An Overview of the Delphi Method's Origin, Modifications, and Use to Augment Instrument Development and Data Collection: A Research Note

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Forecasting or *futuring* is an important task for agricultural education and Extension professionals seeking to position their programs for success in the future (Fox & Garner, 2022). The Delphi method is a forecasting procedure with broad application across disciplines and has been used for many purposes such as examining the impact of historical events on the future, exploring options related to urban planning and rural development, evaluating the implications of new organizational procedures, and developing groups' goals and objectives (Linstone & Turoff, 1975), among others. Delphi methodology is well-established in agricultural education, as broadly defined, and useful for gathering data from participants within a specified field of expertise (Martin & Frick, 1998). The Delphi technique (or method) was designed as a group process aiming to reach consensus of opinion regarding a specific issue or topic (Dalkey & Helmer, 1963). The research technique employs a series of questionnaires through multiple rounds or iterations to collect data from a panel of experts (Hsu & Sandford, 2007). As for the method's reliability, Dalkey et al. (1972) indicated that 11 responses yielded a reliability coefficient of .70, and 13 responses were needed to establish a coefficient of .90.

Martin and Frick (1998) reported that use of the Delphi method in agricultural education dated back to at least 1984 when Curry used it to identify professional competencies needed by agricultural education undergraduates who were not pursuing teaching careers. The authors maintained that, thereafter, the method was used steadily by the profession. Buriak and Shinn (1989) were credited with accelerating the method's implementation through their study to identify the mission, initiatives, and obstacles associated with agricultural education research. Buriak and Shinn used a group of external decision-makers to offer insights on the direction of needed research in agricultural education. As a result, the Delphi method gained more popularity among other researchers in agricultural education and its allied disciplines (Martin & Frick, 1998).

However, in their analysis of the Delphi method's use, as published in the *Journal of Agricultural Education* (*JAE*), Best and Edwards (2024a) found that the first published use of the method was by Lawrence and Mallilo (1981), who

employed it to identify areas of vocational agriculture teacher preparation needing improvement, i.e., three years earlier than what Martin and Frick (1998) reported. This date discrepancy notwithstanding, the method has been used extensively to develop curriculum and to identify a variety of benefits, challenges, and needs associated with agricultural education, among other research topics of interest (Best & Edwards, 2024a). The increased frequency of its appearance in *JAE*, for example, along with its use to explore diverse phenomena, suggests that the method is applicable to a wide range of research topics in agricultural education, Extension, and other related disciplines (Best & Edwards, 2024a).

While such adaptability may be desirable when designing studies, especially if little empirical evidence exists for a phenomenon (Barrios et al., 2021; Hsu & Sandford, 2007), issues with accuracy, validity, and reliability may arise due to the lack of consistency in how the method is deployed (Sackman, 1974). Nonetheless, the method's ease of use, low cost to implement, and simplicity make it popular in social science research (Best & Edwards, 2024a; Sackman, 1974). Moreover, it can be easily modified to address researchers' diverse needs (Adler & Ziglio, 1996). Many consider such adaptability a strength of the method, but this sometimes may have led to confusion and misuse (Sackman, 1974). Our research note is intended to establish the method's origin and procedural standards, uses and modifications over time, as well as describe its utility in augmenting instrumentation and data collection for agricultural and Extension education or related fields of study.

Purpose & Objectives

We sought to explore the origin and adaptations of the Delphi method as a research tool, including its variant or innovative uses over time. Further, by examining a case, we also sought to describe how the method's results can be used to create instruments to collect additional data with implications for enhancing researchers' understandings of phenomena. Three research objectives guided this research note: (1) identify the Delphi method's origin and conventional features as a research tool; (2) describe how researchers procedurally modified the Delphi method; and (3) describe a case in which Delphi study results were used to create a summated-rating scale instrument (i.e., Likert-type) for further data collection and analysis.

Objective 1: Identify the Delphi method's origin and conventional features as a research tool.

The Delphi method was developed in the 1950s as part of a top-secret defense project funded by the U.S. Airforce and conducted by the RAND Corporation (Dalkey & Helmer, 1963). In its earliest iteration, the method was intended for "the systematic solicitation and collation of expert opinions" (Helmer,

1966, p. 1). It arose from the need to establish consensus regarding aerial bombing targets during the Cold War (Dalkey & Helmer, 1963). By soliciting experts' opinions through "a series of intensive questionnaires interspersed with controlled opinion feedback" (p. 458), Dalkey and Helmer (1963) established consensus regarding optimal U.S. bombing targets, i.e., as would be most likely determined by Soviet strategic war planners. Due to their report's sensitive nature, a description of *Project Delphi* (Dalkey & Helmer, 1963) was not released to the public until 1963, a decade after the project had ended (Linstone & Turoff, 1975). Thereafter, the Delphi method became an often-used consensus building methodology of researchers, especially of those in the social sciences (Hsu & Sandford, 2007).

