

A Preliminary Review on Needs Analysis and Delphi Technique: Effective Tools for Data Collection

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ABSTRACT

In any research, data collection is a critical component. Using appropriate data collection approaches or techniques are pertinent to gathering reliable empirical data. This study reviews the concept and application of needs analysis and Delphi technique as effective tools for data collection. Needs analysis is a tool to identify gap or discrepancy. Delphi technique is used in order to gather input from experts for the solution or improvement of the gap, needs or discrepancy identified. This article provides basic description of a combination method of the needs analysis and Delphi technique. Three stages process were discussed for need analysis namely: (a) planning and cause analysis, (b) data collection and analysis, and (c) reporting. When the existing gap or needs have been identified then a Delphi technique is implemented to gather experts' opinions to solve a problem. In addition, an explanation on consensus and stability as criterion in the Delphi technique is further elaborated.

Keywords: Needs analysis, Delphi technique, data collection, expert validation, technology education

INTRODUCTION

A combination of needs analysis and Delphi technique could produce a more reliable and trustworthy research results. The uniqueness of the combination of these approaches is in the first phase needs analysis survey is implemented and then the needs analysis data would be used in the next phase that is the phase Delphi technique in which the opinions of experts are sought until final consensus is achieved. Therefore, this study presents a review on how to conduct a research using the combination of needs analysis and Delphi technique in the technology education field.

Overview of Needs Analysis

Need refers to a gap or discrepancy between a present state (what is) and a desired state (what should be). The need is neither the present nor the future state; it is the gap between them. In other words, need simply means a gap or a discrepancy between current performance and desired performance (Kaufman, 1994; Watkins & Kaufman, 1996; Altschuld, 2014; USAID, 2014). Triner, Greenberry and Watkins (1996) defined needs analysis as a process to determine the reasons and causes for a specific need so that appropriate interventions may be identified and later selected. In employment sector, Mittal et al. (1999) reported that, need analysis is usually conducted to determine long and short range employment opportunities for a specific target group. In general, to develop a needs analysis, a research should follow stages in development process such planning, cause analysis, data collection and data analysis.

Process for Needs Analysis Development

Needs analysis is not spontaneous; it requires a well-defined execution strategy (Stetar, 2005). Therefore, needs analysis planning is a road map of the entire project plan and a well-organized planning will lead to a successful executing of the needs analysis. Conducting the needs analysis is like unfolding prepared plan to determine a gap. As Cohen, Manion, and Morrison (2011) stated that needs analysis

could identify the problems or the needs and then proceeds to determine the aims, content, implementation, target population and outcome of an intervention.

To illustrate a concrete example of a needs analysis process, my study on developing a new ergonomic-based curriculum is stated as a case. Needs analysis and Delphi technique are used in my study. Figure 1 shows the needs analysis process. This process is based on a combination of two frameworks or models, i.e., Development of Needs Analysis (MCDEM, 2010), and Rapid Needs Assessment Guide (USAID, 2014). The Development of Needs Analysis model consists of five key elements: (a) define purpose, (b) plan the process, (c) collect data, (d) analyze data, and (f) report findings. Next, Rapid Needs Assessment Guide has three phases that is (a) planning stage, (b) data collection stage, and (c) reporting and application stage. Figure 1 shows the stages and the proposed elements in this needs analysis to determine the needs for a new ergonomic-based technology education curriculum.

