the area of a figure, and so forth.**

| No Importance | Low Importance | Average Importance | Above Average Importance | High Importance |
|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 |

| No Achievement | Low Achievement | Average Achievement | Above Average Achievement | High Achievement |
|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 |

**11. Mathematics is integrated with other disciplines through selection of problems from areas such as social studies and science; students develop an appreciation for the usefulness of mathematics across a wide variety of areas.**

| No Importance | Low Importance | Average Importance | Above Average Importance | High Importance |
|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 |

| No Achievement | Low Achievement | Average Achievement | Above Average Achievement | High Achievement |
|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 |

**12. Teachers use a variety of strategies and mathematical tasks--projects, questions, problems, and applications--to engage student interest and curiosity.**

| No Importance | Low Importance | Average Importance | Above Average Importance | High Importance |
|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 |

| No Achievement | Low Achievement | Average Achievement | Above Average Achievement | High Achievement |
|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 |

**13. Teachers use a variety of strategies to teach for understanding--to help students make sense of mathematics.**

| No Importance | Low Importance | Average Importance | Above Average Importance | High Importance |
|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 |

| No Achievement | Low Achievement | Average Achievement | Above Average Achievement | High Achievement |
|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 |

**14. Teachers provide learning tasks that are problematic, that have non-obvious solutions, and that promote "what if" explorations by students and teachers.**

| No Importance | Low Importance | Average Importance | Above Average Importance | High Importance |
|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 |

| No Achievement | Low Achievement | Average Achievement | Above Average Achievement | High Achievement |
|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 |

**15. Students are encouraged to communicate about mathematical ideas through reading, writing, and active discussion.**

| No Importance | Low Importance | Average Importance | Above Average Importance | High Importance |
|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 |

| No Achievement | Low Achievement | Average Achievement | Above Average Achievement | High Achievement |
|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 |

**16. Teachers expect that all students can learn and do mathematics; they communicate this expectation to students in a positive way.**

| No Importance | Low Importance | Average Importance | Above Average Importance | High Importance |
|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 |

| No Achievement | Low Achievement | Average Achievement | Above Average Achievement | High Achievement |
|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 |

**17. Students are encouraged to use their own strategies and methods to solve problems; teachers recognize that students construct their own meanings about mathematical concepts.**

| No Importance | Low Importance | Average Importance | Above Average Importance | High Importance |
|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 |

| No Achievement | Low Achievement | Average Achievement | Above Average Achievement | High Achievement |
|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 |

**18. Students use a variety of appropriate tools in the study of mathematics, including calculators, computers, and concrete materials (manipulatives).**

| No Importance | Low Importance | Average Importance | Above Average Importance | High Importance |
|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 |

| No Achievement | Low Achievement | Average Achievement | Above Average Achievement | High Achievement |
|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 |

**19. Students are taught in a non-competitive setting that includes whole class, small group, and individual student activities; cooperative group activities are encouraged.**

| No Importance | Low Importance | Average Importance | Above Average Importance | High Importance |
|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 |

| No Achievement | Low Achievement | Average Achievement | Above Average Achievement | High Achievement |
|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 |

**20. Teachers provide a classroom environment in which students feel free to risk sharing ideas and strategies.**

| No Importance | Low Importance | Average Importance | Above Average Importance | High Importance |
|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 |

| No Achievement | Low Achievement | Average Achievement | Above Average Achievement | High Achievement |
|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 |

**21. Teachers use appropriate materials and teaching techniques that are sensitive to the diversity of students.**

| No Importance | Low Importance | Average Importance | Above Average Importance | High Importance |
|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 |

| No Achievement | Low Achievement | Average Achievement | Above Average Achievement | High Achievement |
|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 |

**22. Teachers use a variety of methods to assess student understanding of mathematical concepts, skills, attitudes, and beliefs, including talking with students, observation, portfolios, journals, open-ended questions, and so forth.**

| No Importance | Low Importance | Average Importance | Above Average Importance | High Importance |
|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 |

| No Achievement | Low Achievement | Average Achievement | Above Average Achievement | High Achievement |
|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 |

**23. Teachers routinely use assessment procedures to evaluate and guide instruction.**

| No Importance | Low Importance | Average Importance | Above Average Importance | High Importance |
|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 |

| No Achievement | Low Achievement | Average Achievement | Above Average Achievement | High Achievement |
|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 |

**24. Teachers use flexible assessment methods that are appropriate for all students; all students are given the assistance they need to fully display their knowledge.**

| No Importance | Low Importance | Average Importance | Above Average Importance | High Importance |
|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 |

| No Achievement | Low Achievement | Average Achievement | Above Average Achievement | High Achievement |
|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 |

**25. Teachers regularly discuss academic issues, share ideas and materials, and so forth.**

| No Importance | Low Importance | Average Importance | Above Average Importance | High Importance |
|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 |

| No Achievement | Low Achievement | Average Achievement | Above Average Achievement | High Achievement |
|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 |

**26. Adequate planning and preparation time is provided for mathematics teaching.**

| No Importance | Low Importance | Average Importance | Above Average Importance | High Importance |
|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 |

| No Achievement | Low Achievement | Average Achievement | Above Average Achievement | High Achievement |
|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 |

**27. Adequate materials, supplies, and equipment are provided for mathematics instruction.**

| No Importance | Low Importance | Average Importance | Above Average Importance | High Importance |
|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 |

| No Achievement | Low Achievement | Average Achievement | Above Average Achievement | High Achievement |
|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 |

**28. Parents are involved in the mathematics program.**

| No Importance | Low Importance | Average Importance | Above Average Importance | High Importance |
|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 |

| No Achievement | Low Achievement | Average Achievement | Above Average Achievement | High Achievement |
|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 |

**29. The mathematics program involves people from the community and from local businesses.**

| No Importance | Low Importance | Average Importance | Above Average Importance | High Importance |
|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 |

| No Achievement | Low Achievement | Average Achievement | Above Average Achievement | High Achievement |
|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 |

**30. Teachers contribute actively to making decisions about mathematics textbooks, curriculum, and resources.**

| No Importance | Low Importance | Average Importance | Above Average Importance | High Importance |
|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 |

| No Achievement | Low Achievement | Average Achievement | Above Average Achievement | High Achievement |
|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 |

**Univeristy of North Carolina at Chapel Hill**
**Mathematics and Science Education Network**
**SCIENCE Needs Assessment**

Listed below are thirty statements that could characterize effective elementary science programs. The statements focus on content (#1-10), instructional practices (#11-20), student assessment (#21-24), and school science environment (#25-30). For each statement, indicate:

1) its importance for your school; and
2) the extent to which this characteristic is achieved in your school.

Use the following scales to rate **Importance** and **Achievement**. First circle a number to indicate the level of **Importance**. Then circle a number to indicate the level of **Achievement**.

| No Importance | Low Importance | Average Importance | Above Average Importance | High Importance |
|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 |

| No Achievement | Low Achievement | Average Achievement | Above Average Achievement | High Achievement |
|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 |

Read each of the following statements carefully and circle a number on the first scale to indicate the level of **Importance**. Then circle a number on the second scale to indicate the level of **Achievement**.

1. **The curriculum focuses on student understanding of science concepts and processes rather than memorization of facts.**

| No Importance | Low Importance | Average Importance | Above Average Importance | High Importance |
|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 |

| No Achievement | Low Achievement | Average Achievement | Above Average Achievement | High Achievement |
|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 |

2. **The curriculum integrates major themes from all area of science: physical, life, and earth/space.**

| No Importance | Low Importance | Average Importance | Above Average Importance | High Importance |
|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 |

| No Achievement | Low Achievement | Average Achievement | Above Average Achievement | High Achievement |
|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 |

3. **Science is taught in a way that makes it applicable and relevant to students' lives.**

| No Importance | Low Importance | Average Importance | Above Average Importance | High Importance |
|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 |

| No Achievement | Low Achievement | Average Achievement | Above Average Achievement | High Achievement |
|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 |

4. **Students learn about science careers as developmentally appropriate.**

| No Importance | Low Importance | Average Importance | Above Average Importance | High Importance |
|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 |

| No Achievement | Low Achievement | Average Achievement | Above Average Achievement | High Achievement |
|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 |

5. **The science curriculum engages students' interest, stimulates their curiosity, and promotes positive attitudes toward science.**

| No Importance | Low Importance | Average Importance | Above Average Importance | High Importance |
|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 |

| No Achievement | Low Achievement | Average Achievement | Above Average Achievement | High Achievement |
|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 |

6. **Students learn to "do" science using science process skills.**

| No Importance | Low Importance | Average Importance | Above Average Importance | High Importance |
|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 |

| No Achievement | Low Achievement | Average Achievement | Above Average Achievement | High Achievement |
|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 |

7. **Science is presented as a tool that humans can use to increase knowledge, improve our world, and preserve life.**

| No Importance | Low Importance | Average Importance | Above Average Importance | High Importance |
|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 |

| No Achievement | Low Achievement | Average Achievement | Above Average Achievement | High Achievement |
|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 |

8. **The curriculum reflects the interdependence of science and technology.**

| No Importance | Low Importance | Average Importance | Above Average Importance | High Importance |
|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 |

| No Achievement | Low Achievement | Average Achievement | Above Average Achievement | High Achievement |
|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 |

9. **The science concepts and process skills taught are developmentally appropriate for students.**

| No Importance | Low Importance | Average Importance | Above Average Importance | High Importance |
|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 |

| No Achievement | Low Achievement | Average Achievement | Above Average Achievement | High Achievement |
|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 |

**10. Science is integrated with other subjects, including language arts, mathematics, and social studies.**

| No Importance | Low Importance | Average Importance | Above Average Importance | High Importance |
|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 |

| No Achievement | Low Achievement | Average Achievement | Above Average Achievement | High Achievement |
|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 |

