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THE DELPHI TECHNIQUE AND EDUCATIONAL PLANNING

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The Delphi Technique, developed by Helmer and others at the RAND Corporation in the 1950s and 1960s, has been widely used by educational researchers and planners for making decisions about the future. This article examines research evidence relating to three aspects of the technique – use of anonymity of response to questionnaires, use of 'expert' respondents and use of pooled nominal group judgments. It looks also at research evidence relating to two claims made for the Delphi Technique, namely that its use reduces or eliminates the effects of socio-psychological variables and that its use produces superior results. The article concludes that, despite its widespread use and 25-year history, the technique's validity is still unestablished.

The Delphi Technique was designed to elicit group opinions for decision-making about the future from a given set of experts (62) and, as such, it has been enthuasiastically received by planners and researchers in education (139). Miller (88) pointed out that educational planners have used the Delphi Technique in five major areas:

> First, it has been used in studies related to cost-effectiveness, particularly in cost-benefit analysis. A second use has been in curriculum and campus planning. A third use has been in statewide, college and university goals and objectives studies. A fourth use has been in relation to rating scales, values and other evaluation elements. Finally, Delphi has been used to identify generalized educational goals and objectives for the future.

Recently, as Dodge and Clark (38) noted, the Delphi Technique has been the object of considerable criticism. Sackman's (111) critique provoked Helmer (62) into labelling it a 'singularly vituperative attack based almost exclusively on .... misconception,' and called forth an entire journal issue of response (*Technological Forecasting and Social Change*, 1975, no. 1).

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Twiss (127), while holding that Sackman's (111) conclusions lacked empirical support, noted that their initial publication by the RAND Corporation (110) had lent them some credence and that, thus, they could not be entirely rejected Helmer (61,62) admitted that the Delphi Technique is open to many justified criticisms – though he rejected Sackman's completely – and that there is a considerable need for further exploration of the whole area of the collection of judgmental data He outlined a number of questions relating to four areas of emphasis in which he would like to see further research (61) Some of these questions were taken up by Dodge and Clark (38) in their review of eight research articles

This article reviews the origins and development of the Delphi Technique and examines in detail three aspects of it the use of expert respondents, the use of anonymity of response and the use of pooled responses It also examines whether the use of the Technique reduces or eliminates the effects of socio psychological variables and whether its use produces superior results, as proponents of the Technique have claimed

ORIGINS OF THE DELPHI TECHNIQUE

The Delphi Technique was originally developed at the RAND Corporation The first published references to it appeared in an article by Helmer and Rescher (63), in which they argued that, as the inexact sciences (i e , basically the social sciences) lacked the mathematically formalized explanatory and predictive methodologies of the exact sciences, such methodologies ought to be developed in order to complement the restricted generalizations (or 'quasi laws') on which explanation and prediction in the inexact sciences are based They claimed that it was desirable that such new methodologies should be based on expert judgment because of the lack of explicitness of background information in the inexact sciences, they further claimed that experts had at their 'ready disposal a large store of (mostly inarticulated) background knowledge and a refined sensitivity to its relevance,' and that 'through the intuitive application' of this background information, experts 'were often able to produce trustworthy personal probabilities regarding hypotheses in (their) area of expertise (63) '

The Delphi Technique was developed as a device to collect, collate and reach consensus on the judgments of an expert group concerning future events – usually the assignment of dates or probabilities to specific future events, or other quantitative estimates relating to possible future events Helmer (60) saw the use of experts as being particularly helpful in the pragmatic applications of the social sciences (i e , with respect to decision

making) where the predictive element is preponderant over the explanatory. He commented that

> the process of choosing among alternative policies for action concerning the future involves (i) forming an image of what the relevant aspects of the future might be, (ii) forecasting probable differential effects of actions called for by alternative policies, and (iii) making preference evaluations between these alternative consequences (60, p.74).

A co-worker of Helmer's, Brown (15), claimed that it was 'inevitable that as questions to be answered get broader and more complex, intuition and judgment must supplement quantitative analysis to an increasing extent' (p.1), a view to which Helmer (62) has consistently adhered.