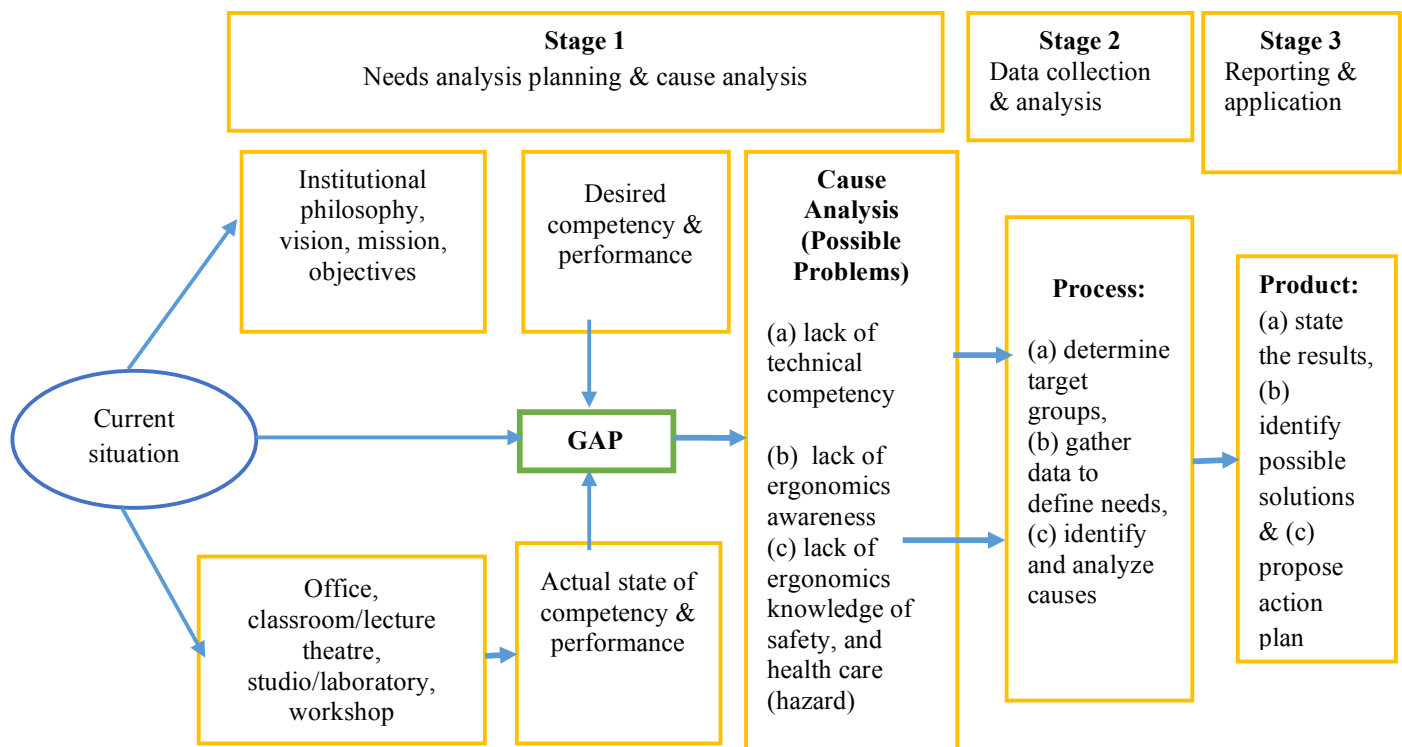


Figure 1. Process for needs analysis development

Participants of the Needs Analysis

According to McKillip (1987), need analysis is a tool for decision making in the human services and education sectors. Need analysis addresses questions about future: “What should be done?” Need analysis puts in perspective problems confronting a target population, services available to it, and actions that might be taken. Furthermore, need analysis is the process of identifying and evaluating needs in a community or other defined population. The identification of needs is a process of describing “problems” of a target population and possible solutions to these problems (McKillip, 1998). In order to select the participants there is need to understand the sample and sampling involved in the research study. Clearly, the success of needs analysis will depend on the careful and appropriate selection of target sample. At times, a researcher may require to state clear criteria for the selection of the participants in the needs analysis and also it depends on the nature of the study.

Instrumentation and Data Collection for Needs Analysis

It is advisable to use more than one instrument to obtain a comprehensive overview of the needs of the sector/region (DOE – TTNA, 1996). The usage of varied instruments is preferable because they could enhance the validation process that is known as triangulation. Triangulation adds more credibility in the methodology and the use of multiple instruments in a research nowadays is preferable (Piaw, 2012). A combination of data collecting instruments, such as interview protocol and questionnaire would increase the likelihood that the phenomenon under study is being understood from various points of view (Ary et al., 2013). In my research, the first phase consists of the needs analysis which is to identify the needs and to determine the gap as well as to report the results or outcomes or an action plan. Needs analysis is a powerful tool that can clarify and validate the true needs and also collect information that can be used in making educational decisions (Grier as cited in Selvadurai & Krashinski, 1989). Subsequently, as soon as the gap is identified at this juncture, the next phase is to implement a Delphi technique which involved several experts to provide their opinions.