**11. Teachers use strategies that focus on development of students' critical, or higher order, thinking skills.**

| No Importance | Low Importance | Average Importance | Above Average Importance | High Importance |
|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 |

| No Achievement | Low Achievement | Average Achievement | Above Average Achievement | High Achievement |
|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 |

**12. Teachers help students construct their own meanings about science concepts.**

| No Importance | Low Importance | Average Importance | Above Average Importance | High Importance |
|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 |

| No Achievement | Low Achievement | Average Achievement | Above Average Achievement | High Achievement |
|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 |

**13. Instruction is experience-based; students are regularly engaged in hands-on activities and exploration.**

| No Importance | Low Importance | Average Importance | Above Average Importance | High Importance |
|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 |

| No Achievement | Low Achievement | Average Achievement | Above Average Achievement | High Achievement |
|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 |

**14. Students use a variety of appropriate tools in the study of science, including computers, lab equipment, and so forth.**

| | | | | |
|---|---|---|---|---|
| No Importance | Low Importance | Average Importance | Above Average Importance | High Importance |
| 1 | 2 | 3 | 4 | 5 |
| No Achievement | Low Achievement | Average Achievement | Above Average Achievement | High Achievement |
| 1 | 2 | 3 | 4 | 5 |

**15. Students are encouraged to communicate about science ideas through reading, writing, and discussion.**

| | | | | |
|---|---|---|---|---|
| No Importance | Low Importance | Average Importance | Above Average Importance | High Importance |
| 1 | 2 | 3 | 4 | 5 |
| No Achievement | Low Achievement | Average Achievement | Above Average Achievement | High Achievement |
| 1 | 2 | 3 | 4 | 5 |

**16. Students are taught in a non-competitive setting that includes whole class, small group, and individual student activities; cooperative group learning activities are encouraged.**

| | | | | |
|---|---|---|---|---|
| No Importance | Low Importance | Average Importance | Above Average Importance | High Importance |
| 1 | 2 | 3 | 4 | 5 |
| No Achievement | Low Achievement | Average Achievement | Above Average Achievement | High Achievement |
| 1 | 2 | 3 | 4 | 5 |

**17. Teachers provide a classroom environment in which students feel free to risk sharing ideas.**

| No Importance | Low Importance | Average Importance | Above Average Importance | High Importance |
|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 |

| No Achievement | Low Achievement | Average Achievement | Above Average Achievement | High Achievement |
|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 |

**18. Teachers expect that <u>all</u> students can learn and do science; they communicate this expectation to students in a positive way.**

| No Importance | Low Importance | Average Importance | Above Average Importance | High Importance |
|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 |

| No Achievement | Low Achievement | Average Achievement | Above Average Achievement | High Achievement |
|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 |

**19. Teachers use appropriate materials and teaching techniques that are sensitive to the diversity of students.**

| No Importance | Low Importance | Average Importance | Above Average Importance | High Importance |
|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 |

| No Achievement | Low Achievement | Average Achievement | Above Average Achievement | High Achievement |
|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 |

**20. Teachers use a variety of instructional strategies to ensure that all students learn, understand, and can do science.**

| No Importance | Low Importance | Average Importance | Above Average Importance | High Importance |
|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 |

| No Achievement | Low Achievement | Average Achievement | Above Average Achievement | High Achievement |
|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 |

21. **Teachers use a variety of methods to assess student understanding, process skills, knowledge, and attitudes, such as talking with students, observation, performance-based testing, portfolios, open-ended test items, and so forth.**

| No Importance | Low Importance | Average Importance | Above Average Importance | High Importance |
|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 |

| No Achievement | Low Achievement | Average Achievement | Above Average Achievement | High Achievement |
|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 |

22. **Teachers routinely use assessment procedures to evaluate and guide instruction.**

| No Importance | Low Importance | Average Importance | Above Average Importance | High Importance |
|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 |

| No Achievement | Low Achievement | Average Achievement | Above Average Achievement | High Achievement |
|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 |

23. **Teachers use flexible assessment methods that are appropriate for all students; all students are given the assistance they need to fully display their knowledge.**

| No Importance | Low Importance | Average Importance | Above Average Importance | High Importance |
|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 |

| No Achievement | Low Achievement | Average Achievement | Above Average Achievement | High Achievement |
|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 |

24. **Assessment focuses on what students can do as well as what they know and understand.**

| No Importance | Low Importance | Average Importance | Above Average Importance | High Importance |
|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 |

| No Achievement | Low Achievement | Average Achievement | Above Average Achievement | High Achievement |
|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 |

**25. Teachers regularly discuss academic issues, share ideas and materials, and so forth.**

| No Importance | Low Importance | Average Importance | Above Average Importance | High Importance |
|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 |

| No Achievement | Low Achievement | Average Achievement | Above Average Achievement | High Achievement |
|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 |

**26. Adequate planning and preparation time is provided for science teaching.**

| No Importance | Low Importance | Average Importance | Above Average Importance | High Importance |
|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 |

| No Achievement | Low Achievement | Average Achievement | Above Average Achievement | High Achievement |
|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 |

**27. Adequate materials, equipment, and facilities are provided for science teaching.**

| No Importance | Low Importance | Average Importance | Above Average Importance | High Importance |
|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 |

| No Achievement | Low Achievement | Average Achievement | Above Average Achievement | High Achievement |
|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 |

**28. Parents are involved in the science program.**

| No Importance | Low Importance | Average Importance | Above Average Importance | High Importance |
|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 |

| No Achievement | Low Achievement | Average Achievement | Above Average Achievement | High Achievement |
|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 |

**29. The science program involves people from the community and from local businesses.**

| No Importance | Low Importance | Average Importance | Above Average Importance | High Importance |
|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 |

| No Achievement | Low Achievement | Average Achievement | Above Average Achievement | High Achievement |
|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 |

**30. Teachers contribute actively to making decisions about science textbooks, curriculum, and resources.**

| No Importance | Low Importance | Average Importance | Above Average Importance | High Importance |
|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 |

| No Achievement | Low Achievement | Average Achievement | Above Average Achievement | High Achievement |
|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 |

# APPENDIX B

Table 33

Mean Difference, WNI, and Del-N Values with their Associated Ranks for Questions 1 to 30 at Elementary School A (n = 30)

| Question Number | Mean Diff Value | Mean Diff Rank | WNI Value | WNI Rank | Del-N Value | Del-N Rank |
|---|---|---|---|---|---|---|
| 1 | 1.00000 | 7 | 0.86667 | 14.5 | 0.14110 | 11 |
| 2 | 0.63333 | 24 | 0.63333 | 24 | 0.08863 | 20 |
| 3 | 0.80000 | 16 | 0.90000 | 12.5 | 0.14614 | 10 |
| 4 | 0.73333 | 20.5 | 0.73333 | 20 | 0.15503 | 8 |
| 5 | 0.80000 | 16 | 0.96667 | 9.5 | 0.13470 | 14 |
| 6 | 0.76667 | 18.5 | 0.76667 | 18 | 0.13143 | 15 |
| 7 | 0.66667 | 23 | 0.33333 | 30 | 0.03196 | 27 |
| 8 | 0.83333 | 13 | 0.70000 | 21.5 | 0.12507 | 17 |
| 9 | 0.53333 | 29 | 0.46667 | 27 | 0.04340 | 26 |
| 10 | 0.80000 | 16 | 0.86667 | 14.5 | 0.13982 | 12 |
| 11 | 0.56667 | 27 | 0.41379 | 29 | 0.05928 | 24 |
| 12 | 0.56667 | 27 | 0.57143 | 25 | 0.07789 | 23 |
| 13 | 0.83333 | 13 | 0.82759 | 16 | 0.10904 | 14 |
| 14 | 0.90000 | 9.5 | 0.90000 | 12.5 | 0.16153 | 7 |
| 15 | 0.86667 | 11 | 0.96429 | 11 | 0.15178 | 9 |
| 16 | 0.60000 | 25 | 0.70000 | 21.5 | 0.00702 | 29 |
| 17 | 0.76667 | 18.5 | 0.56667 | 27 | 0.08405 | 22 |
| 18 | 0.90000 | 9.5 | 1.06897 | 7.5 | 0.12795 | 16 |
| 19 | 0.56667 | 27 | 0.66667 | 23 | 0.01098 | 28 |
| 20 | 0.43333 | 30 | 0.46667 | 27 | -0.05012 | 30 |
| 21 | 0.73333 | 20.5 | 0.76667 | 18 | 0.05635 | 25 |
| 22 | 0.70000 | 22 | 0.76667 | 18 | 0.08413 | 21 |
| 23 | 0.83333 | 13 | 0.96667 | 9.5 | 0.11581 | 18 |
| 24 | 0.96667 | 8 | 1.06897 | 7.5 | 0.13665 | 13 |
| 25 | 1.20000 | 6 | 1.24138 | 6 | 0.20145 | 6 |
| 26 | 1.56667 | 1 | 1.82759 | 1.5 | 0.32205 | 2 |
| 27 | 1.36667 | 4 | 1.63333 | 4 | 0.26734 | 5 |
| 28 | 1.40000 | 3 | 1.73333 | 3 | 0.29533 | 3 |
| 29 | 1.50000 | 2 | 1.82759 | 1.5 | 0.34286 | 1 |
| 30 | 1.26667 | 5 | 1.53333 | 5 | 0.27461 | 4 |

