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A Discrepancy in Discrepancy Scores? Comparing the Borich and Ranked Discrepancy Models for Determining Professional Development Needs

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Abstract

The Borich (1980) model has been widely used to determine professional development (PD) needs of school-based agricultural education (SBAE) teachers over the past 40-plus years. However, recent criticism, primarily focused on a purported statistical issue, has led to development of the Ranked Discrepancy Model [RDM (Narine & Harder, 2021)] as a potential alternative. This article provides perspective on the statistical issue in question and compares the results of using the Borich model and the RDM to assess precision agriculture (PA) PD needs of Arkansas SBAE teachers (*N* = 44). Our quantitative results indicated the two models produced different PD priorities, especially among the highest rated priorities. The mean weighted discrepancy scores [MWDSs (Borich model)] and the ranked discrepancy scores [RDSs (RDM)] had a shared variance of 54.8%; the PD priority rankings established by the two methods had a shared variance of 47.6%. Additionally, the number of tied priorities with the RDM complicated identifying priority PD workshop topics. We recommend further research and dialogue before wholesale abandonment of the Borich model for the RDM as a method of determining PD needs.

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Introduction

Beginning with Barrick et al. (1983), the Borich (1980) needs assessment model has been widely used to determine the professional development (PD) needs of school-based agricultural education (SBAE) teachers (Garton & Chung, 1997; Johnson et al., 1990; Newman & Johnson, 1994; Smalley et al., 2019). Responding to needs assessments based on the Borich model, teachers rate the importance of and their ability to perform specific competencies, typically on a 1 to 5 (1 = *low importance/ability* and 5 = *high importance/ability*) scale. Weighted discrepancy scores are calculated for each respondent on each competency by subtracting the ability rating from the importance rating and multiplying this difference by the mean importance rating for the competency. Lastly, mean weighted discrepancy scores (MWDSs) are determined by calculating the mean of the weighted discrepancy scores for each competency. Competencies with higher MWDSs indicate higher priority PD needs.

Narine and Harder (2021) criticized the Borich (1980) model because it requires researchers to calculate means "for single items measured with ordinal scales (i.e., individual competency items)" (p. 98). As an alternative, they proposed the Ranked Discrepancy Model (RDM). With the RDM, respondents still use individual Likert-type items to rate the importance and their ability relative to a set of competencies, but percentages are used to calculate the ranked discrepancy scores (RDSs) used to establish PD priorities. Using data from a needs assessment of county Extension agents, Narine and Harder used the Borich model and the RDM and found "a great deal of consistency in rankings, despite the RDM discarding the use of the group mean in calculations" (Narine & Harder, 2021, p. 108). Despite this finding, further research is needed prior to wholesale abandonment of the Borich model for the RDM.

Conceptual Framework

Stevens (1946) proposed a scale of measurement containing four levels (nominal, ordinal, interval, and ratio) and statistics for use with variables measured at each level. Stevens' measurement scale constituted a hierarchy moving from nominal to ratio, with each successive level incorporating all the characteristics of the previous level(s). For example, interval level measurements incorporate the characteristics of mutual exclusivity (from the nominal level) and order (from the ordinal level), while adding the characteristic of equality of intervals. Of relevance to our discussion is Stevens' stipulation that the mean is not appropriate for variables measured below the interval level.

Use of the Borich (1980) model of needs assessment requires the calculation of mean importance ratings and MWDSs based on single-item, Likert-type ordinal scales, which is contrary to Stevens (1946) and was one of Narine and Harder's (2021) primary criticisms of the Borich model. While many scholars (Jamieson, 2004; Narine & Harder, 2021; Stevens, 1946) have been adamant in considering data from these scales as ordinal and argued against calculating means, other scholars (Gaito, 1980; Harwell & Gatti, 2001; Lord, 1953; Norman,

2010; Zumbo & Zimmerman, 1993), who also have recognized these measurement scales as ordinal, have argued in favor of calculating means on these items.