The Delphi method was intended originally to augment predictability and forecasting of long-range policies regarding the use of technology in military contexts (Dalkey, 1969; Dalkey & Helmer, 1963; Helmer, 1966; Helmer & Rescher, 1959). Meant to elicit and refine *group judgments* (Dalkey, 1969), in its earliest usage, the method had three key characteristics: anonymous response, iterative and controlled feedback, and statistical group response. These features worked together to eliminate groupthink or the persuasiveness of a few individuals dominating the views of other Delphi committee or panel members (Helmer, 1966). According to Barrios et al. (2021), anonymity reduces the likelihood of a single, dominant voice influencing the other panelists. Whereas controlled feedback permits panelists to reevaluate their responses based on the information provided by researchers following each round of data collection (Linstone & Turoff, 1975). And statistical response, i.e., analysis usually summarizing frequencies, allows for objective decision making during each round of data collection, culminating with a panel's emergent consensus of agreement (Dalkey, 1969). This is important because panelists' views may change from one round to the next, especially as the group's opinion becomes clearer. As such, Barrios et al. asserted that "the Delphi method is well suited as a consensus-building technique" (p. 1) among a group of purposefully chosen experts.

Stitt-Gohdes and Crews (2004) stressed that adroitly selecting a panel of experts is among the most crucial aspects of Delphi methodology. Study participants serving as experts should be those ". . . who are knowledgeable about current information and perceptions regarding the topic under investigation but are open-minded to the [emergent] findings [coalescing to form group consensus]" (Stitt-Gohdes & Crews, 2004, pp. 60–61). Key to successfully selecting *expert panelists* is to rely on informed opinion rather than random selection (Stitt-Gohdes & Crews, 2004; Wicklein, 1993). Therefore, "Delphi subjects should be highly trained and competent within the specialized area of knowledge related to the target issue" (Hsu & Sandford, 2007, p. 3). Further, qualification criteria should be established prior to panelists' selection based on the population of interest and the study's needs (Hsu & Sandford, 2007). Criteria such as professional affiliations,

similar backgrounds, and prior experiences are important considerations when selecting a Delphi panel's members (Stitt-Gohdes & Crews, 2004).

Objective 2: Describe how researchers procedurally modified the Delphi method.

Over time, the Delphi method was adapted to assist in transforming individual opinions into group consensus through multi-stage, carefully facilitated survey research techniques (Hasson et al., 2000). Moreover, the method can be modified to address the needs of a specific study, making it an appropriate, versatile, and high utility tool in social science research (Adler & Ziglio, 1996). Given this malleability, it may be difficult to ascertain the Delphi method's original structure and procedures prior to such adaptations or modifications by innumerable researchers. As such, Sackman's (1974) 11 standard characteristics of what was termed the *conventional Delphi* are presented verbatim:

(1) The format is typically, but not always, a paper-and-pencil questionnaire; it may be administered by mail, in a personal interview, or at an interactive, online computer console. The basic data presentation and data collection technique is the structured, formal questionnaire in each case;

(2) The questionnaire consists of a series of items using similar or different scales, quantitative or qualitative, concerned with study objectives;

(3) The questionnaire items may be generated by the [study's] director, participants, or both;

(4) The questionnaire is accompanied by some set of instructions, guidelines, and ground rules;

(5) The questionnaire is administered to the participants for two or more rounds; participants respond to scaled objective items; they may or may not respond to open-ended verbal requests; (

6) Each iteration is accompanied by some form of statistical feedback which usually involves a measure of central tendency, some measure of dispersion, or perhaps the entire frequency distribution of responses for each item; (

7) Each iteration may or may not be accompanied by selected verbal feedback from some participants, with the types and amounts of feedback determined by the director [i.e., researcher];

(8) Individual responses to items are kept anonymous for all iterations. However, the director may list participants by name and affiliation as part of the study;

(9) Outliers (i.e., upper and lower quartile responses) may be asked by the director to provide written justification for their responses;

(10) Iteration with the above types of feedback is continued until convergence of opinion or 'consensus' reaches some point of diminishing returns, as determined by the director;

(11) Participants do not meet or discuss issues face-to-face, and they may be geographically remote from one another. (pp. 7–8)

Given this extensive list of operational characteristics, opportunities for modifying the method have been plentiful. The scholarly literature is replete with examples of such. In a review of one publication featuring agricultural and Extension education research, i.e., *JAE*, Best and Edwards (2024b) identified three frequent modifications to the conventional Delphi method that Sackman (1974) described: mode of delivery, number of rounds or iterations, and threshold for reaching consensus of agreement. Each are discussed below.