Table 34

Mean Difference, WNI, and Del-N Values with their Associated Ranks for Questions 1 to 30 at Elementary School B (n = 33)

| Question Number | Mean Diff Value | Mean Diff Rank | WNI Value | WNI Rank | Del-N Value | Del-N Rank |
|---|---|---|---|---|---|---|
| 1 | 0.90909 | 13.5 | 1.00000 | 12 | 0.17535 | 11 |
| 2 | 0.93939 | 11.5 | 1.06250 | 10 | 0.20545 | 9 |
| 3 | 0.72727 | 24.5 | 0.78788 | 20.5 | 0.12903 | 17 |
| 4 | 0.84848 | 17.5 | 0.87879 | 17 | 0.16961 | 12 |
| 5 | 0.84848 | 17.5 | 0.90909 | 16 | 0.10827 | 22 |
| 6 | 1.15152 | 8 | 1.18182 | 9 | 0.22794 | 8 |
| 7 | 0.75758 | 23 | 0.54545 | 26 | 0.06574 | 25 |
| 8 | 0.81818 | 21 | 0.66667 | 23 | 0.15253 | 14.5 |
| 9 | 0.69697 | 26 | 0.69697 | 22 | 0.11727 | 20 |
| 10 | 1.21212 | 6.5 | 1.37500 | 6 | 0.30634 | 3 |
| 11 | 0.96970 | 10 | 0.96875 | 13 | 0.15275 | 13 |
| 12 | 0.90909 | 13.5 | 0.93939 | 14.5 | 0.13129 | 16 |
| 13 | 0.81818 | 21 | 0.63636 | 24.5 | 0.08521 | 23 |
| 14 | 1.21212 | 6.5 | 1.36364 | 7 | 0.25805 | 6 |
| 15 | 0.87879 | 15 | 0.78788 | 20.5 | 0.14253 | 14.5 |
| 16 | 0.72727 | 24.5 | 0.63636 | 24.5 | 0.04319 | 26 |
| 17 | 0.81818 | 21 | 0.84848 | 18 | 0.07897 | 24 |
| 18 | 0.51515 | 27 | 0.43750 | 28 | -0.00691 | 27 |
| 19 | 0.48485 | 28.5 | 0.42424 | 29.5 | -0.01590 | 29 |
| 20 | 0.45455 | 30 | 0.42424 | 29.5 | -0.03363 | 30 |
| 21 | 0.48485 | 28.5 | 0.48485 | 27 | -0.01035 | 28 |
| 22 | 0.93939 | 11.5 | 1.06061 | 11 | 0.11913 | 19 |
| 23 | 0.84848 | 17.5 | 0.81818 | 19 | 0.11046 | 21 |
| 24 | 0.84848 | 17.5 | 0.93939 | 14.5 | 0.12269 | 18 |
| 25 | 1.03030 | 9 | 1.21212 | 8 | 0.17788 | 10 |
| 26 | 1.93939 | 1 | 2.30303 | 2 | 0.42740 | 2 |
| 27 | 1.30303 | 4 | 1.42424 | 5 | 0.23040 | 7 |
| 28 | 1.27273 | 5 | 1.45455 | 4 | 0.28274 | 4.5 |
| 29 | 1.84848 | 2 | 2.33333 | 1 | 0.44354 | 1 |
| 30 | 1.42424 | 3 | 1.71875 | 3 | 0.28894 | 4.5 |

Table 35

Mean Difference, WNI, and Del-N Values with their Associated Ranks for Questions 1 to 30 at Elementary School C (n = 14)

| Question Number | Mean Diff Value | Mean Diff Rank | WNI Value | WNI Rank | Del-N Value | Del-N Rank |
|---|---|---|---|---|---|---|
| 1 | 1.64286 | 8.5 | 1.78571 | 13.5 | 0.28979 | 17 |
| 2 | 1.35714 | 22 | 1.78571 | 13.5 | 0.23371 | 25 |
| 3 | 1.35714 | 22 | 1.57143 | 21 | 0.22891 | 26 |
| 4 | 1.42857 | 17 | 1.78571 | 13.5 | 0.36980 | 7 |
| 5 | 1.35714 | 22 | 1.64286 | 19 | 0.25955 | 22 |
| 6 | 1.50000 | 13.5 | 1.64286 | 19 | 0.33486 | 11 |
| 7 | 1.28571 | 26 | 1.50000 | 22.5 | 0.26213 | 21 |
| 8 | 1.50000 | 13.5 | 1.92857 | 9 | 0.36451 | 8 |
| 9 | 1.00000 | 29.5 | 1.07143 | 28 | 0.10871 | 30 |
| 10 | 1.21429 | 27 | 1.21429 | 27 | 0.17329 | 27 |
| 11 | 1.50000 | 13.5 | 1.64286 | 19 | 0.30643 | 15 |
| 12 | 1.57143 | 10.5 | 1.84615 | 11 | 0.33446 | 12 |
| 13 | 1.71429 | 7 | 2.14286 | 7 | 0.34736 | 9 |
| 14 | 2.28571 | 3.5 | 2.78571 | 5 | 0.55418 | 3 |
| 15 | 1..42857 | 17 | 1.71429 | 16.5 | 0.31778 | 14 |
| 16 | 1.35714 | 22 | 1.35714 | 25.5 | 0.24153 | 24 |
| 17 | 1.07143 | 28 | 1.00000 | 29 | 0.11764 | 28 |
| 18 | 1.00000 | 29.5 | 0.64286 | 30 | 0.11257 | 29 |
| 19 | 1.50000 | 13.5 | 1.78571 | 13.5 | 0.28121 | 18 |
| 20 | 1.42857 | 17 | 1.50000 | 22.5 | 0.24167 | 23 |
| 21 | 1.35714 | 22 | 1.42857 | 24 | 0.30553 | 16 |
| 22 | 1.35714 | 22 | 1.71429 | 16.5 | 0.26880 | 19 |
| 23 | 1.57143 | 10.5 | 1.85714 | 10 | 0.32795 | 13 |
| 24 | 1.35714 | 22 | 1.35714 | 25.5 | 0.26564 | 20 |
| 25 | 1.64286 | 8.5 | 2.00000 | 8 | 0.34229 | 10 |
| 26 | 2.42857 | 1 | 3.14286 | 1 | 0.56099 | 2 |
| 27 | 2.14286 | 5 | 3.07143 | 2.5 | 0.51607 | 5 |
| 28 | 2.28571 | 3.5 | 3.07143 | 2.5 | 0.56678 | 1 |
| 29 | 2.35714 | 2 | 2.92857 | 4 | 0.55367 | 4 |
| 30 | 1.85714 | 6 | 2.50000 | 6 | 0.45324 | 6 |

Table 36

Mean Difference, WNI, and Del-N Values with their Associated Ranks for Questions 1 to 30 at Elementary School D (n = 19)

| Question Number | Mean Diff Value | Mean Diff Rank | WNI Value | WNI Rank | Del-N Value | Del-N Rank |
|---|---|---|---|---|---|---|
| 1 | 0.84211 | 19 | 0.84211 | 21.5 | 0.18576 | 18 |
| 2 | 1.00000 | 11.5 | 1.31579 | 9 | 0.26060 | 7 |
| 3 | 0.78947 | 22.5 | 1.00000 | 18 | 0.144449 | 25 |
| 4 | 0.84211 | 19 | 1.00000 | 18 | 0.25925 | 8 |
| 5 | 0.89474 | 17 | 0.84211 | 21.5 | 0.18422 | 20 |
| 6 | 1.00000 | 11.5 | 1.15789 | 14 | 0.21428 | 14 |
| 7 | 1.05263 | 7 | 1.36842 | 7 | 0.21318 | 15 |
| 8 | 1.00000 | 11.5 | 1.21053 | 12 | 0.25307 | 10 |
| 9 | 0.57895 | 29 | 0.57895 | 27.5 | 0.10083 | 28 |
| 10 | 1.05263 | 7 | 1.31579 | 9 | 0.17969 | 21 |
| 11 | 0.78947 | 22.5 | 0.84211 | 21.5 | 0.16578 | 22 |
| 12 | 0.73684 | 25 | 0.84211 | 21.5 | 0.20566 | 17 |
| 13 | 1.00000 | 11.5 | 1.21053 | 12 | 0.18571 | 19 |
| 14 | 0.94737 | 15.5 | 1.05263 | 16 | 0.22147 | 13 |
| 15 | 0.68421 | 26.5 | 0.57895 | 27.5 | 0.15183 | 24 |
| 16 | 0.84211 | 19 | 1.00000 | 18 | 0.16188 | 23 |
| 17 | 0.47368 | 30 | 0.36842 | 30 | 0.00809 | 30 |
| 18 | 0.68421 | 26.5 | 0.73684 | 26 | 0.10337 | 27 |
| 19 | 0.63158 | 28 | 0.47368 | 29 | 0.07824 | 29 |
| 20 | 0.78947 | 22.5 | 0.78947 | 24.5 | 0.12216 | 26 |
| 21 | 1.00000 | 11.5 | 1.31579 | 9 | 0.26623 | 6 |
| 22 | 0.94737 | 15.5 | 1.10526 | 15 | 0.24274 | 11 |
| 23 | 1.05263 | 7 | 1.42105 | 6 | 0.25821 | 9 |
| 24 | 1.00000 | 11.5 | 1.21053 | 12 | 0.24167 | 12 |
| 25 | 0.78947 | 22.5 | 0.78947 | 24.5 | 0.20859 | 16 |
| 26 | 1.63158 | 1.5 | 2.15789 | 1 | 0.42442 | 1 |
| 27 | 1.57895 | 3 | 2.10526 | 2 | 0.36544 | 4 |
| 28 | 1.52632 | 4 | 1.84211 | 4 | 0.41600 | 2 |
| 29 | 1.63158 | 1.5 | 1.89474 | 3 | 0.39410 | 3 |
| 30 | 1.21053 | 5 | 1.57895 | 5 | 0.27816 | 5 |