DELPHI PROCEDURES

The Delphi Technique has three distinctive features:

> (i) anonymity, (ii) controlled feedback, and (iii) statistical group response. Anonymity, effected by the use of questionnaires or other formal communication channels, such as on-line computer communication, is a way of reducing the effect of dominant individuals. Controlled feedback – conducting the exercise in a sequence of rounds between which a summary of the results of the previous round are communicated to the participants – is a device for reducing noise. Use of a statistical group response is a way of reducing group pressure for conformity; at the end of the exercise there may still be a significant spread of individual opinions. Probably more important, the statistical group response is a device to assure that the opinion of every member of the group is represented in the final response (32).

Thus, the basic features of the Delphi Technique as it was originally developed were its procedure of sequential interaction between experts who remain anonymous to each other, and its procedure of providing controlled feedback and statistical group response. As Weaver (139) indicated, however, it is possible to have many variations, and 'modified' Delphi studies seem to be the rule rather than the exception. Gordon (54), for example, describes a variant, termed 'embedded Delphi', in which anonymity is eliminated.

The characteristics of the classic Delphi Technique have been embodied in a set of procedures which, essentially, comprise three steps. The first step involves the selection of a panel of appropriate experts from the

'Advice Community' (29), whose identification is made possible by the precise identification and description of the problem area Each respondent is asked to indicate his opinion on one or more problems in terms of specified criteria Questionnaire techniques are normally used, with the questionnaire items consisting of any combination of codable materials – statements with which the respondents may agree or disagree or questions which respondents can answer by choosing the most appropriate of the responses provided in multiple-choice format In some cases, the initial questionnaire solicits responses to open-ended questions, the responses to which become the codable items in subsequent questionnaires

In the second step, the responses are pooled, coded and averaged in order to obtain, for each item, a measure of group opinion and a measure of the range of opinion Generally, the median and the inter quartile ranges of responses are the measures used This information is returned to respondents

In the third step, respondents are asked to reconsider their opinions, and, for those items for which their responses were atypical, they are asked to provide a written justification of their position

Responses to the re-circulated questionnaire are again analysed and the information returned to respondents, together with the justifications of atypical responses The procedure is continued until it no longer yields significant changes in the expressed views, i e , the cycle is repeated as long as there are moves towards consensus of opinion, where consensus of opinion is measured by convergence towards a measure of central tendency

DELPHI AND EXPERTS

Helmer and Rescher (63) claimed, and Helmer (61) later reiterated, that predicting the future or making judgments concerned with goals and policies must be based not only on specific and explicit evidence, but also on a body of potentially relevant background information which may be neither explicit nor specific Helmer and Rescher wrote that this 'non explicitness of background knowledge, which nonetheless may be significant or even predominantly important, is typical of the inexact sciences ' For these two writers, the persons who possess this background information were defined as 'experts' since they are able to combine such information with empirical evidence to make successful predictions and judgments in areas of specialized knowledge They put it thus

> The important place of expert judgment for predictions in the inexact sciences is further indicated by the prominence of quasi laws among the

> explanatory instrumentalities of this domain. Since the conditions of applicability of such generalizations are neither fully nor even explicitly formulable, their use in specific circumstances presupposes the exercise of sound judgment as to their applicability to the case in hand. The informed expert, with his resources of background knowledge and his cultivated sense of the relevance and bearing of generalities in particular cases, is best able to carry out the application of quasi-laws necessary for reasoned prediction in this field (63).

Many planning situations make use of a group of 'experts', each of whom contributes specialist knowledge in an area relevant to the task at hand. As a number of commentators (113, 143, 144) have observed, however, while the argument put forward by Helmer and Rescher and by RAND Corporation researchers generally, is logical and cogent, research does not support the definition of terms such as 'expert' nor the means of his selection.

Brown (15) admitted that the selection of experts is an intricate problem and suggested that one's expertness could be judged by status among one's peers, by years of professional experience, by the amount of relevant information to which one has had access, or by some combination of objective indices and *a priori* judgment factors. With Helmer, Brown proposed that expertise might be ascertained by a self-assessment of forecast subject-matter knowledgeability by the Delphi participant himself (16). Dalkey (31) suggested that, for most scholarly fields, the community roughly grades its own members, but he pointed out that this could be based merely on volume of publication – a not very effective index of expertise. He suggested also that experts could be selected on the basis of their general intelligence, by gender (he claimed women were less accurate than men in Delphi studies) and by subject or area of study (he claimed that students majoring in the 'soft' sciences and humanities were more accurate predictors than those majoring in physics, mathematics, engineering and the like).