OVERVIEW OF DELPHI TECHNIQUE

The Delphi technique is in an essence a series of sequential or “rounds”, interspersed by controlled feedback, that seeks to gain the most reliable consensus of opinion of a group of experts (Linstone & Turoff, 1975). The Delphi technique was first introduced in the late 1950s by RAND Corporation for scientific study of expert opinions on security and military defense project. However, for the security reasons, this technique was not proposed over ten years and in 1963 until Dalkey and Helmer formally introduced it (Keil, Lee, & Deng, 2013; Kauko & Palmroos, 2014). Since then Delphi technique has been developed and widely used in various fields of study such as economy, politics, education, science and technology (Nashir, Mustapha, & Yusoff, 2015). According to Habibi, Sarafrazi, and Izadyar (cited in Landeta, 2006) asserted that since 1995 to 1999 a total 444 articles on this technique have been published in "Science Direct" and "ABI / Inform" journals. Since 2000 to 2004, this number has increased to 667 articles. An update report by Rundgren and Rundgren (2016) shows that to date, after half a century, according to the Google Scholar database (retrieved on July 7, 2014), there have been 203,000 Delphi studies. The Delphi technique is not a substitute for other scientific testing, but rather an option for complex and intertwined subjects that cross over disciplinary boundaries (Grisham, 2009). Therefore, Delphi technique is a commonly used approach in varied fields (Linstone & Turoff, 1975).

Characteristics of Delphi Technique

The Delphi technique has four distinct characteristics namely: (1) anonymity, (2) iteration, (3) controlled feedback, and (4) statistical group response (Landeta & Barrutia, 2011; Gracht, 2012). The characteristics are applicable to Delphi technique regardless of the variation type. The anonymity of the experts' panel could alleviate bias or negative factor. This is to allow the experts to freely express their opinions without undue social pressures to conform from others in the group (Gracht, 2012). Decisions are evaluated on their merit, rather than who has proposed the idea. Also, the iteration a series of rounds and the judgements of the respondents are summarized by the facilitator and provided as feedback or basic information for the following round (Gracht, 2012). Furthermore, a controlled feedback enables the panel members to focus on the objectives of Delphi rather than concentrating on winning the argument (Martino, 1983). Statistical aggregation of group response is used to allow for a quantitative analysis and interpretation of the data. Dunn (as cited in Heiko, 2012) argues that the group response can be presented statistically. In terms the suitable number of experts in Delphi, Clayton (1997) reported that 5 to 10 experts are adequate although the size could range from 7 to 30 (Turoff, 1970; Cavalli-Sforza & Ortolano, 1984; Armstrong, 1985; Phillips, 2000; Dalkey, 2003).

Criteria for Delphi Experts

Delphi panel experts are selected because of their knowledge and expertise related to the study. An expert is defined as a person that has at least 20 years of practical experience working in the field or a person that has an advanced degree with over 20 years of research, teaching, and publication or a combination of the two (Grisham, 2009). The Delphi panels should meet four “expertise” requirements: (a) knowledge and experience with the issues under investigation; (b) capacity and willingness to participate; (c) sufficient time to participate in the Delphi; and, (d) having effective communication skills (Adler & Ziglio, 1996; Skulmoski et al., 2007). The heterogeneity of the experts must be maintained to ensure the validity of the results. This heterogeneity can be expressed in the expertise of the panels and through other dimensions (Meijering, Kampen, & Tobi, 2013). Furthermore, Watkins, Meiers, and Visser (2012) stated that a researcher should try to screen the panels to make sure that the researcher has selected a group of experts who represent diverse perspectives about the focus area.

Procedures for Selecting Delphi Experts

One important issue to be considered according to Grisham (2009) is that, it is important to select panel members who have a balance between impartiality and an interest in the topic. Patton (1990) stated that Delphi panel should be an expert in a subject matter or a field study. A researcher should establish a predetermined set of criteria or qualification for the Delphi experts (Andranovich, 1995). This avoids the inclusion of panels with little knowledge that might distort the results. The expert participation is paramount and most important requisites in the research methodology of Delphi technique.