Table 37

Mean Difference, WNI, and Del-N Values with their Associated Ranks for Questions 1 to 30 at Elementary School E (n = 19)

| Question Number | Mean Diff Value | Mean Diff Rank | WNI Value | WNI Rank | Del-N Value | Del-N Rank |
|---|---|---|---|---|---|---|
| 1 | 0.84211 | 24.5 | 0.68421 | 26.5 | 0.11463 | 26 |
| 2 | 0.94737 | 20.5 | 1.00000 | 23 | 0.19490 | 18 |
| 3 | 0.89474 | 22.5 | 0.57895 | 29.5 | 0.12167 | 25 |
| 4 | 0.84211 | 24.5 | 1.10526 | 21 | 0.21444 | 14 |
| 5 | 1.10526 | 13.5 | 1.26316 | 14.5 | 0.18508 | 20 |
| 6 | 1.10526 | 13.5 | 1.36842 | 12 | 0.23964 | 11 |
| 7 | 1.36842 | 4.5 | 1.68421 | 5 | 0.29176 | 7 |
| 8 | 1.31579 | 7 | 1.63158 | 7 | 0.32564 | 4 |
| 9 | 0.73684 | 28 | 0.89474 | 24 | 0.12452 | 24 |
| 10 | 0.78947 | 26.5 | 0.68421 | 26.5 | 0.09806 | 28 |
| 11 | 1.10526 | 13.5 | 1.10526 | 21 | 0.22507 | 13 |
| 12 | 1.26316 | 9.5 | 1.52632 | 9 | 0.29238 | 6 |
| 13 | 1.26316 | 9.5 | 1.47368 | 10 | 0.27510 | 10 |
| 14 | 1.31579 | 7 | 1.73684 | 4 | 0.29095 | 9 |
| 15 | 1.05263 | 17 | 1.21053 | 16.5 | 0.17487 | 22 |
| 16 | 0.78947 | 26.5 | 0.84211 | 25 | 0.10735 | 27 |
| 17 | 0.63158 | 29 | 0.63158 | 28 | 0.04002 | 29 |
| 18 | 0.52632 | 30 | 0.57895 | 29.5 | 0.03371 | 30 |
| 19 | 0.89474 | 22.5 | 1.15789 | 18.5 | 0.17271 | 23 |
| 20 | 1.10526 | 13.5 | 1.21053 | 16.5 | 0.20931 | 15 |
| 21 | 1.10526 | 13.5 | 1.42105 | 11 | 0.19919 | 17 |
| 22 | 1.00000 | 18.5 | 1.26316 | 14.5 | 0.19381 | 19 |
| 23 | 0.94737 | 20.5 | 1.10526 | 21 | 0.18443 | 21 |
| 24 | 1.10526 | 13.5 | 1.31579 | 13 | 0..23753 | 12 |
| 25 | 1.00000 | 18.5 | 1.15789 | 18.5 | 0.20663 | 16 |
| 26 | 1.31579 | 7 | 1.63158 | 7 | 0.29096 | 8 |
| 27 | 1.73684 | 2 | 2.21053 | 2 | 0.38065 | 2 |
| 28 | 1.63158 | 3 | 2.15789 | 3 | 0.35693 | 3 |
| 29 | 1.84211 | 1 | 2.47368 | 1 | 0.40060 | 1 |
| 30 | 1.36842 | 4.5 | 1.63158 | 7 | 0.32140 | 5 |

Table 38

Mean Difference, WNI, and Del-N Values with their Associated Ranks for Questions 1 to 30 at Middle School A (n = 19)

| Question Number | Mean Diff Value | Mean Diff Rank | WNI Value | WNI Rank | Del-N Value | Del-N Rank |
|---|---|---|---|---|---|---|
| 1 | 0.78947 | 28.5 | 1.10526 | 22.5 | 0.16074 | 26 |
| 2 | 1.36842 | 11 | 1.57895 | 12 | 0.33257 | 10 |
| 3 | 1.10526 | 20.5 | 1.15789 | 20.5 | 0.25521 | 17 |
| 4 | 1.26316 | 14.5 | 1.57895 | 12 | 0.32122 | 11 |
| 5 | 1.31579 | 13 | 1.26316 | 19 | 0.26310 | 15 |
| 6 | 1.26316 | 14.5 | 1.27778 | 18 | 0.27589 | 13 |
| 7 | 1.05263 | 23 | 1.00000 | 25 | 0.19710 | 20 |
| 8 | 1.47368 | 8 | 1.73684 | 8 | 0.33771 | 8 |
| 9 | 1.47368 | 8 | 1.68421 | 10 | 0.35382 | 6 |
| 10 | 1.47368 | 8 | 1.73684 | 8 | 0.32093 | 12 |
| 11 | 1.21053 | 16.5 | 1.57895 | 12 | 0.26137 | 16 |
| 12 | 1.15789 | 18 | 1.52632 | 15 | 0.22577 | 19 |
| 13 | 1.10526 | 20.5 | 1.10526 | 22.5 | 0.18453 | 22 |
| 14 | 1.36842 | 11 | 1.73684 | 8 | 0.33718 | 9 |
| 15 | 1.57895 | 5 | 1.94737 | 5.5 | 0.35730 | 4 |
| 16 | 1.00000 | 24.5 | 1.05263 | 24 | 0.17525 | 23 |
| 17 | 1.21053 | 16.5 | 1.52632 | 15 | 0.25312 | 18 |
| 18 | 1.57895 | 5 | 1.94737 | 5.5 | 0.35690 | 5 |
| 19 | 0.68421 | 30 | 0.63158 | 29 | 0.09698 | 29 |
| 20 | 0.89474 | 26 | 0.89474 | 26.5 | 0.12227 | 27 |
| 21 | 1.10526 | 20.5 | 1.15789 | 20.5 | 0.19616 | 21 |
| 22 | 1.10526 | 20.5 | 1.36842 | 17 | 0.17358 | 24 |
| 23 | 0.84211 | 27 | 0.73684 | 28 | 0.10525 | 28 |
| 24 | 0.78947 | 28.5 | 0.42105 | 30 | 0.08941 | 30 |
| 25 | 1.00000 | 24.5 | 0.89474 | 26.5 | 0.16549 | 25 |
| 26 | 1.36842 | 11 | 1.52632 | 15 | 0.26616 | 14 |
| 27 | 2.26316 | 1 | 3.00000 | 1 | 0.52306 | 1 |
| 28 | 2.00000 | 2 | 2.52632 | 2 | 0.48596 | 2 |
| 29 | 1.94737 | 3 | 2.42105 | 3 | 0.48042 | 3 |
| 30 | 1.57895 | 5 | 2.10526 | 4 | 0.33830 | 7 |

Table 39

Mean Difference, WNI, and Del-N Values with their Associated Ranks for Questions 1 to 30 at High School A (n = 7)

| Question Number | Mean Diff Value | Mean Diff Rank | WNI Value | WNI Rank | Del-N Value | Del-N Rank |
|---|---|---|---|---|---|---|
| 1 | 1.14286 | 11.5 | 0.85714 | 20 | 0.23332 | 14 |
| 2 | 0.57143 | 26.5 | 0.14286 | 29.5 | 0.08637 | 29 |
| 3 | 0.71429 | 23.5 | 0.14286 | 29.5 | 0.11506 | 26 |
| 4 | 1.42857 | 8 | 1.71429 | 7 | 0.39182 | 6 |
| 5 | 1.14286 | 11.5 | 0.71429 | 23 | 0.21481 | 17 |
| 6 | 1.00000 | 16 | 0.57143 | 26 | 0.17943 | 20 |
| 7 | 0.85714 | 20 | 0.85714 | 20 | 0.19765 | 19 |
| 8 | 1.42857 | 8 | 1.42857 | 11 | 0.32387 | 8 |
| 9 | 1.00000 | 16 | 0.85714 | 20 | 0.24517 | 13 |
| 10 | 0.42857 | 29 | 1.00000 | 16.5 | 0.11854 | 25 |
| 11 | 0.85714 | 20 | 1.16667 | 13 | 0.24802 | 12 |
| 12 | 0.71429 | 23.5 | 0.66667 | 24 | 0.17701 | 21 |
| 13 | 1.00000 | 16 | 1.57143 | 8.5 | 0.16670 | 22 |
| 14 | 1.57143 | 6 | 2.00000 | 6 | 0.35642 | 7 |
| 15 | 1.42857 | 8 | 1.42857 | 11 | 0.31620 | 9 |
| 16 | 0.42857 | 29 | 0.85714 | 20 | 0.10140 | 27 |
| 17 | 0.57143 | 26.5 | 0.57143 | 26 | 0.08954 | 28 |
| 18 | 0.71429 | 23.5 | 0.85714 | 20 | 0.13256 | 24 |
| 19 | 0.85714 | 20 | 1.14286 | 14.5 | 0.20081 | 18 |
| 20 | 1.00000 | 16 | 1.14286 | 14.5 | 0.21547 | 16 |
| 21 | 1.00000 | 16 | 1.00000 | 16.5 | 0.22314 | 15 |
| 22 | 0.42857 | 29 | 0.57143 | 26 | 0.15375 | 23 |
| 23 | 1.14286 | 11.5 | 1.42857 | 11 | 0.30222 | 10 |
| 24 | 1.14286 | 11.5 | 1.57143 | 8.5 | 0.27700 | 11 |
| 25 | 0.71429 | 23.5 | 0.42857 | 28 | 0.08216 | 30 |
| 26 | 2.00000 | 5 | 2.42857 | 5 | 0.47303 | 5 |
| 27 | 3.00000 | 1 | 3.85714 | 1 | 0.72389 | 1 |
| 28 | 2.42857 | 2.5 | 3.00000 | 3.5 | 0.60982 | 2.5 |
| 29 | 2.42857 | 2.5 | 3.00000 | 3.5 | 0.60982 | 2.5 |
| 30 | 2.28571 | 4 | 3.14286 | 2 | 0.51632 | 4 |