The problem of 'expert' respondents in Delphi studies has been examined by several writers. Sandow (113, 114, 115, 116) put forward the viewpoint that, though a person may describe himself as knowledgeable in an area, he could not ascribe to himself the status of 'expert' since this is a descriptor which is attributed to someone else. Citing Wolfson (146), he noted that claimed expertise about the future was difficult to countenance as the future is a mental construct developed by each individual in his own mind (114). Sackman (110) examined the concept of 'expert' as put forward by the developers of the Delphi Technique, and concluded that

> the Delphi concept of the expert, and its claim to represent valid expert

> opinion, is scientifically untenable and overstated As summarised by Professor Haythorn the procedure by which the selection of subjects occurs is not properly explicated, the exact nature of the panel of experts is often left unspecified, and the implicit assumption that results obtained using conventional Delphi with a panel of experts is better than or different from results that could be obtained using another population has not been empirically established (p 67)

Welty (143, 144) also questioned the role of 'experts' in Delphi studies, drawing attention to two major problems in selecting participants for such studies the problem of differentiation of levels of expertise and the problem of the relevance of experts in forecasting areas where the subject matter related to cultural values rather than to technology With regard to the problem of 'expertise' in value related areas, Welty (143) concluded that it 'may not be relevant', a view echoing that of Marien (79) who categorically stated that 'the Delphi is of little or no use in dealing with social matters, which are considerably more complex and difficult to agree upon than the forecasting of a single crisp event such as three dimensional television (p 15)' Johnston (69) pointed out that persons chosen as 'experts' because they enjoyed the highest professional status in a field were probably fully in tune with the present (as they had probably influenced its development) but they were not necessarily the best persons to turn to for information about the future Turoff (125) also questioned the nature of expertise in Delphi respondents, Milkovich *et al* (87) have echoed Johnston's view, while Pill (101) suggested that most Delphi studies seemed to be akin 'to a Brave New World there is always the use of "experts", and when it is thus used on social questions, the information invariably comes second hand' Both Marien (79) and Welty (114) had suggested that the Delphi Technique was of little use for social questions, but Pill (101) concluded that it was not necessarily harmful, though there was a danger of a loss of contact with the public and he suggested that there was no reason why the Technique should not be used to elicit the opinions of 'mere people' Randolph (103) noted that Soviet researchers have also questioned the use of experts in Delphi studies

As both Sackman (110) and Lonsdale (76) have pointed out, very few researchers have examined the question does the use of 'experts' produce better results? Lonsdale further suggested that the question is, in part, unanswerable, but there are a number of studies which may go some way towards providing some sort of answer

In one of these, eight independent forecasts of the United States Gross

National Product from 1953 to 1963 derived from 'expert' opinion were examined (148). It was found that average observed absolute error for experts was $10 billion, or about 2% of the GNP during this period; it was also found that simple arithmetical extrapolation of the increase occurring in the previous year gave an average absolute error of $12 billion, effectively the same as the average expert prediction. In a further study, Parsons (99) reviewed some 40 large-scale programmes in man-machine system experimentation and concluded that reliance on 'so-called expert system operators' is 'foolhardy'. He suggested that such experts 'may provide suggestive leads, but are not reliable guides, as demonstrated by their repeated disagreement with objective data (p.553).' Nehnevajsa (94) sequentially polled 900 students and 778 legislators in seven countries on their anticipation of cold-war outcomes and concluded that the majority of all correlations (78.3%) exceeded .76, which suggested that the difference in anticipation (or predictions of outcomes) between students and legislators (i.e., the 'experts') was not substantial.