Okoli and Pawlowski (2005) and Elmendorf and Song (2015) suggest an approach called Knowledge Resource Nomination Worksheet (KRNW) to select Delphi experts. Table 1 shows the outline of steps or procedure for selecting Delphi experts. The purpose of the KRNW is to help categorize the experts before identifying them, in order to prevent overlooking any important class of experts (Okoli & Pawlowski, 2005). In step 1, the researcher identifies experts with relevant qualification, area of specialization and with expertise in professional practice. List the expert names in step 2 based on the most qualified who fulfill the step 1 requirements. If there is a need for additional experts in step 3, the researcher should obtain nomination from the present panel or the researcher should follow the previous procedure for adding experts. In step 4, experts will be categorized and ranked based on prioritization especially on qualification and area of specialization. In the last step (step 5), a formal invitation should be sent to the selected experts (Okoli & Pawlowski, 2005)

Table 1: Procedure for selecting experts

Step 1	<ul style="list-style-type: none"> ● Identify relevant qualification
Prepare KRNW	<ul style="list-style-type: none"> ● Identify relevant area of specialization ● Identify relevant professional practice
Step 2	<ul style="list-style-type: none"> ● Write in names of individuals in
Populate KRNW with names	<ul style="list-style-type: none"> relevant qualification, specialization and professional practice
Step 3	<ul style="list-style-type: none"> ● Contact experts on KRNW
Nominate /search experts	<ul style="list-style-type: none"> ● Search for additional experts

Step 4	<ul style="list-style-type: none">• Categorize experts according to appropriate list
Rank experts	<ul style="list-style-type: none">• Rank experts based on their qualification
Step 5	<ul style="list-style-type: none">• Invite experts
Invite experts	<ul style="list-style-type: none">• Stop inviting experts when panel size is reached

Source: Adapted from Okoli & Pawlowski (2005); Elmendorf & Song (2015)

Instrumentation for Delphi Technique

Several factors should be taken into consideration when deciding on the most appropriate research instrument to be used. Ludwig (1997) supports this view that the Delphi technique combined both quantitative and qualitative data collection methods through oral and/or written accounts that allow the experts to share their expert opinions. For qualitative instrument, researcher may use interview protocol and open-ended items and for quantitative instrument, a researcher may use semi-structured and/or structured questionnaire. In the stage of data collection and analysis, according to Hasson et al. (2000), there are three stages: (a) the proposing relevant constructs, (b) the process of determining the most important constructs, and (c) the process of reaching a consensus.

Rounds for Delphi Technique

There are different opinions regarding the exact number of rounds in Delphi technique. Literature reviewed shows that some researchers opined that until consensus is achieved, while other believed it to be between 2 to 9 rounds, but the most frequently used are three rounds. Various researches have used three rounds for the Delphi technique such as Crews and Ray (1997), Rossouw et al. (2011), Masud et al. (2014), Sitlington and Coetzer (2015), Sakhnini and Blonder (2015), and Rundgren and Rundgren (2016). Therefore, it is common to use three rounds of Delphi technique. However, a researcher may decide the relevant round number based on the situation and the nature of the study.

In round one, semi-structured questionnaire may be used and mostly the items required dichotomous responses from the experts. Beside semi-structured questionnaire at least one open-ended or more are required to ask experts for additional suggestions or comments. In addition, sometimes interview may also be used to compliment the questionnaire. Next, in round two, normally a fully structured questionnaire using 5-point Likert scale is used. In the third round, experts are asked to re-evaluate all feedback of the second round. In other words, a report of the findings from round two is presented and a final evaluation for items were given for the final rating. The expert panel refine and rate the items using the 5-point Likert scale. The purpose of the third round is to draw final consensus among the experts panel regarding the constructs and items.