Table 40

Mean Difference, WNI, and Del-N Values with their Associated Ranks for Questions 1 to 30 at Elementary School F (n = 21)

| Question Number | Mean Diff Value | Mean Diff Rank | WNI Value | WNI Rank | Del-N Value | Del-N Rank |
|---|---|---|---|---|---|---|
| 1 | 1.57143 | 4 | 2.04762 | 1 | 0.38549 | 5 |
| 2 | 1.38095 | 8.5 | 1.57143 | 9 | 0.38217 | 6 |
| 3 | 1.09524 | 18 | 1.42857 | 15.5 | 0.25107 | 21 |
| 4 | 0.95238 | 28 | 1.23810 | 23 | 0.30793 | 14 |
| 5 | 1.57143 | 4 | 1.76190 | 7 | 0.38807 | 4 |
| 6 | 1.61905 | 1.5 | 1.95238 | 4 | 0.42974 | 1 |
| 7 | 1.42857 | 7 | 1.95238 | 4 | 0.32414 | 11 |
| 8 | 1.00000 | 24.5 | 1.28571 | 21.5 | 0.22982 | 26 |
| 9 | 0.85714 | 29 | 1.04762 | 28 | 0.25254 | 20 |
| 10 | 1.57143 | 4 | 1.95238 | 4 | 0.42497 | 2 |
| 11 | 1.47619 | 6 | 1.85714 | 6 | 0.35351 | 7 |
| 12 | 1.38095 | 8.5 | 1.71429 | 8 | 0.32694 | 10 |
| 13 | 1.09524 | 18 | 1.42857 | 15.5 | 0.28287 | 19 |
| 14 | 1.04762 | 20.5 | 1.19048 | 25 | 0.33844 | 8 |
| 15 | 1.14286 | 15 | 1.47619 | 11 | 0.31446 | 13 |
| 16 | 1.04762 | 20.5 | 1.42857 | 15.5 | 0.23330 | 25 |
| 17 | 1.23810 | 10.5 | 1.52381 | 10 | 0.30071 | 16 |
| 18 | 1.00000 | 24.5 | 1.19048 | 25 | 0.24823 | 22 |
| 19 | 1.14286 | 15 | 1.38095 | 20 | 0.22010 | 28 |
| 20 | 1.00000 | 24.5 | 1.19048 | 25 | 0.22164 | 27 |
| 21 | 1.00000 | 24.5 | 1.28571 | 21.5 | 0.23365 | 23 |
| 22 | 1.23810 | 10.5 | 1.42857 | 15.5 | 0.30157 | 15 |
| 23 | 1.00000 | 24.5 | 0.95238 | 29 | 0.19175 | 30 |
| 24 | 1.00000 | 24.5 | 1.14286 | 27 | 0.21877 | 29 |
| 25 | 0.76190 | 30 | 0.85714 | 30 | 0.23353 | 24 |
| 26 | 1.61905 | 1.5 | 2.00000 | 2 | 0.40091 | 3 |
| 27 | 1.14286 | 15 | 1.42857 | 15.5 | 0.28477 | 18 |
| 28 | 1.19048 | 12.5 | 1.42857 | 15.5 | 0.32977 | 9 |
| 29 | 1.19048 | 12.5 | 1.42857 | 15.5 | 0.32104 | 12 |
| 30 | 1.09524 | 18 | 1.42857 | 15.5 | 0.28897 | 17 |

Table 41

Mean Difference, WNI, and Del-N Values with their Associated Ranks for Questions 1 to 30 at Elementary School G (n = 8)

| Question Number | Mean Diff Value | Mean Diff Rank | WNI Value | WNI Rank | Del-N Value | Del-N Rank |
|---|---|---|---|---|---|---|
| 1 | 1.125 | 23 | 1.50000 | 15 | 0.25354 | 18 |
| 2 | 1.125 | 23 | 1.50000 | 15 | 0.30437 | 14 |
| 3 | 1.375 | 13 | 1.62500 | 11.5 | 0.32415 | 11 |
| 4 | 1.375 | 13 | 1.28571 | 20 | 0.33892 | 8 |
| 5 | 1.375 | 13 | 1.50000 | 15 | 0.26662 | 17 |
| 6 | 1.375 | 13 | 1.37500 | 18.5 | 0.32417 | 10 |
| 7 | 1.250 | 17.5 | 0.75000 | 29 | 0.17145 | 24 |
| 8 | 1.500 | 8 | 1.85714 | 8 | 0.32384 | 12 |
| 9 | 1.500 | 8 | 2.00000 | 5 | 0.31961 | 13 |
| 10 | 1.500 | 8 | 1.75000 | 9.5 | 0.35510 | 6 |
| 11 | 1.250 | 17.5 | 1.50000 | 15 | 0.28535 | 16 |
| 12 | 1.750 | 4.5 | 2.00000 | 5 | 0.36618 | 4 |
| 13 | 1.500 | 8 | 1.75000 | 9.5 | 0.30427 | 15 |
| 14 | 1.750 | 4.5 | 2.00000 | 5 | 0.43909 | 3 |
| 15 | 1.375 | 13 | 1.62500 | 11.5 | 0.34816 | 7 |
| 16 | 1.125 | 23 | 1.12500 | 22 | 0.16532 | 26 |
| 17 | 1.125 | 23 | 1.50000 | 15 | 0.25160 | 19 |
| 18 | 1.000 | 27 | 1.12500 | 22 | 0.09610 | 30 |
| 19 | 1.125 | 23 | 1.00000 | 25.5 | 0.22286 | 20.5 |
| 20 | 1.125 | 23 | 1.00000 | 25.5 | 0.22286 | 20.5 |
| 21 | 0.875 | 29 | 1.12500 | 22 | 0.15309 | 27 |
| 22 | 1.500 | 8 | 1.87500 | 7 | 0.33303 | 9 |
| 23 | 0.875 | 28 | 1.00000 | 25.5 | 0.14753 | 28 |
| 24 | 1.250 | 17.5 | 0.87500 | 28 | 0.20301 | 23 |
| 25 | 0.750 | 30 | 0.71429 | 30 | 0.11883 | 29 |
| 26 | 1.875 | 3 | 2.50000 | 3 | 0.35970 | 5 |
| 27 | 1.250 | 17.5 | 1.37500 | 18.5 | 0.17143 | 25 |
| 28 | 2.500 | 2 | 2.87500 | 2 | 0.61423 | 2 |
| 29 | 2.750 | 1 | 3.25000 | 1 | 0.71162 | 1 |
| 30 | 1.125 | 23 | 1.00000 | 25.5 | 0.20667 | 22 |

Table 42

Mean Difference, WNI, and Del-N Values with their Associated Ranks for Questions 1 to 30 at Elementary School H (n = 16)

| Question Number | Mean Diff Value | Mean Diff Rank | WNI Value | WNI Rank | Del-N Value | Del-N Rank |
|---|---|---|---|---|---|---|
| 1 | 0.8750 | 23.5 | 1.18750 | 17.5 | 0.24206 | 22 |
| 2 | 0.6875 | 29 | 1.06250 | 22 | 0.19998 | 27 |
| 3 | 10625 | 16 | 1.18750 | 17.5 | 0.24325 | 21 |
| 4 | 0.6875 | 29 | 0.93750 | 26.5 | 0.23667 | 24 |
| 5 | 0.8125 | 25.5 | 0.81250 | 29 | 0.18051 | 28 |
| 6 | 1.0625 | 16 | 1.00000 | 24.5 | 0.24145 | 23 |
| 7 | 1.1250 | 11 | 1.43750 | 11.5 | 0.28220 | 15 |
| 8 | 1.0625 | 16 | 1.18750 | 17.5 | 0.30176 | 11 |
| 9 | 1.0000 | 21 | 1.12500 | 20.5 | 0.26283 | 16 |
| 10 | 1.0625 | 16 | 0.93750 | 26.5 | 0.22274 | 26 |
| 11 | 1.5000 | 1.5 | 1.93333 | 1 | 0.35316 | 6 |
| 12 | 0.8750 | 23.5 | 1.12500 | 20.5 | 0.24946 | 19 |
| 13 | 1.3750 | 4 | 1.62500 | 5.5 | 0.29914 | 13 |
| 14 | 1.3750 | 4 | 1.81250 | 2.5 | 0.35806 | 4 |
| 15 | 1.0625 | 16 | 1.25000 | 15 | 0.26281 | 17 |
| 16 | 1.0625 | 16 | 1.00000 | 24.5 | 0.22470 | 25 |
| 17 | 0.6875 | 29 | 0.81250 | 29 | 0.12162 | 29 |
| 18 | 0.7500 | 27 | 0.81250 | 29 | 0.111504 | 30 |
| 19 | 1.3125 | 6.5 | 1.56250 | 8 | 0.35656 | 5 |
| 20 | 1.0625 | 16 | 1.31250 | 14 | 0.26058 | 18 |
| 21 | 1.1875 | 9.5 | 1.62500 | 5.5 | 0.32923 | 7 |
| 22 | 1.0625 | 16 | 1.43750 | 11.5 | 0.31656 | 9 |
| 23 | 1.2500 | 8 | 1.56250 | 8 | 0.31860 | 8 |
| 24 | 1.0625 | 16 | 1.18750 | 17.5 | 0.30191 | 10 |
| 25 | 0.8125 | 25.5 | 1.00000 | 24.5 | 0.24460 | 20 |
| 26 | 1.1875 | 9.5 | 1.50000 | 10 | 0.29962 | 12 |
| 27 | 1.5000 | 1.5 | 1.81250 | 2.5 | 0.40581 | 1 |
| 28 | 0.9375 | 22 | 1.33333 | 13 | 0.29148 | 14 |
| 29 | 1.3125 | 6.5 | 1.56250 | 8 | 0.39329 | 2 |
| 30 | 1.3750 | 4 | 1.80000 | 4 | 0.38490 | 3 |