According to Gaito (1980) this fundamental disagreement has resulted from confusion between measurement theory and statistical theory. In measurement theory, “The validity or authenticity aspect brings into focus the meaning underlying the numbers that are used to indicate amounts of the characteristics of concern” (Gaito, p. 567). From a measurement theory perspective, the differences in the characteristic being measured may not be equal between scale numbers, so the level of measurement is ordinal. This is a measurement issue related to the meaning of numbers relative to the characteristic being measured.

Gaito (1980) stated that in statistical theory, the “meaning of numbers does not enter the picture because, as Lord (1953) stated, ‘the numbers do not know where they came from’” (p. 566). Thus, according to statistical theory, the mathematical difference between a rating of 1 and 2 and between a rating of 4 and 5 are equal. Consequently, from a statistical perspective use of the mean (and other parametric statistics) is permissible. Gaito concluded by stating:

> In mathematical statistics literature one will not find scale properties as a requirement for the use of various statistical procedures. This requirement is merely a figment of the imagination of a number of psychologists because of a confusion of measurement theory and statistical theory. Statistical procedures do not require specific scale properties (pp. 547–548).

Norman (2010) further clarified the difference between measurement theory and statistical theory stating, “We cannot, strictly speaking, make further inferences about differences in the underlying, latent characteristic reflected in Likert numbers [a measurement issue], but this does not invalidate conclusions about the numbers [a statistical issue]” (p. 629). Harwell and Gatti (2001) argued “statistical techniques should not be held hostage to measurement scales because there is no requirement underlying these procedures that ties them to such scales” (p. 107). In the context of the Borich (1980) model, the issue is not whether we can calculate means on these responses, but rather, how to interpret the means in relation to the characteristics being measured. However, with the Borich model, no direct interpretation of the mean importance ratings is necessary and the resultant MWDSs are interpreted as ordinal measures for determining PD priorities (i.e., no one argues that a competency with a MWDS of 6.0 represents one additional 'unit' of PD need compared to a competency with a MWDS of 5.0, only that the need is greater for the competency with the higher MWDS).

Purpose and Objectives

The purpose of this study was to compare the results of the Borich (1980) model and the RDM (Narine & Harder, 2021) using data collected from a precision agriculture (PA) needs assessment of Arkansas SBAE teachers (Akwah, 2024). Specific objectives were to:

1. Determine and compare the PD priorities as determined by the Borich model and the RDM;
2. Determine the correlation between MWDSs obtained using the Borich model and RDSs obtained using the RDM;
3. Determine the correlation between PD priority rankings determined by the Borich model and the RDM.

Methods

Data were collected from a survey administered to a non-probability sample of Arkansas SBAE teachers (N = 44) immediately before an introductory PA workshop conducted in July 2023. The survey was administered in-person using a paper survey instrument. The instrument contained 29 PA competencies where teachers rated (a) the importance of teaching and (b) their ability to teach each competency using two 1 to 5 Likert-type scales (1 = *no importance/ability*, 2 = *below average importance/ability*, 3 = *average importance/ability*, 4 = *above average importance/ability*, and 5 = *high importance/ability*). A panel of four experts in PA and in social science research, who were informed of the research objectives and participant characteristics, reviewed the instrument and judged it to possess face and content validity (Gates et al., 2018). Coefficients of stability were established using 13 agricultural education graduate students who completed the instrument twice (14-day interval), resulting in coefficients of stability values of r = .94 for importance and r = .87 for ability.

MWDSs were calculated for each competency using Equation 1 (Borich, 1980). In calculating a MWDS for a specific competency, each respondent's ability rating for the competency was subtracted from their importance rating for that same competency, then multiplied by the mean importance rating for that competency. Finally, the MWDS was determined by calculating the mean of all weighted discrepancy scores for that competency. When using 1 to 5 scales to measure importance and ability, MWDSs can range from -4 to 20, with higher scores indicating greater PD needs.

$$\text{MWDS} = \Sigma\,[(\text{Importance} - \text{Ability}) * M_i] / N \quad (1)$$

RDSs were calculated using Equation 2 (Narine & Harder, 2021). In the equation, NR% (percent of negative ranks) represents the percent of respondents rating their ability lower than the importance of a competency; PR% (percent of positive ranks) is the percent of respondents rating their ability higher than the importance of the competency; and TR% (percent of tied ranks) is the percent of respondents giving ability and importance the same rating. RDSs can range from -100 to 100; lower negative scores represent greater PD needs while positive scores

indicate no need for PD. One advantage of the RDM is the range of RDSs is the same regardless of the number of points on the rating scales (Narine & Harder).

