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Review

Developing a modified delta N method for training needs assessment

Bahgat M. Abdel-Maksoud

Department of Rural Sociology and Agricultural Extension, Faculty of Agriculture, Assiut University, Assiut, Egypt.
E-mail: bahgatm43@yahoo.com.

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This paper briefly reviewed different methods/techniques for training needs assessment, particularly, Delta N method. It explained Delta N, its computation, highlighted its drawbacks and, more importantly, proposed a modified Delta N method. The paper, further, presented empirical findings of actual data gathered to assess training needs for extension personnel in the area of Information Communication Technology (ICT) in Assiut governorate, Egypt. The results of the modified Delta N were presented and discussed in comparison to those of Delta N method. The application of the proposed modified Delta N method, in addition to its computation simplicity, needed no postulated assumptions and gave more logical and convincing results. Findings of this paper, in particular the validation of the proposed modified Delta N method, contribute significantly in developing training and extension needs assessment methods in the field of agricultural extension education.

Key words: Delta N, Egypt, extension, ICT, modified delta N, training needs assessment methods.

INTRODUCTION AND STUDY OBJECTIVES

Needs assessment refers to the process of identifying problems/needs and placing them in some order of priority. It is a systematic process for establishing priorities and making decisions regarding program planning, development and operations (McCaslin and Tibezinda, 1998; Sofranko and Khan, 1988). Extension and training programmes, in order to be effective, should be based on accurate precisely determined needs. Sofranko and Khan (1988) argue that “needs assessments are the mainstay of extension programming”. There are many quantitative/qualitative needs assessment methods and techniques. Each has its advantages and disadvantages, thus, commentators advocate the use of multiple methods for needs assessment as to balance the strengths and limitations of each (Mulroy, 2008: 386).

The most important quantitative methods and techniques used for training needs assessment are: (1) Assessment of knowledge and skills; and competence or ability, (2) Assessment of the degree of importance, (3) Assessment of the discrepancy between importance and knowledge or competency, (4) A 2 x 2 low-high importance / knowledge or competency matrix, (5) Borich model, and (6) Delta N method. All these methods are based on identifying individuals’ perception of their levels of knowledge, and skill or competence concerning particular issues or items and their perception of the degree of importance of these issues or items. Data are often gathered through a survey using a five point Likert scale ranging from very low to very high (Halim and Ali, 1998 and McCaslin and Tibezinda, 1998). When assessing knowledge and skills, competence or ability, individuals who have low levels of knowledge and skills or competence can be determined. Items can be ranked according to knowledge mean or the discrepancy between the existing and the desired level of knowledge. When adopting the degree of importance method for training needs assessment, contrary to the previous method, high degree of importance indicates a high need for education or training. Assessment of the discrepancy between importance and knowledge or competency depends on measuring the difference between respondents’ perception of the degree of importance of each item and their levels of knowledge about it. The greater the difference is, the greater the need for extension education or training.

The 2 x 2 low-high importance / knowledge or competency matrix was identified by Hershkowitz in 1973

(McCaslin and Tibezinda, 1998). A 2 x 2 low-high matrix is created to establish priorities according to importance and knowledge skill, or competence. An overall mean score is calculated for ability and importance for all items. Then items can be distributed on the four quadrants of the matrix (low knowledge - low importance, low knowledge - high importance, high knowledge - low importance, and high knowledge - high importance). Individuals also can be distributed on the same basis and items or individuals most need education and training can be determined. Borich model was developed by Borich in 1980 and adopted by many researchers (see for example: Pigg et al., 1995; Nieto et al., 1997; McCaslin and Tibezinda, 1998; Bowe et al., 1999; Gregg and Irani, 2004). According to Borich model (Borich, 1980), training needs can be calculated using the following formula:

(Training need = (Importance - Knowledge) × Mean Importance)

Training needs are computed for all items, issues, topics and skills and then ranked accordingly. These training needs can be computed for each item and also for individuals to determine their training needs.