If the seminal studies of Cantril (23), McGregor (84) and Kaplan *et al* (71), to which the RAND Corporation researchers attribute some of the impetus for developing the Delphi Technique, are examined, it will be found that in these studies the expertness of the forecaster had little or no significance in the determination of predictions of complex social events. McGregor (84) concluded that

> the amount of information possessed by the predictor and his sophistication or expertness are shown to have little significance in the determination of predictions concerning complex social phenomena. The quality of information as determined by ambiguity and importance is much more predictive.

Cantril (23) came to a similar conclusion, noting that 'whenever the prediction of a social event is based wholly or in part upon internal frame of reference, objectivity is rare, if not impossible, because of ego-involvement.' He found, too, that the academics – the 'experts' – were less certain of outcomes of events than were the 'men of affairs' – the bankers, insurance executives and newspaper editors – though the differences were not significant. Kaplan *et al's* (71) conclusions are not dissimilar; they found that 'the success of the best informed predictors was not vastly greater than that of the worst informed.'

In a recent study, Nutt (96) examined the quality of output from expert and non-expert (consumer) health planning groups, using the nominal

group technique developed by Delbecq *et al* (36) to produce the plans As a consequence of this well designed experiment, Nutt concluded that the plans produced by expert groups were of a considerably higher quality than those produced by the consumers He found, however, that the consumers produced more innovative plans than did the experts, but that the experts found these plans unacceptable

In their study, conducted for the Jewish Community Federation of Cleveland, Illinois, Reisman *et al* (105) reported on a relatively large-scale Delphi type experiment, the objective of which was to estimate the relative values of services offered by the agency Three groups were used – members of the research staff who were themselves members of the JCF, members of the JCF involved in the services and a panel of lay leaders in the community The investigators reported that there was a 'surprisingly high correlation between the three groups', a result which tends to suggest that experts do not give better and/or more accurate judgments than do non-experts

Other investigators have compared the performance of experts with that of non-experts on a variety of tasks Bedford (6) matched a panel of 26 experts in 'communications, consumer behaviour, sociology and futurism generally' with a panel of 25 housewives, in a two round Delphi study on the future of communications services in the home 'Remarkably few differences between the experts and the housewives on the panel ' (p 1) were found Burks (18,19) matched an expert panel of sociologists with a non-expert panel of adults in predicting the future of the family and found that there were 'no significant differences' between the experts and non expert panelists Snell (120) used both expert and non-expert Delphi respondents to develop community based goals of education and found that though the percentage of responses from the non experts was lower than that from the experts, the goals developed by the two groups were almost identical

Welty (141) replicated a study of Rescher (106) in which Rescher had used a panel of 58 experts – high level scientists and science adminis trators – in a Delphi exercise aimed at determining the impact of technolog ical change on American values Welty used identical questions and procedures but instead of expert respondents he used 192 engineering students He claimed that this replication showed that people in the same discipline but differing in their degree of expertise did not differ in terms of their judgments In a later study, (142), he again replicated the Rescher study, but this time used respondents from an entirely different discipline

(43 sociology students). Again he found no significant differences. On the results of these two studies, Welty has questioned the use of experts in judgmental forecasting.

What picture emerges from this examination of the use of expert opinion in decision-making? Helmer and his colleagues at the RAND Corporation have put forward a cogent, logical and well-reasoned argument concerning the need for using the opinions of experts in decision-making about the future, i.e., in planning. While there is support for this view (83), it also has been challenged (101, 114), and indeed Sackman (111) has dismissed the Delphi concept of the expert as scientifically untenable and overstated.

Some writers (99, 148) who have examined the efficacy of expert opinion have concluded that it is ineffective and unreliable. Those who have compared the output from expert and non-expert groups, by means of either the Delphi Technique or some other process, have found, with one exception, that there has been little difference in the output from the different groups in such factors as quality and accuracy. Thus, the notion of the 'expert' as the sole source of opinion for decision-making about the future is not one supported by research. Despite the claims of Helmer and Rescher (63), the background knowledge of 'experts' may be neither significant nor even predominantly important in planning.

DELPHI AND ANONYMITY

Dalkey (32) wrote:

> Anonymity, effected by the use of questionnaires or other formal communication channels, such as on-line computer communication, is a way of reducing the effect of dominant individuals.