$$RDS = NR\% (-1) + PR\% (1) + TR\% (0) \quad (2)$$

Once MWDSs and RDSs were calculated, PD priorities were established for the 29 PA competencies based on both the Borich (1980) model and the RDM (Narine & Harder, 2021). The two sets of priorities were then examined to determine similarities and differences. Next, the two sets of scores were correlated to determine the percentage of shared variance. (Because positive MWDSs indicate PD needs, while negative RDSs indicate PD needs, the absolute value of the correlation coefficient was reported). Finally, the two sets of PD priority rankings were correlated to determine the percentage of shared variance.

Results

Mean weighted discrepancy scores (MWDSs) and ranked discrepancy scores (RDSs) were calculated for each of the 29 PA competencies (C1 – C29) and priority rankings were made based on each type of score (Table 1). The Borich (1980) and the Ranked Discrepancy (Nadine & Harder, 2021) models produced different PD priorities. Based on MWDSs the two highest PD priorities were C29 and C26; when prioritized using RDSs, these competencies were ranked at 10.5 (as part of a four-way tie). Based on RDSs, the two highest PD priorities were C21 and C23; these competencies were rated as the 8th and 7th highest priorities, respectively, using MWDSs. There was greater agreement between priorities for the lower priority competencies. For example, three of the four lowest priority competencies based on both MWDSs and RDSs were C14, C15, and C16.

Table 1

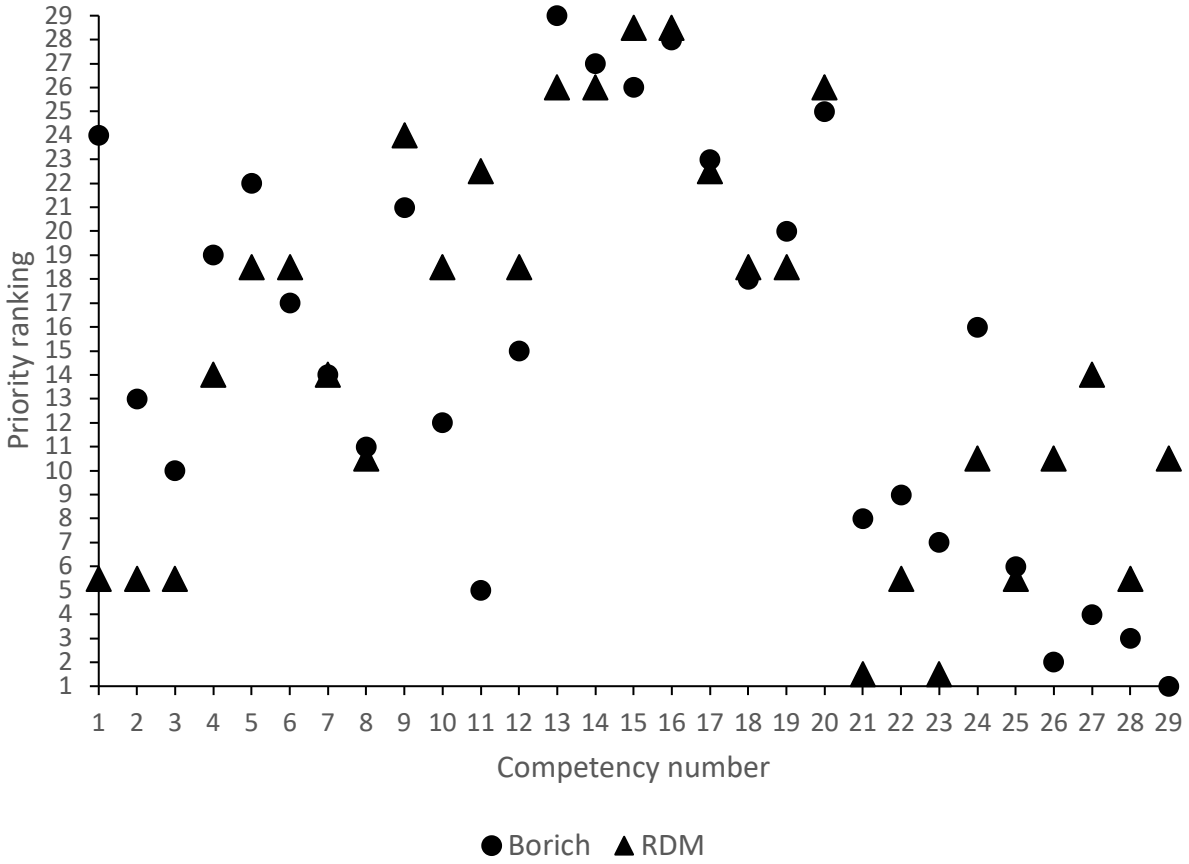
Comparison of PA Professional Development Priorities Based on Borich and RDM Scores