Table 43

Mean Difference, WNI, and Del-N Values with their Associated Ranks for Questions 1 to 30 at Elementary School I (n = 19)

| Question Number | Mean Diff Value | Mean Diff Rank | WNI Value | WNI Rank | Del-N Value | Del-N Rank |
|---|---|---|---|---|---|---|
| 1 | 1.05263 | 10 | 1.26316 | 8 | 0.15064 | 17 |
| 2 | 0.84211 | 20.5 | 0.78947 | 20 | 0.16319 | 14 |
| 3 | 1.15789 | 7 | 1.05556 | 14 | 0.16307 | 15 |
| 4 | 1.10526 | 9 | 1.33333 | 5 | 0.29154 | 4 |
| 5 | 0.73684 | 24 | 0.36842 | 27.5 | 0.08739 | 25 |
| 6 | 1.00000 | 12.5 | 1.00000 | 17 | 0.14291 | 20 |
| 7 | 0.94737 | 15 | 1.15789 | 11.5 | 0.16573 | 13 |
| 8 | 1.15789 | 7 | 1.31579 | 6.5 | 0.25221 | 6 |
| 9 | 0.73684 | 24 | 0.42105 | 26 | 0.05553 | 28 |
| 10 | 0.63158 | 26.5 | 0.57895 | 24.5 | 0.06895 | 26 |
| 11 | 1.00000 | 12.5 | 0.89474 | 18 | 0.16949 | 12 |
| 12 | 0.89474 | 17.5 | 1.05263 | 15.5 | 0.17410 | 11 |
| 13 | 0.78947 | 22 | 0.66667 | 23 | 0.11343 | 22 |
| 14 | 1.15789 | 7 | 1.21053 | 9 | 0.22634 | 8 |
| 15 | 0.89474 | 17.5 | 0.73684 | 21 | 0.14989 | 18 |
| 16 | 0.52632 | 28 | 0.21053 | 29 | 0.06030 | 27 |
| 17 | 0.31579 | 29 | 0.36842 | 27.5 | 0.07135 | 30 |
| 18 | 0.26316 | 30 | 0.05263 | 30 | 0.06862 | 29 |
| 19 | 0.63158 | 26.5 | 0.57895 | 24.5 | 0.11223 | 23 |
| 20 | 0.73684 | 24 | 0.84211 | 19 | 0.11042 | 24 |
| 21 | 1.21053 | 4.5 | 1.31579 | 6.5 | 0.24349 | 7 |
| 22 | 0.89474 | 17.5 | 1.05263 | 15.5 | 0.15516 | 16 |
| 23 | 1.00000 | 12.5 | 1.15789 | 11.5 | 0.19370 | 9 |
| 24 | 0.84211 | 20.5 | 0.68421 | 22 | 0.14167 | 21 |
| 25 | 1.00000 | 12.5 | 1.15789 | 11.5 | 0.18276 | 10 |
| 26 | 1.26316 | 3 | 1.68421 | 3 | 0.26298 | 5 |
| 27 | 0.89474 | 17.5 | 1.15789 | 11.5 | 0.14837 | 19 |
| 28 | 1.21053 | 4.5 | 1.50000 | 4 | 0.33146 | 3 |
| 29 | 1.78947 | 2 | 2.36842 | 2 | 0.42472 | 1 |
| 30 | 1.84211 | 1 | 2.42105 | 1 | 0.39378 | 2 |

Table 44

Mean Difference, WNI, and Del-N Values with their Associated Ranks for Questions 1 to 30 at Elementary School J (n = 26)

| **Question Number** | **Mean Diff Value** | **Mean Diff Rank** | **WNI Value** | **WNI Rank** | **Del-N Value** | **Del-N Rank** |
|---|---|---|---|---|---|---|
| 1 | 1.03846 | 13 | 1.15385 | 13 | 0.20549 | 15 |
| 2 | 0.69231 | 28 | 0.65385 | 26.5 | 0.13006 | 22 |
| 3 | 0.76923 | 24 | 0.69231 | 24.5 | 0.08879 | 26 |
| 4 | 0.88462 | 18 | 0.96154 | 18 | 0.25005 | 11 |
| 5 | 0.88462 | 18 | 0.88462 | 20 | 0.12940 | 23 |
| 6 | 1.11538 | 9.5 | 1.23077 | 10.5 | 0.22094 | 13 |
| 7 | 0.96154 | 15 | 1.11538 | 14.5 | 0.18164 | 18 |
| 8 | 1.07692 | 11 | 1.26923 | 9 | 0.27498 | 9 |
| 9 | 0.84615 | 20 | 0.76923 | 21.5 | 0.12580 | 24 |
| 10 | 0.73077 | 26.5 | 0.69231 | 24.5 | 0.07782 | 28 |
| 11 | 1.26923 | 6.5 | 1.34615 | 7.5 | 0.27811 | 8 |
| 12 | 1.11538 | 9.5 | 1.19231 | 12 | 0.28013 | 7 |
| 13 | 1.03846 | 13 | 1.11538 | 14.5 | 0.17232 | 19 |
| 14 | 1.50000 | 4 | 1.73077 | 5 | 0.32434 | 5 |
| 15 | 0.76923 | 24 | 0.76923 | 21.5 | 0.16604 | 20 |
| 16 | 0.76923 | 24 | 0..57692 | 28 | 0.07935 | 27 |
| 17 | 0.53846 | 29 | 0.26923 | 29 | 0.01446 | 29 |
| 18 | 0.46154 | 30 | 0.23077 | 30 | -0.03312 | 10 |
| 19 | 0.73077 | 26.5 | 0.65385 | 26.5 | 0.12017 | 25 |
| 20 | 0.88462 | 18 | 1.07692 | 16 | 0.13437 | 21 |
| 21 | 1.26923 | 6.5 | 1.56000 | 6 | 0.30182 | 6 |
| 22 | 0.80769 | 21.5 | 0.96000 | 19 | 0.22878 | 12 |
| 23 | 0.92308 | 16 | 1.00000 | 17 | 0.20175 | 16 |
| 24 | 1.19231 | 8 | 1.34615 | 7.5 | 0.25871 | 10 |
| 25 | 0.80769 | 21.5 | 0.73077 | 23 | 0.19886 | 17 |
| 26 | 1.61538 | 3 | 1.96154 | 2 | 0.34965 | 4 |
| 27 | 2.11538 | 1 | 2.84615 | 1 | 0.49762 | 1 |
| 28 | 1.69231 | 2 | 1.92308 | 3 | 0.43333 | 2 |
| 29 | 1.46154 | 5 | 1.76923 | 4 | 0.35933 | 3 |
| 30 | 1.03846 | 13 | 1.23077 | 10.5 | 0.21931 | 14 |

Table 45

Mean Difference, WNI, and Del-N Values with their Associated Ranks for Questions 1 to 30 at Elementary School K (n = 12)

| Question Number | Mean Diff Value | Mean Diff Rank | WNI Value | WNI Rank | Del-N Value | Del-N Rank |
|---|---|---|---|---|---|---|
| 1 | 1.66667 | 5 | 2.45455 | 4 | 0.38645 | 6 |
| 2 | 1.25000 | 16 | 1.63636 | 15 | 0.33727 | 10 |
| 3 | 0.83333 | 25.5 | 0.91667 | 24 | 0.20377 | 22 |
| 4 | 0.08333 | 30 | 0.16667 | 30 | 0.13866 | 25 |
| 5 | 1.00000 | 22 | 1.08333 | 20.5 | 0.21861 | 21 |
| 6 | 1.50000 | 10 | 1.91667 | 10 | 0.32716 | 11 |
| 7 | 1.50000 | 10 | 1.83333 | 11.5 | 0.36105 | 8 |
| 8 | 1.00000 | 22 | 0.91667 | 24 | 0.29049 | 19 |
| 9 | 1.50000 | 10 | 2.00000 | 8.5 | 0.31188 | 13 |
| 10 | 083333 | 25.5 | 0.83333 | 26.5 | 0.11738 | 29 |
| 11 | 1.58333 | 6.5 | 2.16667 | 6 | 0.36882 | 7 |
| 12 | 1.00000 | 22 | 0.91667 | 24 | 0.20225 | 23 |
| 13 | 0.83333 | 25.5 | 0.75000 | 28 | 0.13308 | 26 |
| 14 | 1.91667 | 3 | 2.41667 | 5 | 0.45847 | 4 |
| 15 | 0.66667 | 29 | 0.83333 | 26.5 | 0.08001 | 30 |
| 16 | 1.08333 | 19.5 | 1.25000 | 19 | 0.18060 | 24 |
| 17 | 0.75000 | 28 | 0.58333 | 29 | 0.08204 | 29 |
| 18 | 0.83333 | 25.5 | 1.00000 | 22 | 0.10267 | 28 |
| 19 | 1.25000 | 16 | 1.83333 | 11.5 | 0.29302 | 18 |
| 20 | 1.33333 | 13.5 | 1.58333 | 16.5 | 0.30190 | 16 |
| 21 | 1.50000 | 10 | 2.08333 | 7 | 0.32454 | 12 |
| 22 | 1.08333 | 19.5 | 1.08333 | 20.5 | 0.26252 | 20 |
| 23 | 1.25000 | 16 | 1.58333 | 16.5 | 0.30043 | 17 |
| 24 | 1.16667 | 18 | 1.50000 | 18 | 0.30289 | 15 |
| 25 | 1.50000 | 10 | 1.75000 | 13.5 | 0.43666 | 5 |
| 26 | 1.58333 | 6.5 | 2.00000 | 8.5 | 0.34333 | 9 |
| 27 | 1.83333 | 4 | 2.66667 | 2 | 0.46539 | 2 |
| 28 | 2.25000 | 1 | 2.91667 | 1 | 0.49374 | 1 |
| 29 | 1.33333 | 13.5 | 1.75000 | 13.5 | 0.30451 | 14 |
| 30 | 2.00000 | 2 | 2.50000 | 3 | 0.46069 | 3 |