This view was elaborated by Martino (83):

> Delphi is characterized by anonymity .... The group interaction in Delphi is anonymous, in that comments, forecasts, etc. are not identified as to their originator, permitting other members of the panel to respond to them without regard as to how they might feel about the originator. Moreover, since interaction is anonymous, panel members feel fewer inhibitions about changing a previous position.

Helmer (61) raised a number of questions about the use of anonymity in Delphi studies. Among these were questions concerning how this feature

compared with other modes of using experts (such as pooling) and concerning the degree of anonymity that is most helpful to the performance of a Delphi panel

Wildman (145) commented that anonymity, or its lack, is frequently considered as a potential source of bias This view is one accepted by proponents of the Delphi Technique But it is a view that appears not to be borne out by research studies which have specifically investigated the effects of conditions of anonymity and identification on responses to questionnaires Of 19 studies conducted between 1936 and 1974, which compared anonymous and identified responses to questionnaire items, 13 reported no differences between the responses of anonymous and identified respondents (3, 5, 20, 26, 48, 51, 53, 57, 73, 74, 85, 100, 108) while only six did (41, 49, 52, 97, 118, 122), though most concluded the differences were of little practical importance A recent study by Wildman (145) provides further evidence suggesting that anonymity of responses does not affect the outcome of mailed questionnaire studies He examined the effects of anonymity and social setting as potential sources of bias in mail surveys, concluding, that neither 'setting nor anonymity alone or in combination, appeared to affect response beyond chance levels '

DELPHI AND POOLED RESULTS

Helmer and Rescher (63) have discussed numerous ways of arriving at the best use of experts, ranging from the use of a single expert to the pooling of various expert valuations into a single average of some sort, 'possibly the median, or a mean weighted so as to reflect past predictive success ' In developing the Delphi Technique, the notion of pooled opinions was adopted since, it was argued, the statistical aggregation of the group response assured 'that the opinion of every member of the group is represented in the final response (32) '

Sackman (110) suggested that much of the popularity and acceptance of the Delphi Technique rests on the claim of the superiority of group over individual opinions, and the preferability of private opinion over face to face confrontation, with the tacit assumption that pooled opinion of experts is better than that of any subgroup of experts He concluded, however, that Delphi consensus is specious consensus and that the Technique seriously confuses aggregations of raw opinion with systematic prediction

Many investigators using the Delphi Technique take the inter quartile range of responses as reflecting the opinion of the group Since the inter quartile range reflects the viewpoint of only 50% of a group, it cannot be

viewed as a majority opinion. Sandow (114) has commented that 'it is difficult to accept the "consensus" idea when only 50% of the respondents are reported (p.30).' He further remarked that aggregate opinion cannot be construed as representing a valid forecast. Derian and Morize (37) criticized the Delphi Technique for taking the central tendency of pooled opinion at face value as the *best* estimate of group opinion; their findings indicated that subgroups with consistent opinions clustered together, leading them to the suggestion that analyses of subgroups were likely to offer more information to decision-makers than group opinion.

In considering whether pooled opinions of nominal groups are superior to opinions derived from face-to-face confrontation groups, the results of research into aggregating individual opinions in brainstorming, a technique pioneered by Osborn (98), seem relevant. The rationale for this is the observation (68, 75) that the Delphi Technique is essentially a refinement of brainstorming procedures developed by Osborn. Therefore, it seems logical to examine results from the technique closest to the Delphi Technique for clues as to the effectiveness of the procedure of aggregating group opinion.

Three brainstorming studies (21, 40, 123) found that pooling the ideas of individuals working alone produced significantly better results than those achieved by face-to-face groups. As Dunnette *et al* (40) noted: 'The evidence is clear cut; brainstorming is most effective when undertaken by individuals working *alone* in an atmosphere free from the apparently inhibiting influences of group interaction.' Campbell (21) stated that 'the quality of the group solution was inferior to the nominal group's composite score and was even inferior to the average individual's solution.' A number of studies which compared brainstorming to interacting, face-to-face group processes, however, produced results which cannot be seen as conclusively demonstrating differences in the treatments, but rather point to inherent differences in the participant groups (11, 13, 14, 47, 124, 133). Caution must be exercised in the interpretation of results from brainstorming experiments. As has been suggested, the outcomes of these experiments have often been badly misinterpreted. 'For one thing, they do not disprove the effectiveness of brainstorming as a problem-solving method. They simply show that individual creativeness is better than group brainstorming under conditions imposed by these studies (12).'