	Scores		Ranks by Model	
Competency	MWDS	RDS	Borich	RDM
C1	9.50	-95.4	24	5.5T
C2	10.54	-95.4	13	5.5T
C3	10.78	-95.4	10	5.5T
C4	10.07	-90.9	19	14T
C5	9.88	-86.4	22	18.5T
C6	10.14	-86.4	17	18.5T
C7	10.40	-90.9	14	14T
C8	10.77	-93.2	11	10.5T
C9	9.91	-81.8	21	24
C10	10.62	-86.4	12	18.5T
C11	11.53	-84.1	5	22.5T
C12	10.36	-86.4	15	18.5T
C13	7.64	-79.5	29	26T
C14	8.22	-79.5	27	26T
C15	8.59	-77.3	26	28.5T
C16	8.19	-77.3	28	28.5T
C17	9.66	-84.1	23	22.5
C18	10.09	-86.4	18	18.5T
C19	9.99	-86.4	20	18.5T
C20	9.09	-79.5	25	26T
C21	10.95	-97.7	8	1.5T
C22	10.88	-95.4	9	5.5T
C23	10.97	-97.7	7	1.5T
C24	10.35	-93.2	16	10.5T
C25	11.24	-95.4	6	5.5T
C26	12.08	-93.2	2	10.5T
C27	11.63	-90.9	4	14T
C28	11.77	-95.4	3	5.5T
C29	12.33	-93.2	1	10.5T

Figure 1 presents a visual display of the priority rankings for each competency based on MWDSs and the RDSs. Overall, the RDM (Narine & Harder, 2021) tended to place lower priority on the competencies the Borich (1980) model prioritized, and prioritized competencies given lower priority by the Borich model. The mean absolute difference in priority rankings across all 29 competencies using the two models was 4.62 (*SD* = 4.60) ranks.

Figure 1

Priority Rankings for PA Competencies Based on the Borich and RDM Models



There was a significant ($p < .001$) correlation between MWDSs and RDSs ($|r| = .74$), indicating one set of scores explained 54.8% of the variance in the other set of scores. This was substantially lower than the .98 correlation ($r^2 = .96$) between MWDSs and RDSs reported by Narine and Harder (2021). Because the ultimate purpose of the Borich and Ranked Discrepancy models is the prioritization of teacher PD needs, a Spearman rank-order rho correlation was calculated between the two sets of priority rankings, resulting in an $r_s = .69$ ($p < .001$), indicating one set of rankings explained 47.6% of the variance in the other set of rankings.

Conclusions, Discussion, and Recommendations

Contrary to Narine and Harder (2021), we found substantial differences between the PD priorities established by the Borich (1980) and Ranked Discrepancy (Narine & Harder, 2021) models. For example, if a PD workshop were to be offered based on the five highest priorities by each method, the Borich model would prioritize, in order, competencies C29, C26, C28, C27, and C11. However, if prioritized by the RDM, the workshop would prioritize competencies C21 and C23, followed by three competencies selected from the tied ranks of C1, C2, C3, C22, C25,

and C28. Depending upon the competencies selected from the six tied RDM ranks, the two workshops would include either zero or one common competency. Consequently, two different PD workshops would be planned and delivered based on whether the Borich model or the RDM was used to prioritize PD content. With the RDM, the prevalence of tied priority rankings complicated decision making, particularly if only a limited number of competencies could be addressed. As a result, the best allocation of scarce PD resources was not clear.