Table 46

Mean Difference, WNI, and Del-N Values with their Associated Ranks for Questions 1 to 30 at Elementary School L (n = 23)

| Question Number | Mean Diff Value | Mean Diff Rank | WNI Value | WNI Rank | Del-N Value | Del-N Rank |
|---|---|---|---|---|---|---|
| 1 | 0.82609 | 26 | 0.69565 | 27 | 011734 | 27 |
| 2 | 0.82609 | 26 | 0.78261 | 25 | 0.15447 | 23 |
| 3 | 1.13043 | 9.5 | 1.31818 | 10 | 0.21346 | 14 |
| 4 | 0.86957 | 24 | 1.17391 | 13 | 0.22438 | 12 |
| 5 | 0.82609 | 26 | 0.78261 | 25 | 0.10005 | 28 |
| 6 | 1.08696 | 11.5 | 1.04348 | 18 | 0.21333 | 15 |
| 7 | 1.00000 | 18 | 1.13043 | 15 | 0.19634 | 16 |
| 8 | 1.04348 | 14.5 | 1.04348 | 18 | 0.22149 | 13 |
| 9 | 0.95652 | 21 | 0.86957 | 22 | 0.16334 | 21 |
| 10 | 0.73913 | 28 | 0.47826 | 28.5 | 0.11816 | 26 |
| 11 | 1.47826 | 5 | 1.60870 | 6 | 0.30888 | 6 |
| 12 | 1.00000 | 18 | 1.26087 | 11.5 | 0.24802 | 8 |
| 13 | 1.04348 | 14.5 | 1.26087 | 11.5 | 0.15883. | 22 |
| 14 | 1.13043 | 9.5 | 1.52174 | 7 | 0.19087 | 18 |
| 15 | 0.91304 | 23 | 0.86957 | 22 | 0.14927 | 25 |
| 16 | 1.04348 | 14.5 | 0.86957 | 22 | 0.15322 | 24 |
| 17 | 0.65217 | 29.5 | 0.39130 | 30 | 0.05427 | 29 |
| 18 | 0.65217 | 29.5 | 0.47826 | 28.5 | 0.04426 | 30 |
| 19 | 0.95652 | 21 | 0.78261 | 25 | 0.18035 | 19 |
| 20 | 1.00000 | 18 | 1.00000 | 20 | 0.16439 | 20 |
| 21 | 1.17391 | 7.5 | 1.39130 | 8.5 | 0.27789 | 7 |
| 22 | 1.04348 | 14.5 | 1.04348 | 18 | 0.24287 | 9 |
| 23 | 1.08696 | 11.5 | 1.13043 | 15 | 0.24033 | 10 |
| 24 | 1.17391 | 7.5 | 1.39130 | 8.5 | 0.23757 | 11 |
| 25 | 0.95652 | 21 | 1.13043 | 15 | 0.19625 | 17 |
| 26 | 1.95652 | 1 | 2.56522 | 1 | 0.46131 | 1 |
| 27 | 1.82609 | 2 | 2.43478 | 2 | 0.41132 | 3 |
| 28 | 1.52174 | 4 | 2.08696 | 4 | 0.37034 | 4 |
| 29 | 1.73913 | 3 | 2.21739 | 3 | 0.42913 | 2 |
| 30 | 1.43478 | 6 | 1.69565 | 5 | 0.31743 | 5 |

Table 47

Mean Difference, WNI, and Del-N Values with their Associated Ranks for Questions 1 to 30 at Elementary School M (n = 38)

| Question Number | Mean Diff Value | Mean Diff Rank | WNI Value | WNI Rank | Del-N Value | Del-N Rank |
|---|---|---|---|---|---|---|
| 1 | 1.34211 | 20 | 1.68421 | 17.5 | 0.27989 | 20 |
| 2 | 1.34211 | 20 | 1.55263 | 20 | 0.26955 | 21 |
| 3 | 1.36842 | 17.5 | 1.68421 | 17.5 | 0.26442 | 23 |
| 4 | 1.23684 | 24 | 1.50000 | 23 | 0.35243 | 10 |
| 5 | 1.55263 | 11 | 1.84211 | 11 | 0.34597 | 11 |
| 6 | 1.68421 | 7 | 2.05263 | 7 | 0.39208 | 7 |
| 7 | 1.65789 | 8 | 2.00000 | 9 | 0.36534 | 8 |
| 8 | 1.47368 | 14 | 1.78947 | 14.5 | 0.34494 | 12 |
| 9 | 1.18421 | 28 | 1.47368 | 24.5 | 0.21956 | 27 |
| 10 | 1.21053 | 25.5 | 1.47368 | 24.5 | 0.22690 | 25 |
| 11 | 1.52632 | 12.5 | 1.81579 | 13 | 0.32087 | 15 |
| 12 | 1.44737 | 15 | 1.73684 | 16 | 0.35964 | 9 |
| 13 | 1.60526 | 10 | 2.02632 | 8 | 0.33614 | 13 |
| 14 | 1.97368 | 4 | 2.57895 | 3 | 0.45660 | 4 |
| 15 | 1.21053 | 25.5 | 1.28947 | 30 | 0.25602 | 24 |
| 16 | 1.28947 | 22 | 1.52632 | 21.5 | 0.21800 | 28 |
| 17 | 1.15789 | 30 | 1.36842 | 27.5 | 0.16566 | 30 |
| 18 | 1.18421 | 28 | 1.34211 | 29 | 0.18546 | 29 |
| 19 | 1.39474 | 16 | 1.39474 | 26 | 0.28530 | 19 |
| 20 | 1.63158 | 9 | 1.94737 | 10 | 0.33260 | 14 |
| 21 | 1.52632 | 12.5 | 1.83784 | 12 | 0.30562 | 17 |
| 22 | 1.26316 | 23 | 1.52632 | 21.5 | 0.26751 | 22 |
| 23 | 1.36842 | 17.5 | 1.60526 | 19 | 0.28577 | 18 |
| 24 | 1.18421 | 28 | 1.36842 | 27.5 | 0.22462 | 26 |
| 25 | 1.34211 | 20 | 1.78947 | 14.5 | 0.31304 | 16 |
| 26 | 1.94737 | 5 | 2.40541 | 6 | 0.45144 | 5 |
| 27 | 2.42105 | 1 | 3.02703 | 1 | 0.56808 | 1 |
| 28 | 2.02632 | 3 | 2.47368 | 4.5 | 0.51192 | 3 |
| 29 | 2.18421 | 2 | 2.76316 | 2 | 0.53444 | 2 |
| 30 | 1.86842 | 6 | 2.47368 | 4.5 | 0.41182 | 6 |

Table 48

Mean Difference, WNI, and Del-N Values with their Associated Ranks for Questions 1 to 30 at Middle School B (n = 9)

| Question Number | Mean Diff Value | Mean Diff Rank | WNI Value | WNI Rank | Del-N Value | Del-N Rank |
|---|---|---|---|---|---|---|
| 1 | 1.66667 | 3 | 1.88889 | 4 | 0.41289 | 4 |
| 2 | 1.22222 | 14.5 | 1.33333 | 15.5 | 0.32417 | 17 |
| 3 | 0.88889 | 26.5 | 0.88889 | 27.5 | 0.25851 | 28 |
| 4 | 0.88889 | 26.5 | 1.00000 | 25 | 0.27984 | 25 |
| 5 | 1.77778 | 2 | 2.11111 | 2 | 0.48560 | 2 |
| 6 | 1.22222 | 14.5 | 1.55556 | 9.5 | 0.35720 | 14 |
| 7 | 1.55556 | 5 | 1.88889 | 4 | 0.41863 | 3 |
| 8 | 0.77778 | 29 | 0.77778 | 29 | 0.28311 | 24 |
| 9 | 1.11111 | 17 | 1.11111 | 21.5 | 0.36566 | 12 |
| 10 | 1.00000 | 21.5 | 1.00000 | 25 | 0.31929 | 20 |
| 11 | 0.88889 | 26.5 | 1.00000 | 25 | 0.30815 | 22 |
| 12 | 1.33333 | 11 | 1.33333 | 15.5 | 0.37727 | 10 |
| 13 | 1.55556 | 5 | 1.66667 | 7 | 0.39903 | 9 |
| 14 | 1.33333 | 11 | 1.55556 | 9.5 | 0.40433 | 7 |
| 15 | 1.11111 | 17 | 1.22222 | 18.5 | 0.32718 | 16 |
| 16 | 1.00000 | 21.5 | 0.88889 | 27.5 | 0.25971 | 27 |
| 17 | 1.11111 | 17 | 1.33333 | 15.5 | 0.32122 | 19 |
| 18 | 1.44444 | 7.5 | 1.66667 | 7 | 0.41074 | 5 |
| 19 | 0.88889 | 26.5 | 1.11111 | 21.5 | 0.25673 | 29 |
| 20 | 1.00000 | 21.5 | 1.22222 | 18.5 | 0.29891 | 23 |
| 21 | 1.00000 | 21.5 | 1.11111 | 21.5 | 0.31432 | 21 |
| 22 | 1.33333 | 11 | 1.44444 | 12 | 0.36534 | 13 |
| 23 | 0.55556 | 30 | 0.66667 | 30 | 0.20149 | 30 |
| 24 | 1.00000 | 21.5 | 1.11111 | 21.5 | 0.32201 | 18 |
| 25 | 1.00000 | 21.5 | 1.33333 | 15.5 | 0.27929 | 26 |
| 26 | 1.33333 | 11 | 1.44444 | 12 | 0.34820 | 15 |
| 27 | 2.11111 | 1 | 2.55556 | 1 | 0.54084 | 1 |
| 28 | 1.44444 | 7.5 | 1.66667 | 7 | 0.39956 | 8 |
| 29 | 1.55556 | 5 | 1.88889 | 4 | 0.40746 | 6 |
| 30 | 1.33333 | 11 | 1.44444 | 12 | 0.37131 | 11 |