The findings of other studies which compared pooled and individual results are also inconclusive. Kaplan *et al* (71) reported that when they compared pooled judgments with those of face-to-face groups, they did not

find the two sets of results to be significantly different, an interesting result in light of the importance ascribed to this experiment by the developers of the Delphi Technique On the other hand, Hall *et al* (56) conclude from a study of group solving effectiveness under conditions of pooling and interaction that

> (a) it is possible to obtain a 'group' score which is superior or equal to the majority of individual contributions by pooling, (b) this pooled score is, in turn, significantly inferior to one produced by a group through interaction, and (c) the group judgement approaches the *best* individual judgement rather than the worst

On the basis of these findings and those of brainstorming it is clear that the effect of pooling responses is in need of further research

DELPHI AND SOCIO–PSYCHOLOGICAL PRESSURES

In examining ways of using expert respondents as a source of group opinion, Helmer and Rescher (63) discussed the merits of using face to face confrontation group processes, but they pointed out that consensus valuation under these circumstances is affected by socio psychological influences operating within the group, e g , views of the most respected or of the most persuasive group member The effects of these socio psychological variables have been the subject of several investigations (cf 2, 25, 64, 72, 109, 130, 147) This research (and it is of interest to note that much of it was carried out after the development of the Delphi Technique) indicates the operation of a number of socio psychological processes For example, individuals within groups tend to develop a common set in their approach to the problem under discussion and to behave as if they do not want the group to be divided Further, there is a group pressure to conform, which can distort individual judgment Again, a dominant person, perhaps the most talkative, most extrovert or most highly motivated, can control the discussion to such an extent that his opinion is elevated to the opinion of the majority, an individual's participation may be enhanced or inhibited by his perception of his own expertise in relation to that of the other participants, the presence of a high status person within the group may result in a greater concentration being placed on his ideas than on those of other group members, and this represents an implied threat to group members, group members may be reluctant to abandon publicly held opinions and the desire to win the argument may induce such persons to spend much of their time trying to win over group members rather than in trying to achieve the best solution to the problem Finally, much of the communication

within the group is affected by semantic 'noise', i.e., overt discussion which is covertly concerned with individual and group interests only.

Helmer and Rescher (63) claimed that, as the Delphi Technique eliminates face-to-face contact between participants, replacing it with 'a carefully designed programme of sequential individual interrogations (best conducted by questionnaires) interspersed with information and opinion feedback derived from computed consensus from earlier parts of the program', the influence of socio-psychological variables is reduced. Vaughan (132) demonstrated, however, that the use of a questionnaire may not eliminate such group pressures.

Several investigations have provided evidence relating to the effects of socio-psychological variables in the use of the Delphi Technique. Among the variables which have been found to affect the operation of the technique are social pressure (16), personality traits, especially 'inclusion' and 'affection' needs (22), levels of optimism and pessimism (81), levels of confidence (117) and possibly levels of dogmatism (39, 91, 92).

A number of studies report that the conceptual level of respondents also had a significant effect on the outcomes of Delphi studies (10, 134, 136). Albertson and Cutler (1) hypothesized that since the image of the future held by Delphi panelists should provide the context within which forecasts are made, this, rather than the relative expertise of panelists, might account for differences in forecasting. As predicted, they found that different groups of respondents in fact held different world views and that these world views significantly correlated with forecast length. On the other hand, Meyer (86) did not find significant differences between the responses of people holding different types of values ('emergent' and 'traditional').

A number of investigators examined the effects of perceived self-expertise or 'self-weighting of expertise', some finding that asking participants to rate their own expertise in the subject matter of the study had no effect on the outcomes (22, 24, 90), others that it did (8, 9, 95), while yet another obtained inconclusive results (7). Encel, Marstrand and Page (42) commented:

> The practice of asking panel members to rate their confidence in their answers may contradict the spirit of the technique – the ratings will reflect personality as well as the quality of the answers; and, if much more weight is given to those claiming confidence, one of the problems of the committee style is reintroduced (p.81).