The Pearson-product moment correlation between the MWDSs (Borich model) and the RDSs (Ranked Discrepancy Model) indicated one discrepancy model failed to explain 45.2% of the variance in the other discrepancy model. When comparing ranked PD priorities, the Spearman correlation indicated that one discrepancy model failed to explain 52.4% of the variance in rankings by the other discrepancy model.

The question emerged as to why the scores and the priority rankings differed between the two discrepancy models. Our conclusion was that use of the RDM (Narine & Harder, 2021) reduced valuable information contained in the survey data by not using a measure of overall perceived importance as a weighting factor. As an example, assume two competencies (A and B) were rated by five respondents on 1 to 5 importance and ability scales. Using the RDM, if four respondents (80%) rated competency A as five in importance and one in ability, and one respondent (20%) rated importance as one and ability as five, the RDS would be -60. Likewise, for competency B, if four respondents (80%) rated importance as two and ability as one, and one respondent (20%) rated importance as one and ability as two, the RDS would also be -60, and the two competencies would receive equal priority based on RDSs. However, given the importance ratings, respondents clearly see competency A as more important than competency B; thus, competency A should receive priority as a PD topic. In contrast to the RDM, because the Borich model weights the discrepancy score by the mean importance of the competency, the MWDS for competency A would be 10.08 while the MWDS for competency B would be 1.08. Thus, by including the mean importance for each competency, the Borich model clearly identifies competency A as the priority PD topic. This demonstrates the efficacy of using perceived importance as a weighting factor in determining PD priorities.

There can be legitimate discussion and disagreement related to the measurement and statistical issues of using either the Borich (1980) model or the RDM (Narine & Harder, 2021). The Borich model treats single-item scale responses as interval level data in the calculation of discrepancy scores, weighted discrepancy scores and, finally MWDSs. However, the argument from statistical theory that scale of measurement does not dictate statistical procedures (Gaito, 1980; Harwell & Gatti, 2001; Lord, 1953; Norman, 2010; Zumbo & Zimmerman, 1993) supports this use. Conversely, use of the RDM essentially reduces measurement to -1, 0, or 1, and subsequently ignores the 0 scores. This leads to a reduction of information contained in the original data concerning the importance and ability relative to the competencies. Further, the RDM does not give weight to the overall importance ratings in prioritizing PD needs.

We believe the arguments from statistical theory supporting use of the mean with individual Likert items to calculate MWDSs when using the Borich (1980) model are compelling; however,

for those not convinced and preferring the RDM (Narine & Harder, 2021), a modest suggestion would be to incorporate the median importance into the calculation by multiplying the RDS for each item by the median importance for that item. Perhaps the resulting score might be called a 'median weighted ranked discrepancy score' (MWRDS). When we calculated MWRDSs and correlated these scores to the MWDSs using our dataset, the correlation between scores increased to $|r| = .88$ (from $|r| = .74$) and the Spearman rho correlation between PD priority rankings increased to $r = .86$ (from $r = .69$). Additionally, the mean difference between priority rankings by the two models decreased from 4.62 ($SD = 4.60$) to 2.82 ($SD = 3.49$). Finally, use of the MWRDSs identified the same top five PD priorities as did use of the MWDSs. This illustrated the efficacy of taking item importance ratings into account when determining PD needs.

Agricultural education is a pragmatic discipline (Barrick, 1989) often characterized by applied research conducted to solve practical problems (Dyer et al., 2003; Roberts et al., 2016). This is particularly true of needs assessments used to identify PD priorities for SBAE teachers. According to the pragmatist philosopher Henry James (1907), the "only test of probable truth is what works best in the way of leading us" (Lecture II, para. 55). The Borich model has been used to effectively identify teacher PD needs for over 40 years. Given our results, further research and discussion about measurement, statistical, and methodological issues are needed prior to abandoning the Borich (1980) model in favor of the RDM (Narine & Harder, 2021).

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