Although the conventional Delphi was typically conducted through "pencil-and-paper questionnaires" (Sackman, 1974, p. 7), in the last few decades, technological advancements have allowed other methods of questionnaire delivery to emerge (Hsu & Sandford, 2007) and now dominate. In 1975, Linstone and Turoff described two procedural versions of the Delphi method: the *Delphi Exercise* and the *Delphi Conference*. The Delphi Exercise consisted of panelists answering questions on paper and returning their responses to the research team for analysis following each round of a study. The Delphi Conference involved electronic facilitation, i.e., responding by telephone or facsimile (Fax) machines, enabling researchers to gather data more quickly (Linstone & Turoff, 1975). As such, the Delphi Conference was used frequently when panelists were geographically dispersed (Linstone & Turoff, 1975). With today's ubiquity of electronic mail via the internet, researchers increasingly rely on such to conduct studies, and often in conjunction with survey questionnaire software (Dillman et al., 2014). Electronic delivery, therefore, has enabled social scientists to implement the Delphi method more easily in their research endeavors (Hsu & Sandford, 2007).

Another frequent modification of the Delphi method has been the number of rounds, or iterations, administered to gather, return, and finalize data collection (Hsu & Sandford, 2007). Skulmoski et al. (2007) described the Delphi method as "an iterative process used to collect and distill the judgments of experts using a series of questionnaires interspersed with feedback" (p. 2). The Delphi method is considered a multiple-round approach to collecting data (Hsu & Sandford, 2007). Although it can involve numerous rounds to reach consensus, "three iterations are often sufficient to collect the needed information and to reach a consensus in most cases" (Hsu & Sandford, 2007, p. 2). In a review of *JAE*, Best and Edwards (2024b) found that most Delphi studies typically employed from two to five rounds, with three the usual number of data collection points, i.e., in 59 of 79 studies, supporting Hsu and Sandford's (2007) assertion.

The threshold for having reached consensus of agreement has varied somewhat widely among researchers over time. Sackman (1974) contended that the conventional Delphi method can employ as many iterations as the investigator(s) deemed necessary for consensus of agreement to be reached. Several statistical methods for determining consensus have been used in agricultural and Extension education studies and other contexts. Examples include identifying a percentage threshold for agreement a priori (e.g., Flores et al., 2021; Ramsey & Edwards, 2011), predetermined mean score cutoff points (e.g., Myers et al., 2005; Slusher et al., 2011), item rankings (e.g., Connors, 1998; Mantooth & Fritz, 2006), or combinations of these approaches (e.g., Easterly & Myers, 2017; Powell et al., 2023). Of note, disagreement exists regarding the appropriateness of reporting mean scores instead of frequencies, although Sackman's (1974) standard characteristic six mentions using measures of central tendency and dispersion among other statistical approaches to summarizing a Delphi study's findings.

Nonetheless, consensus is an essential component of Delphi methodology and relies on anonymity, controlled feedback, and statistical analysis of a group's responses (Dalkey, 1969; Linstone & Turoff, 1975; Rowe & Wright, 1999). Some trends have emerged regarding ways to refine consensus of agreement (Linstone & Turoff, 1975) in the later rounds of Delphi studies, such as eliminating items that fail to reach the consensus threshold during earlier rounds of data collection. According to Linstone and Turoff (1975), refining a Delphi panel's consensus involves successive rounds of questioning participants to reach a statistically supported convergence of agreement. Variations of this process include reintroducing items failing to achieve consensus in preceding rounds and using Likert-type scales, often with levels of (dis)agreement or importance (e.g., Best & Edwards, 2024b; Flores et al., 2021; Lundry et al., 2015; Ramsey & Edwards, 2011; Wooten et al., 2013) or dichotomous Yes/No or Agree/Disagree response choices (e.g., Eck et al., 2019; Jenkins & Kitchel, 2009; Lamm et al., 2020). As Sackman (1974) indicated, a study's director determines when "convergence of opinion" (p. 8) among the panelists has occurred, providing investigators latitude in deciding how to best determine consensus of agreement for their studies.