Table 49

Mean Difference, WNI, and Del-N Values with their Associated Ranks for Questions 1 to 30 at Middle School C (n = 12)

| Question Number | Mean Diff Value | Mean Diff Rank | WNI Value | WNI Rank | Del-N Value | Del-N Rank |
|---|---|---|---|---|---|---|
| 1 | 1.41667 | 5.5 | 1.66667 | 6 | 0.29964 | 9 |
| 2 | 1.00000 | 18 | 0.91667 | 19.5 | 0.19777 | 23 |
| 3 | 1.08333 | 14.5 | 1.08333 | 17 | 0.22082 | 21 |
| 4 | 0.66667 | 26.5 | 0.50000 | 27.5 | 0.21166 | 22 |
| 5 | 1.33333 | 7 | 1.50000 | 8 | 0.28347 | 13 |
| 6 | 1.58333 | 4 | 2.00000 | 2 | 0.34855 | 6 |
| 7 | 1.08333 | 14.5 | 1.33333 | 13 | 0.28355 | 12 |
| 8 | 0.91667 | 20 | 1.00000 | 18 | 0.27431 | 15 |
| 9 | 1.00000 | 18 | 1.25000 | 15 | 0.27186 | 16 |
| 10 | 1.16667 | 12 | 1.16667 | 16 | 0.28373 | 11 |
| 11 | 1.25000 | 9.5 | 1.41667 | 10.5 | 0.30697 | 8 |
| 12 | 0.75000 | 25 | 0.83333 | 21.5 | 0.24643 | 18 |
| 13 | 1.66667 | 2.5 | 1.91667 | 3 | 0.39657 | 3 |
| 14 | 1.41667 | 5.5 | 1.83333 | 4.5 | 0.35959 | 5 |
| 15 | 1.25000 | 9.5 | 1.50000 | 8 | 0.32353 | 7 |
| 16 | 0.83333 | 22.5 | 0.75000 | 23.5 | 0.15388 | 25 |
| 17 | 0.50000 | 29 | 0.33333 | 29.5 | 0.08659 | 28 |
| 18 | 0.83333 | 22.5 | 0.66667 | 25 | 0.08426 | 29 |
| 19 | 0.66667 | 26.5 | 0.33333 | 29.5 | 0.10760 | 27 |
| 20 | 0.50000 | 29 | 0.50000 | 27.5 | 0.07578 | 30 |
| 21 | 1.08333 | 14.5 | 1.33333 | 13 | 0.27517 | 14 |
| 22 | 0.50000 | 29 | 0.58333 | 26 | 0.14729 | 26 |
| 23 | 1.00000 | 18 | 0.91667 | 19.5 | 0.23146 | 19 |
| 24 | 1.08333 | 14.5 | 1.33333 | 13 | 0.27126 | 17 |
| 25 | 0.83333 | 22.5 | 0.83333 | 21.5 | 0.22927 | 20 |
| 26 | 1.25000 | 9.5 | 1.50000 | 8 | 0.28518 | 10 |
| 27 | 1.83333 | 1 | 2.25000 | 1 | 0.42704 | 2 |
| 28 | 1.25000 | 9.5 | 1.41667 | 10.5 | 0.36114 | 4 |
| 29 | 1.66667 | 2.5 | 1.83333 | 4.5 | 0.43623 | 1 |
| 30 | 0.83333 | 22.5 | 0.75000 | 23.5 | 0.17492 | 24 |

Table 50

Mean Difference, WNI, and Del-N Values with their Associated Ranks for Questions 1 to 30 at Middle School D (n = 9)

| Question Number | Mean Diff Value | Mean Diff Rank | WNI Value | WNI Rank | Del-N Value | Del-N Rank |
|---|---|---|---|---|---|---|
| 1 | 0.88889 | 17.5 | 0.88889 | 17 | 0.19221 | 15 |
| 2 | 0.22222 | 29.5 | 0.00000 | 29 | -0.04290 | 30 |
| 3 | 0.66667 | 24.5 | 0.55556 | 23.5 | 0.10292 | 23.5 |
| 4 | 0.88889 | 17.5 | 0.88889 | 17 | 0.22623 | 12 |
| 5 | 1.00000 | 12.5 | 1.00000 | 13.5 | 0.16934 | 16 |
| 6 | 1.22222 | 7 | 1.22222 | 8.5 | 0.25590 | 7 |
| 7 | 1.22222 | 7 | 1.37500 | 6 | 0.23175 | 10 |
| 8 | 0.88889 | 17.5 | 1.11111 | 10.5 | 0.20661 | 14 |
| 9 | 0.88889 | 17.5 | 1.11111 | 10.5 | 0.22869 | 11 |
| 10 | 0.77778 | 21.5 | 0.87500 | 19 | 0.20786 | 13 |
| 11 | 1.11111 | 9.5 | 1.22222 | 8.5 | 0.25395 | 8 |
| 12 | 0.77778 | 21.5 | 0.44444 | 25.5 | 0.15951 | 19 |
| 13 | 1.11111 | 9.5 | 1.33333 | 7 | 0.25889 | 6 |
| 14 | 1.44444 | 4.5 | 1.44444 | 5 | 0.36557 | 3 |
| 15 | 0.44444 | 27 | 0.44444 | 25.5 | 0.04961 | 26 |
| 16 | 0.22222 | 29.5 | 0.00000 | 29 | -0.02472 | 29 |
| 17 | 0.33333 | 28 | 0.11111 | 27 | -0.02307 | 28 |
| 18 | 066667 | 24.5 | 0.66667 | 22 | 0.05177 | 25 |
| 19 | 1.22222 | 7 | 1.00000 | 13.5 | 0.24227 | 9 |
| 20 | 0.88889 | 17.5 | 1.00000 | 13.5 | 0.13834 | 22 |
| 21 | 0.88889 | 17.5 | 0.88889 | 17 | 0.16144 | 18 |
| 22 | 0.66667 | 24.5 | 0.55556 | 23.5 | 0.10292 | 23.5 |
| 23 | 1.00000 | 12.5 | 1.00000 | 13.5 | 0.15220 | 20 |
| 24 | 1.00000 | 12.5 | 0.77778 | 20.5 | 0.14974 | 21 |
| 25 | 0.66667 | 24.5 | 0.00000 | 29 | 0.02376 | 27 |
| 26 | 1.44444 | 4.5 | 1.77778 | 4 | 0.29480 | 5 |
| 27 | 2.11111 | 1 | 2.77778 | 1 | 0.47851 | 1 |
| 28 | 1.88889 | 2 | 2.11111 | 2 | 0.43467 | 2 |
| 29 | 1.55556 | 3 | 1.88889 | 3 | 0.33423 | 4 |
| 30 | 1.00000 | 12.5 | 0.77778 | 20.5 | 0.16339 | 17 |

Table 51

Mean Difference, WNI, and Del-N Values with their Associated Ranks for Questions 1 to 30 at High School B (n = 5)

| Question Number | Mean Diff Value | Mean Diff Rank | WNI Value | WNI Rank | Del-N Value | Del-N Rank |
|---|---|---|---|---|---|---|
| 1 | 1.4 | 14.5 | 1.40 | 20.5 | 0.34398 | 10.5 |
| 2 | 0.4 | 30 | 0.80 | 29 | 0.16645 | 29 |
| 3 | 1.0 | 26.5 | 0.80 | 29 | 0.21274 | 28 |
| 4 | 1.4 | 14.5 | 1.80 | 11.5 | 0.37926 | 6 |
| 5 | 1.4 | 14.5 | 1.20 | 23 | 0.30870 | 22 |
| 6 | 1.4 | 14.5 | 2.00 | 8 | 0.33321 | 14 |
| 7 | 1.0 | 26.5 | 1.20 | 23 | 0.30924 | 21 |
| 8 | 0.8 | 28.5 | 1.00 | 26 | 0.24898 | 25 |
| 9 | 1.6 | 6.5 | 1.80 | 11.5 | 0.36893 | 8 |
| 10 | 1.2 | 23 | 1.20 | 23 | 0.28818 | 23 |
| 11 | 1.2 | 23 | 1.00 | 26 | 0.24843 | 26.5 |
| 12 | 1.2 | 23 | 1.60 | 16.5 | 0.31899 | 18.5 |
| 13 | 1.4 | 14.5 | 1.80 | 11.5 | 0.26708 | 24 |
| 14 | 1.6 | 6.5 | 2.20 | 5.5 | 0.39348 | 5 |
| 15 | 1.4 | 14.5 | 1.60 | 16.5 | 0.33324 | 12 |
| 16 | 1.4 | 14.5 | 1.40 | 20.5 | 0.34398 | 10.5 |
| 17 | 1.4 | 14.5 | 1.60 | 16.5 | 0.32250 | 17 |
| 18 | 1.2 | 23 | 1.00 | 26 | 0.24843 | 26.5 |
| 19 | 1.2 | 23 | 1.60 | 16.5 | 0.31899 | 18.5 |
| 20 | 1.4 | 14.5 | 2.00 | 8 | 0.33321 | 14 |
| 21 | 1.4 | 14.5 | 2.00 | 8 | 0.33321 | 14 |
| 22 | 1.4 | 14.5 | 1.80 | 11.5 | 0.35468 | 9 |
| 23 | 1.4 | 14.5 | 1.60 | 16.5 | 0.31313 | 20 |
| 24 | 1.6 | 6.5 | 2.20 | 5.5 | 0.37336 | 7 |
| 25 | 0.8 | 28.5 | 0.80 | 29 | 0.13236 | 30 |
| 26 | 2.0 | 3.5 | 2.40 | 4 | 0.43268 | 4 |
| 27 | 2.0 | 3.5 | 2.75 | 3 | 0.48561 | 3 |
| 28 | 2.8 | 1.5 | 3.60 | 1.5 | 0.67371 | 2 |
| 29 | 2.8 | 1.5 | 3.60 | 1.5 | 0.68445 | 1 |
| 30 | 1.6 | 6.5 | 1.60 | 16.5 | 0.32291 | 16 |