Data Analysis for Delphi Technique

Both parametric and nonparametric tests have been used in Delphi research for consensus measurement to achieve stability or convergence between Delphi rounds (Gracht, 2012). The consensus measurement can be done through qualitative analysis, descriptive and/or inferential statistics. The most importance for the determination of consensus and the quantification of agreement are the cut-off point of the tools employed for analysis such as: percentage, mean, standard deviation, Interquartile Range (IQR), Chi square test and others. Furthermore, consensus is not sufficient for Delphi technique stopping criterion but stability should be tested before terminating the Delphi rounds (Gracht, 2012). A researcher may use changes in percentage, means differences and percentage change, comparison of standard deviation changes to test stability between rounds.

METHODOLOGICAL FRAMEWORK

The methodological framework comprises the combination of the two stages: needs analysis phase and Delphi technique phase. In my research, the needs analysis started with literature review and the construction of needs analysis interview protocol. Data from the needs analysis could be used to justify the need to have Delphi verification on the new constructs. The Delphi sessions comprised three rounds starting from Round 1 to Round 3. The final round is achieved when the data are saturated, agreed upon and verified by all experts. Then the new constructs or domains are ready to be used in the construction of a new instrument.

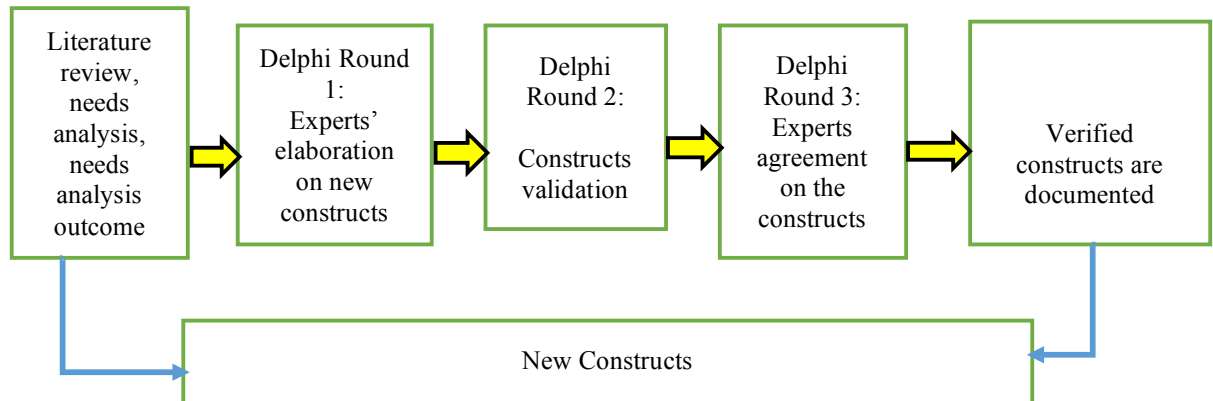


Figure 2. Methodological framework for needs analysis and Delphi technique

CONCLUSION

This preliminary review of needs analysis and Delphi technique is presented to expose readers to critical data collection techniques. The combination of the two approaches provides a unique strategy for developing a viable and rigorous data collection method. This article highlighted basic concepts regarding needs analysis approach and Delphi technique. Needs analysis consists of three stages, namely (1) planning and cause analysis (2) data collection and analysis, and (3) reporting and application. After the needs analysis phase, Delphi technique is conducted in which it could consist of several rounds. The final constructs or domains are postulated after obtaining the highest consensus among the Delphi experts. The key benefits of the combination of the needs analysis and Delphi technique include the identification of the gap and the validation of the new constructs by the experts.

REFERENCES

- Adler, M. & Ziglio, E. (1996). *Gazing into the oracle: The Delphi method and its application to social policy and public health*. London: Jessica Kingsley Publishers.
- Altschuld, J.W. (2014). *Bridging the gap between asset/capacity building and needs assessment: Concepts and practical applications*. Thousand Oaks, CA: Sage Publication.
- Andranovich, G. (1995). *Developing community participation and consensus: The Delphi technique*. Pullman, WA: Western Regional Extension Publication.
- Armstrong, J.S. (1985). *Long range forecasting: From crystal ball to computer*. New York: Wiley.
- Ary, D., Jacobs, L.C., Sorensen, C.K., & Walker, D. (2013). *Introduction to research in education*. Belmont: Cengage Learning.