Objective 3: Describe a case in which Delphi study results were used to create a summated-rating scale instrument (i.e., Likert-type) for further data collection and analysis.

The Delphi method may be modified or adapted by investigators for specific research contexts and purposes (Adler & Ziglio, 1996). One such study used a Delphi approach to identify the attitudes, knowledge, and skills (AKS) U.S. Extension administrators considered most important for success of the urban Extension workforce to confront its future challenges (Campbell, 2024). This study identified the top 10 challenges facing Extension in urban areas and the top 10 most

important AKS competencies by category for urban Extension professionals. Using a purposive sampling method (Dalkey & Helmer, 1963; Linstone & Turoff, 1975), Extension administrators of various levels with supervisory responsibilities over urban-serving professionals were solicited to serve as the Delphi study's panelists (Campbell, 2024). This portion of a larger study consisted of three phases and was initiated through Qualtrics by using its internal electronic mail distribution function. A message was sent to the potential panelists detailing the research process and expected time period for participation. It was conducted electronically because panelists were distributed across the United States (Campbell, 2024); 14 panelists responded to the study's three rounds, thus supporting its reliability (Dalkey, 2002).

Round one consisted of four open-ended questions about challenges and competencies regarding the delivery of urban Extension (Campbell, 2024). In round two, panelists were asked to rate statements generated in round one using a six-point, Likert-type scale: 1 (*no importance*) to 6 (*highest importance*). Consensus to advance items to round three meant that $\geq 75\%$ of panelists rated items as having either *high* or *highest importance*, i.e., 5 or 6. For round three, panelists were asked to select their top 10 most important items for each of the four lists *and* rank order those items within each respective category. Data from this portion of the study were used to develop a needs assessment instrument to identify gaps in urban Extension educators' competencies and to inform priorities for professional development and onboarding activities targeting these personnel. The Borich model's (1980) approach to data collection and analysis was used during this portion of the study (Campbell, 2024) for its usefulness in prioritizing needs.

Waters and Haskell (1989) suggested that the Delphi method was useful for identifying concepts and gathering information on a topic but has less utility if planning educational programs based on priority needs. It, along with other forecasting methods, do not distinguish between an individual's perceived importance of a topic and their deficit of knowledge about such. However, the Borich (1980) model's mean weighted discrepancy score analysis made this possible by using data derived from the earlier Delphi study, as described above, to develop the larger investigation's needs assessment instrument. As such, gaps in Extension educators' competencies were not only identified but also *prioritized* for professional development offerings and additional research (Campbell, 2024).

Conclusions, Implications, & Recommendations

The Delphi method's versatility enables investigators to query experts on innumerable topics spanning myriad phenomena, positioning it as a valuable research tool in agricultural and Extension education and allied disciplines. The forecasting of future needs and emerging issues, which may include quantitative or qualitative data, or both, are but two of many examples. The method's attributes

coupled with today's electronic delivery modes and platforms make its cost modest while quickening data collection and analysis. It, however, behooves researchers, instructors of research methods courses, editors of scholarly journals and reviewers of the same, including international publications, to familiarize themselves with the origin and formalization of Delphi methodology as a research tool in the social sciences. We recommend consulting the works of Dalkey, Helmer, Linstone, Rescher, Sackman, and Turoff from the 1950s, 60s, and 70s. Sackman's (1974) 11 standard characteristics of a *conventional Delphi*, in particular, should be referenced when modifying or portraying presumed modification(s) of the method, so as to transparently identify adaptation(s) in contrast to the longstanding convention developed to guide the method's use. Doing this would be preferable and more rigorous than relying on secondary sources to describe or justify Delphi researchers' procedural choices.

The Delphi method, albeit an essential forecasting tool, is limited in what it can accomplish if used singularly (Waters & Haskell, 1989). However, coupling the approach with other methods may strengthen its utility and yield more actionable results. Campbell (2024) used their Delphi findings to develop an instrument that both identified gaps in competencies and prioritized related training topics for the professional development of urban Extension personnel. This approach underscores the Delphi method's potential as a foundational step in instrument development and how it can complement other research tools to produce more practical research outcomes. Such may be of particular importance in many international settings where often scant resources exist to conduct social science research and/or the investigatory conditions present significant challenges but, nonetheless, the contexts are in dire need of impactful results.

The validity of describing Delphi findings by using measures of central tendency, especially mean scores and their dispersion (Sackman, 1974), warrants further study. In addition, future inquiries should explore other data collection approaches which may also complement the Delphi method's strengths while compensating for its limitations.

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