Delta N method was devised by Misanchuk in 1984. Since this method is the core of this paper, it is discussed in details in this paper. The main objective of this paper is to develop a modified Delta N method to be used for needs assessment. This will be achieved through the following stages:

1. Describing Delta N statistic, its computation method and its drawbacks.
2. Developing a modified Delta N method for needs assessment to overcome drawbacks of Delta N method.
3. Presenting an empirical application of the modified Delta N method with a comparison to Delta N method to assess training needs for extension personnel in the area of information communication technology (ICT) in Assiut governorate, Egypt.

Delta N method

Delta N method was devised by Misanchuk in 1984, and adopted by Pigg et al. (1995) to analyze survey results carried out by university extension on 17,000 Missouri citizens for needs assessment. The computation of Delta N is based on distributions of responses on a five point scale according to perceived relevance or importance of an item or skill and perceived level of knowledge or competence concerning that item or skill. The method of computation of Delta N involves establishing cell values following the proportionate reduction in error approach defined by Hildebrand in 1977 (Misachuk, 1984). This approach predicts the probability of occurrence of certain combinations of joint distribution.

Misanchuk argues that “it is reasonable to say that the highest need exists for that skill in which all respondents show a great lack of competence coupled with a great job relevance, that is, all respondents fall into cell (1,5)” (Misachuk, 1984:29). In prediction terms, no error is made in predicting maximum need for a given skill if all respondents fall into cell (1, 5). Accordingly, “cell (1, 5) is an errorless cell while all the other cells are error cells” (Misachuk, 1984: 30). Misanchuk suggests an error weight of zero for cell (1, 5), and increasing error weights for the other cells as we move remote from cell (1, 5) giving the highest error weight (the worst or the whole error) to cell (5, 1). Suggested values for error weights for Delta N computation are shown in Table 1.

The computation method of Delta N is well explained by Misanchuk (1984 and 1987), formula is presented in Appendix 1. The numerator is calculated for nonzero cells only, and marginal totals are used to calculate the denominator. If the observed marginal totals are used, values of the denominator will be near the value of the numerator and result in unconvincing Delta N values. Misanchuk points out that “it makes more sense to assume some prior knowledge of the expected distribution than to allow the observed marginal probabilities to determine the expected distribution. If the marginal probabilities are known, the denominator of the above equation becomes defined independently from the observed data” (Misanchuk, 1984: 31).

Misanchuk proposes a number of distributions that can be postulated: flat (0.2, 0.2, 0.2, 0.2, and 0.2), normal (.036, 0.238, 0.451, 0.238 and 0.036) and monotonically increasing set (0, 0.1, 0.2, 0.3 and 0.4) as one moves away from the upper left corner of the needs assessment data matrix (Misanchuk, 1984: 31). Therefore, the denominator is calculated for all cells. The denominator of Delta N equation using a postulated flat set of marginal total probabilities as shown above and the suggested error weights given in Table 1 will equal .5610. However, if a normally distributed marginal total probabilities are assumed, and following the same procedure, the denominator will equal 0.5234. If a monotonically increasing set are assumed, the denominator will be 0.5867. These values of the denominator will not be affected if the distribution of respondents has changed. If all respondents fall into cell (1, 5), Delta N will equal one assuming any marginal total probabilities since the numerator equals zero. Misanchuk suggests a hypothetical example including six different distributions of 45 respondents (Misanchuk, 1984). Delta N was computed for these distributions using the above three postulated distributions (flat, normal, and increasing monotonically distributions). The range of obtained Delta N values included some negative values (Table 2).

Critiques of delta N method

Delta N method, recalling from the aforementioned

Table 1. Suggested error weights for computing delta N.

Competence*	Importance* 1	2	3	4	5
1	0.7071	0.5303	0.3536	0.1768	0.000
2	0.7289	0.5590	0.3953	0.2500	0.1768
3	0.7906	0.6374	0.500	0.3953	0.3536
4	0.8839	0.7500	0.6374	0.5590	0.5303
5	1.000	0.8839	0.7906	0.7289	0.7071

Source: Misancuk, 1984: 30. Both importance and competence are measured on a five point Likert-type scale ranging from 1 (very low) to 5 (very high). Values in the body of the Table show the error weights. If all respondents fall in the cell (1, 5) where their level of competence is very low and the degree of importance of the item is very high, the error will equal zero, and if all respondents fall in the cell (5, 1) where their level of competence is very high and the degree of importance is very low, the error will equal one. The error weights increase as one moves through any direction from cell (1, 5) to cell (5, 1).