It is obvious that the use of the procedures which characterize the Delphi Technique neither eliminates nor reduces the effect of socio psychological variables Dodge and Clark (38) wrote

> If the Delphi method were shown to interact with personality or other characteristics of the panelists, there would be cause for concern for the validity of the technique

Since there is evidence that there is an interaction between the Delphi Technique and panelist characteristics, the validity of the Technique must be questioned, though it is not clear what the implications of this are for Delphi practitioners

DELPHI VERSUS THE REST

Helmer (62), writing about the use of the Delphi Technique in polling expert opinion, claimed that 'the experimental evidence indicates a slight superiority of Delphi over other procedures' To examine this claim, it is necessary to consider research which has compared results from Delphi panels with results from panels which have used other procedures

Holland (66) compared the Delphi Technique with both questionnaire and committee processes, while Van de Ven (130) compared it with both nominal and interacting group processes Holland's findings indicate that application of the Delphi Technique resulted in more accurate group estimates than could be achieved by either the committee or the questionnaire method, while Van de Ven found that use of the Delphi Technique generated both more and better ideas than did the face to face confrontation group

Gustafson *et al* (73) compared the Delphi Technique with a range of other processes They used a heavily modified Delphi Technique, and concluded that their research findings stood 'in contradiction to the results of the Delphi procedure in the studies of Dalkey and Helmer', i e , the Technique did not produce better results than face to face confrontation group processes This finding must be regarded as inconclusive, however, because the modification used involved Delphi participants in receiving written feedback in each other's presence – a procedure which clearly permitted social facilitation

Campbell (22) compared face to face and Delphi procedures, but so heavily modified the face to face procedures that interaction took place in a Delphi format, e g , meetings were kept within fixed time periods,

with one meeting corresponding to one round of Delphi questioning, while at the same time they were kept leaderless. He suggested that his results showed that the Delphi Technique produced better results than face-to-face meetings, but as his research design handicapped the operations of the face-to-face groups, his findings cannot be regarded as conclusive either.

Farquhar (46) found that participants in face-to-face meetings consistently obtained better results than did participants in his Delphi study, but the difference between the performance of the groups was not statistically significant.

In examining ways in which correctional counsellors and psychologists attached to the California State Department of Corrections prepared pre-sentence recommendations for the courts, Van Gigch and Hommes (131) compared the Delphi Technique and 'group staffing' as a means of achieving consensus. 'Group staffing' was described as

> a meeting during which several counsellors and psychologists (total: six to eight) review a case and render a group decision. At this meeting, the counsellor and the psychologist, who have handled the case scheduled for consideration, make an oral presentation. This presentation consists of summarizing the salient points of the case ... for the benefit of those present. A discussion ensues, questions are asked, points are clarified. Finally, an open oral vote is taken and the recommendation is made (131).

In describing the operations of the 'group staffing' meetings, Van Gigch and Hommes outlined the ways in which they observed the operation of socio-psychological variables such as status-differences and voice-intonation and they claimed that the use of the Delphi Technique eliminated these variables. They reported, too, that consensus was reached in most cases after the first round and in all cases before three rounds. They also concluded however, that the use of the Delphi Technique in this particular context proved it does not lend itself to problems where progressive improvement toward a solution is likely, and that the Delphi Technique is not an appropriate way of reaching consensus on problems or questions where the *opinion* of the panel members is fixed and unchangeable, as was the case in this study. Their final conclusion was that, for this type of problem, a modified face-to-face confrontation 'group staffing' process was the most appropriate method of reaching consensus.