- Cavalli-Sforza, V. & Ortolano, L. (1984). Delphi forecasts of land-use – Transportation interactions. *Journal of Transportation Engineering*, 110(3), 324-339.
- Chen, D.F., Wu, T.C., Chen, C.H., Chang, S.H., Yao, K.C., & Liao, C.W. (2015). Developing an industry-oriented safety curriculum using the Delphi technique. *International Journal of Injury Control and Safety Promotion*, 23(3), 302-316.
- Clayton, M.J. (1997). Delphi: A technique to harness expert opinion for critical decision- making tasks in education. *Educational Psychology*, 17(4), 373-386.
- Cohen, L., Manion, L., & Morrison, K. (2011). *Research methods in education* (7th edition), Abingdon, Oxon: Routledge.
- Crews, T.B. & Ray, C.M. (1998). Course content for a telecommunication course in an end-user computing support program. *Office Systems Research Journal*, 16(2), 9-16.
- Custer, R.L., Scarella, J.A., & Stewart, B.R. (1999). The modified Delphi technique: A rotational modification. *Journal of Vocational and Technical Education*, 15(2), 1-10.
- Dalkey, N.C. (2003). *The Delphi methodology*. [pdf] [Retrieved 20/09/2016] from <http://www.optimizationgroup.com/wp-content/uploads/2013/02/IdeaGeneration-TurningQuestions-Into-Answers.pdf>
- DOE - HANDBOOK – TTNA (1996). DOE table top needs analysis (DOE-HDBK-1103-96). Washington: Department of Energy.
- Elmendorf, D.C. & Song, L. (2015). Developing indicators for a classroom observation tool on pedagogy and technology integration: A Delphi study. *Computers in the Schools*, 32(1), 1-19.
- Gracht, H.A. (2012). Consensus measurement in Delphi studies. *Technological Forecasting and Social Change*, 79(8), 1525-1536.
- Grisham, T. (2009). The Delphi technique: A method for testing complex and multifaceted topics. *International Journal of Managing Projects in Business*, 2(1), 112-130.
- Habibi, A., Sarafrazi, A., & Izadyar, S. (2014). Delphi technique theoretical framework in qualitative research. *The International Journal of Engineering and Science*, 3(4), 8-13.
- Hasson, F., Keeney, S., & Mckenna, H. (2000). Research guidelines for the Delphi survey technique. *Journal of Advanced Nursing*, 32(4), 1008-1015.
- Kaufman, R. (1994). A needs assessment audit. *Performance Instruction*, 33(2), 14-16.
- Kauko, K. & Palmroos, P. (2014). The Delphi method in forecasting financial markets - An experimental study. *International Journal of Forecasting*, 30(2), 313-327.
- Keil, M., Lee, H.K., & Deng, T. (2013). Understanding the most critical skills for managing IT projects: A Delphi study of IT project managers. *Information & Management*, 50(7), 398-414.
- Landeta, J. & Barrutia, J. (2011). People consultation to construct the future: A Delphi application. *International Journal of Forecasting*, 27(1), 134-151.
- Landeta, J. (2006). Current validity of the Delphi method in social sciences. *Technological Forecasting and Social Change*, 73(5), 467-482.