Table 2. Delta N and the modified delta N values.

Distribution	Delta N* Flat	Normal	Monoton.	Modified** Delta N
1	0.9552	0.9488	0.9543	0.9731
2	0.7939	0.7795	0.8029	0.8843
3	0.6785	0.6560	0.6926	0.8196
4	0.3570	0.3121	0.3851	0.6395
5	- 0.2964	- 0.3869	- 0.2397	0.2728
6	- 0.5178	- 0.6237	- 0.4513	0.1486

*Source: Misanchuk, 1984: 33. ** Calculated from data assumed by Misanchuk, 1984. The values in the body of the Table represent training needs for assumed distributions. The greater these values are, the greater the training needs are.

discussion, is based on a strong assumption that it assumes a postulated marginal probability distribution to calculate the denominator which might result in meaning-less negative values which, in turn, affects the method's interpretability, hence, applicability. Accordingly, the author proposes a modified method of computing Delta N. The proposed modified method is explained next.

The modified delta N method

This modified Delta N method is based on the logic of the proportionate reduction of error. Following the same logic, one would expect that the values of Delta N should be ranged between zero and one. It should equal one if all respondents fall in cell (1-5) (very important and very low level of knowledge) where the error weight equals zero, and where the highest need can be predicted. Its value goes down nearer to zero as it remotes away from cell (1-5) through any direction until it vanishes or becomes zero if all respondents fall in cell (5-1) (not important and high level of knowledge) where the error weight equals one, and where the need for education and training becomes zero. The author proposes that values of Delta N and the observed error are regarded as two complementary proportions where the summation of them adds up, proportionately, to the value of one.

According to the above explanation, the modified Delta N equals the difference between one and the observed error. It can be computed simply by subtracting the observed error from one, or by using the modified Delta N equation presented in Appendix (2). Alternatively, the modified Delta N can be computed by eliminating the proportionate error weight when computing the denominator of Delta N equation. Therefore, the modified Delta N value can be computed simply by subtracting the value of the numerator in Delta N equation from one. To further elaborate on the above point, the hypothetical example presented by Misanchuk (1984) is extended. As mentioned earlier, Misanchuk assumes six different distributions of 45 responses. The modified Delta N and Delta N are computed assuming the three postulated marginal total probabilities suggested by Misanchuk (a flat, a normal, and a monotonically increasing set). It can be seen from the results that the values obtained by using the modified Delta N are consistent with those obtained by adopting Delta N method and the ranks of the six different assumed distributions are the same using

Table 3. Results of the application of Delta N and the Modified Delta N to assess training needs for extension personnel in Assiut governorate, Egypt in the Area of ICT.

ICT Skills	Delta N*			Modified** Delta N
	Flat	Normal	Monoton.	
Word processing	0.5945	0.5653	0.6122	0.7725
Spread Sheet	0.6381	0.6122	0.6540	0.7970
Data Base	0.6428	0.6171	0.6584	0.7996
E-Mail	0.6237	0.5967	0.6402	0.7889
Chatting	0.6398	0.6139	0.6555	0.7979
Attached Files	0.6253	0.5984	0.6417	0.7898
The Internet	0.5850	0.5552	0.6032	0.7672
Web Sites	0.5986	0.5697	0.6162	0.7748
Presentation	0.6223	0.5951	0.6388	0.7881
Use of ICT in Extension	0.6007	0.5720	0.6182	0.7760

* Source: Calculated from data collected from respondents. The values in the body of the Table represent training needs for ICT skills. The greater these values are, the greater the training needs are.

methods (Table 2). The application of Kendall and Spearman rank correlation coefficients between the values obtained by using these two methods has resulted in a positive correlation coefficient equals one. The empirical framework section, presented next, provides an empirical survey to assess training needs for extension personnel in Assiut governorate, Egypt, using Delta N and the proposed modified Delta N methods.