Nardoni (93) compared the results obtained from a Delphi panel of educational planners with those obtained from a group of planners who

responded to a questionnaire, finding that educational planners who had participated in the Delphi process considered more factors as important than did those who responded to the questionnaire In other words, the quality of output from the Delphi panelists was superior to that gained from a questionnaire

The relative effectiveness of three diverse group problem-solving methods – Problem Centered Leadership (PCL), Nominal Leadership (a nominal group process) and the Delphi Technique – in solving a problem that required a solution containing high levels of technical accuracy (quality) and support by the members involved was investigated by Miner (89) He found that, on the acceptance index, the Delphi Technique came second to the PCL process, on the quality index, the Delphi Technique came last On a composite measure of effectiveness, determined by multiplying the quality and acceptance indices, the Delphi technique was significantly inferior to the PCL process and inferior also (though not significantly so) to the nominal leadership process Thus, Helmer's (62) claim that the Delphi Technique is 'slightly' superior to other procedures does not receive consistent support from research findings Rather, it seems that for certain tasks or in certain situations, other techniques or processes may be more useful The Delphi Technique must be seen as only one technique available to planners and decision makers, rather than as the key to all educational planning which some writers have seen it to be (e g , 70)

FURTHER ASPECTS OF THE DELPHI TECHNIQUE

There are a number of other aspects of the Delphi Technique which have been the subject of research, the findings of which raise further questions about its value These will be considered briefly in this section

A number of investigators experimented with feeding back bogus information to respondents, finding that when Delphi panelists were provided with fictitious first round information, second round mean opinion changed in the direction of the feedback provided (28, 50, 117) It would seem that the Delphi Technique can be used to modify or guide opinion as well as collect consensus about it

Barnette *et al* (4) queried a number of aspects of the Delphi Technique They suggested that the iterative procedure provided little useful information after the first round of questioning beyond a decrease in variance and that there is a positive relationship between the length of the questionnaire and return rates They also found that there was a tendency

for convergence to decay with time between rounds, a result also reported by Uhl (128).

Stander and Rickards (121) found that panelists expressed discontent with the length and number of questionnaires and several studies have found extremely high drop-out rates. For example, Lopiano (78) had an approximately 80 per cent attrition rate, while Curran (27) and Robinson (107) had response return rates of approximately 30 per cent. This raises the possibility of a strong self-selection bias among continuing participants.

CONCLUSION

Weaver (140) claimed that educational researchers have 'widely seized upon' the Delphi Technique as a research and planning tool. Furthermore, educational writers have asserted that the Delphi Technique is 'a fairly proven process for gathering and refining opinions (17)' and that it provides educational planners with an important means of making decisions based on 'more objective data than today's crude common sense decision-making method (67, pp. 85-86).'

Many educational researchers and planners who have made use of the Delphi Technique have accepted the claims advanced by its proponents, and the comments of such researchers as Falek (45), Holden (65) and Nardoni (93) are typical of those put forward as reasons for the utilization of the Technique. Pill (101) noted that participation in a Delphi study often produces a high degree of panel commitment to the output; a similar observation can be made concerning the commitment of Delphi's users. Etling (43), Faherty (44) and Randall (102) are three among the many writers who have urged the continued use of the Delphi Technique in educational research and planning.

This article examined the Delphi Technique, its origins and characteristic procedures, and it looked in detail at the use of expert panelists, of anonymous responses to questionnaires, and of pooling of individual judgments to produce a group consensus. The article also looked at two of the claims advanced for the Technique, namely that its use reduces or eliminates the effects of socio-psychological variables and that its output is superior to that produced by other processes. Our review of the research evidence leads us to the conclusion that after a quarter of a century of use – the first Delphi experiment was conducted in 1952 (35) – in a multiplicity of settings, the Technique still cannot be regarded as a proven one. Turoff (125) asserted that the Delphi Technique could be viewed as an

attempt to put human judgment, in terms of a group judgment of experts, 'on a par with a page of computer output', but Rasp (104), however, asserted that the Technique is largely supported and legitimated by assumptions rather than research findings while Sackman (112) claimed that 'the critical scientific literature on Delphi is virtually non existent' The research cited in this article, also suggests that the value of the Technique's emphasis on the use of experts, anonymity of response and pooled judgments is not entirely borne out by research findings Neither are the claims advanced for the Technique concerning the elimination of socio psychological variables and the superiority of its findings supported by research In the light of these conclusions, educational researchers and planners should be advised to temper their enthusiasm for the Delphi Technique with caution and to apply to it the same critical standards they apply to other methods for decision making about the future

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