- Linstone, H. A. & Turoff, M. (Eds.). (1975). *The Delphi method: Techniques and applications*. Massachusetts: Addison-Wesley Publisher.
- Ludwig, B. (1997). Predicting the future: Have you considered using the Delphi methodology? *Journal of Extension*, 35 (5), 1-4.
- Martino, J. P. (1983). *Technological forecasting for decision making*. New York: Elsevier Science Publishing Co.
- Masud, T., Blundell, A., Gordon, A. L., Mulpeter, K., Roller, R., Singler, K., & Stuck, A. (2014). European undergraduate curriculum in geriatric medicine developed using an international modified Delphi technique. *Age and Ageing*, 43(5), 695-702.
- MCDEM (2010). Development needs analysis best practice guideline for civil defence emergency management sector [BPG 5/10]. New Zealand <http://www.civildefence.govt.nz/assets/Uploads/publications/bpg-05-10-development-needs-analysis.pdf>
- McKillip, J. (1987). *Need analysis: Tools for the human services and education*. Newbury Park, CA: Sage.
- McKillip, J. (1998). Needs analysis. In L. Bickman, & D.J. Rog (Eds). *Handbook of applied social research methods*. Thousand Oaks, CA: Sage Publication.
- Meijering, J.V., Kampen, J.K, & Tobi, H. (2013). Quantifying the development of agreement among experts in Delphi studies. *Technological Forecasting and Social Change*, 80(8), 1607-1614.
- Mittal, L.N., Anand, Y.K, Singla, P.K., Gupta, A.B., Gupta, S.K., & Thukral, T.N. (1999). *Curriculum development for polytechnics*. Technical Teachers' Training Institute (TTTI). <https://www.giz.de/expertise/downloads/Fachexpertise/en-pedagogy-curriculum-development-for-polytechnics.pdf>
- Nashir, I.M., Mustapha, R., & Yusoff, A. (2015). Delphi technique: Enhancing research in technical and vocational education. *Journal of Technical Education and Training*, 7(2). <http://penerbit.uthm.edu.my/ojs/index.php/JTET/article/view/1001>.
- Okoli, C. & Pawlowski, S.D. (2005). The Delphi method as a research tool: An example, design considerations and applications. *Information & Management*, 42(1), 15-29.
- Patton, M.Q. (1990). *Qualitative evaluation and research methods*. Newbury Park, CA: Sage Publications.
- Phillips, R. (2000). New applications for the Delphi technique. In R. Phillips (Ed.). San Francisco, CA: Jossey-Bass/Pfeiffer.
- Piaw, Y.C. (2012). *Mastering research methods*. Petaling Jaya, Selangor: McGraw-Hill Education (Malaysia) Sdn. Bhd.
- Rossouw, A., Hacker, M., & Vries, M.J. (2011). Concepts and contexts in engineering and technology education: An international and interdisciplinary Delphi study. *International Journal of Technology and Design Education*, 21(4), 409-424.
- Rundgren, S.C. & Rundgren, C. (2016). What are we aiming for?—A Delphi study on the development of civic scientific literacy in Sweden. *Scandinavian Journal of Educational Research*, 61(2), 224-239.

- Sakhnini, S. & Blonder, R. (2015). Essential concepts of nanoscale science and technology for high school students based on a Delphi study by the expert community. *International Journal of Science Education*, 37(11), 1699-1738.
- Sava, S.D. (2012). *Needs analysis and programme planning in adult education*. Opladen: Barbara Budrich.
- Selvadurai, R.H. & Krashinski, E.J. (1989). *Needs assessment and evaluation. A synthesis paper*. ERIC Document Reproduction Service (No. ED322177).
- Sitlington, H. & Coetzer, A. (2015). Using the Delphi technique to support curriculum development. *Education Training*, 57(3), 306-321.
- Skulmoski, G.J., Hartman, F.T., & Krahn, J. (2007). The Delphi method for graduate research. *Journal of information technology education*, 6, 1-21.
- Stetar, B. (2005). Training: It's not always the answer. *Quality progress*, 38(3), 44-49.
- Triner, D., Greenberry, A., & Watkins, R. (1996). Training needs assessment: A contradiction in terms. *Educational Technology*, 36(6), 51-55.
- Turoff, M. (1970). The design of a policy Delphi. *Technological Forecasting*, 2(2), 149-171.
- USAID (2014). A rapid needs assessment guide for education in countries affected by crisis and conflict. <https://www.usaid.gov/what-we-do/education/educating-children-and-youth-crisis-and-conflict-situations/Rapid-Needs-Assessment-Guide-Education>.
- Watkins, R. & Kaufman, R. (1996). An update on relating needs assessment and needs analysis. *Performance Instruction*, 35 (10), 10-13.
- Watkins, R., West-Meiers, M., & Visser, Y.L. (2012). *A guide to assessing needs: Essential tools for collecting information, making decisions, and achieving development results*. Washington, DC: World Bank.
- Ziglio, E. (1996). The Delphi method and its contribution to decision-making. In M. Adler & E. Ziglio (Eds.), *Gazing into the oracle: The Delphi and its application to social policy and public health*. London: Jessica Kingsley.