The empirical framework

The responsibility of agricultural extension in Egypt rests in the hands of the central administration for agricultural extension which is one of several central administrations at the ministry of agriculture. This central administration represents the top level of the extension system in Egypt and includes several subunits, departments and sections across Egypt. At the governorate level, there is an administration for agricultural extension which also has a number of departments representing general administrations and departments at the national level. In addition to this there is an administration for agricultural extension centres which had been established in some villages overall the county. These extension centres were equipped with information communication technology (ICT) and their personnel should have been trained on the use of this technology and its skills.

The size of agricultural extension workforce in Assiut governorate at the time of carrying out the empirical study was 456 staff. Out of them, 155 were working at the 21 extension centres established in Assiut governorate. The empirical survey was carried out to assess training needs for extension staff working at these centres in the area of ICT in Assiut governorate where the project of Virtual Extension and Research Communication Network (VERCON) had been implemented and extension personnel at these centres were expected to be aware of ICT and its uses in agricultural extension. A survey was conducted on all extension staff at the extension centres in Assiut governorate. Data were collected throughout personal interviews with respondents during May - July 2007 using structured questionnaire forms. Ten ICT skills were considered in the survey, these are: word processing, spread sheets, data base, e-mail, chatting, attaching files, searching the Internet, web pages, presentation, and use of ICT in extension. The questionnaire form included questions concerning respondents' characteristics and their evaluations of the degree of importance, levels of knowledge and use of ICT skills. For data analysis, SPSS (14) was used and the proposed modified Delta N and Delta N methods were adopted.

Most respondents (58%) are 50 years or more; 49% of them hold diploma of agricultural secondary schools, and nearly half (48%) hold a university degree in agricultural sciences and three quarters of them have ten years or more of relevant work experience. Although the vast majority of respondents (91.6%) perceived the importance of ICT to be high, most of them have low or very low level of knowledge on it and did not have a personal computer (69 and 89% respectively). Three quarters of them (75%) never received any training on ICT, and only 15.5% of them worked for VERCON which interprets the low level of use of ICT reported above.

Based on the distribution of respondents according to their perception of the degree of importance ad their level of knowledge of each skill, training needs are computed using Delta N and the modified Delta N methods. Results show that the values obtained by using the modified Delta N are consistent with those values obtained by using Delta N method assuming different marginal total probabilities (Table 3). Ranking ICT skills according to these two methods reveal the same results where data base, chatting, spread sheets, attaching files, and e-mail appear to be the top five skills that need training (Table 3). The application of Kendall and Spearman rank correlation coefficients between the values obtained by using these two methods has resulted in a positive correlation coefficient of one.

SUMMARY AND CONCLUSION

Different methods of training needs assessment are briefly reviewed. Delta N and its computation method are described. Drawbacks of Delta N are identified as follows: (1) the strong assumption upon which Delta N is based, (2) the meaningless negative values which may be obtained, and (3) Delta N needs a postulated marginal probability distribution to be assumed to calculate the denominator of Delta N equation. A modified Delta N method is developed and proposed. The proposed modified method and Delta N method are applied empirically to assess training needs in the area of ICT for 155 extension staff in Assiut governorate, Egypt. Results show that the proposed modified Delta N is consistent with Delta N and ends up at the same ranks. It, though, needs no postulated assumption of data distribution, and gives more convincing values for needs, in addition to its simplicity of computation. Therefore, the proposed modified Delta N is recommended as a proper tool to be used for extension and training needs assessment in the field of agricultural extension education.

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APPENDIX

Appendix 1: Delta N equation

$$\text{Delta N} = 1 - \frac{\sum_{i=1}^{R} \sum_{j=1}^{C} \text{Wij Pij}}{\sum_{i=1}^{R} \sum_{j=1}^{C} \text{Wij Pi Pj}}$$

Appendix 2: The modified delta N equation

$$\text{Modified Delta N} = 1 - \sum_{i=1}^{R} \sum_{j=1}^{C} \text{Wij Pij}$$

Keys to equations in Appendix 1 and Appendix 2

Ri: Refers to rows from i = 1 to 5,
Cj: Refers to columns from j = 1 to 5,
Wij: The error weight for cell (i,j),
Pij: The probability of a randomly sampled observation falling into cell (i,j),
Pi and Pj: The expected marginal probabilities for rows (Ri) and columns (Cj) respectively.