Quantitative Research Instrumentation *for Educators*

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Definition of Terms

- Quantitative research uses numerical data and statistical analysis to investigate a research question or hypothesis (Babbie, 2016; Bryman, 2016; Creswell, 2014; Neuman, 2013). Social sciences, education, and psychology often use it to study various phenomena, including academic performance, behavior, attitudes, and perceptions.
- Instrumentation refers to the tools, methods, or procedures used to collect data in research (Babbie, 2016; Creswell, 2014; Johnson & Christensen, 2014; Neuman, 2013). In quantitative research, the instrumentation is a critical aspect of the research process, as it directly affects the validity and reliability of the data collected.

Quantitative Research Instrumentation

Understanding quantitative research instrumentation is critical for advancing educational research, both theory and practice since it contributes to the **accuracy** and **credibility** of research findings (Creswell & Plano Clark, 2017; DeVellis, 2017; Streiner et al., 2014). Using inappropriate or poorly designed instruments can result in inaccurate or unreliable data, compromising the quality of the research findings and limiting the research's usefulness.

Understanding the appropriate use of quantitative research instruments is critical from a theoretical standpoint for ensuring that research questions are answered accurately. Researchers (*pre-service teachers, in-service teachers, teacher educators, and educational leaders*) can get high-quality data that can be used to create and test theories in a particular field by selecting and designing the relevant instrument. Furthermore, using reliable and valid quantitative research instruments can boost the credibility of research findings and aid in developing new research questions and hypotheses.

From a practical perspective, understanding quantitative research instrumentation can improve the quality of research practice. Researchers can ensure that the data acquired is accurate and reliable by selecting and creating appropriate instruments, which can help to guide decision-making in a particular subject. Furthermore, reliable and valid instruments can guide policy decisions, program development, and evaluation, resulting in more effective interventions and better outcomes.

Where and How to Begin?

The choice of research instrument depends on the **research question**, the **nature of the phenomenon being studied**, and the **available resources** (Bryman, 2016; Creswell, 2014; Dörnyei, 2007; Hair et al., 2014). Researchers can acquire accurate and valid data to answer their research questions and contribute to the knowledge base in their field by carefully selecting and building instruments. In education and the social sciences, quantitative research frequently involves using various instruments or tools to collect and analyze data. Surveys, questionnaires, tests, and observations are examples of such instruments (Bryman, 2016; Creswell & Creswell, 2018; Fraenkel et al., 2018; Leedy & Ormrod, 2016).

Researchers can look through academic and commercial databases to check if an appropriate instrument is available. They can examine academic and commercial databases to discover an appropriate instrument for their topic (Burns & Grove, 2011; DeVellis, 2017; McDowell, 2006). Academic databases are excellent tools for locating verified and tested research instruments for reliability and validity. Also, commercial databases may sell or provide access to instruments. However, before utilizing an instrument in a research project, it must be validated and evaluated for reliability and validity. Additionally, permission from the original authors or copyright holders may be required before the researchers utilize the instrument. Furthermore, researchers can refer to theses or dissertations available through the library.

- *Academic Databases*
  - Scopus - https://www.scopus.com/
  - Web of Science - https://www.webofscience.com/
  - JSTOR - https://www.jstor.org/
  - PubMed - https://pubmed.ncbi.nlm.nih.gov/
  - Google Scholar - https://scholar.google.com/
  - ScienceDirect - https://www.sciencedirect.com/
  - Academic Search Premier - https://www.ebscohost.com/academic/academic-search-premier
  - Project MUSE - https://muse.jhu.edu/
  - ERIC - https://eric.ed.gov/
  - PsycINFO - https://www.apa.org/pubs/databases/psycinfo

- *Commercial Databases*
  - EBSCOhost - https://www.ebscohost.com/
  - ProQuest - https://www.proquest.com/
  - LexisNexis - https://www.lexisnexis.com/
  - Factiva - https://www.dowjones.com/products/factiva/
  - Bloomberg Terminal - https://www.bloomberg.com/professional/solution/bloomberg-terminal/
  - Westlaw - https://legal.thomsonreuters.com/en/products/westlaw
  - Statista - https://www.statista.com/
  - PitchBook - https://pitchbook.com/
  - CB Insights - https://www.cbinsights.com/
  - Gartner - https://www.gartner.com/

If it is determined that no instruments exist that accurately measure the variables in a study, there are several stages for constructing an instrument that accurately measures the variables of interest – planning, construction, and evaluation (Creswell, 2014; DeVellis, 2017; Streiner et al., 2014).

- *Planning*. During the planning stage, researchers must define the construct(s) or variable(s) of interest and develop a conceptual framework that outlines how the variables are related to each other (DeVellis, 2017; Hair et al., 2014). They should also consider the type of data that needs to be collected, such as nominal, ordinal, interval, or ratio, and choose the most appropriate measurement methods for each variable.

  > *Suppose a researcher wants to develop an instrument to measure stress in college students. In the planning stage, the researcher would identify the variables of interest (e.g., stress, anxiety, coping strategies) and develop a conceptual framework that outlines how these variables are related to each other. They would also determine the most appropriate measurement methods for each variable, such as self-report questionnaires for stress and anxiety and behavioral observation for coping strategies.*

- *Construction*. In the construction stage, researchers develop the instrument and conduct a pilot study to evaluate its psychometric properties (Dillman et al., 2014; Fowler, 2013). This includes assessing the reliability and validity of the instrument. Reliability refers to the consistency of the instrument's measurements, while validity refers to "the extent to which the instrument measures what it is intended to measure" (Heale & Twycross, 2015; Leedy & Ormrod, 2016). Pilot testing may involve administering the instrument to a small sample of participants and analyzing the data to identify potential problems with the instrument's items or response options.

  > *In the construction stage, the researcher would develop the instrument, which could be a questionnaire or survey. They might include questions like, "How often have you felt stressed in the past week?" and "What strategies have you employed to cope with stress?" They then pilot-test the instrument with a small sample of college students to ensure reliability and validity. This might involve administering the instrument to 30 students and analyzing the data to identify any potential problems with the questions or response options.*

- *Evaluation*. In the evaluation stage, the researcher analyzes the data collected from the instrument and uses statistical techniques to assess the instrument's psychometric properties, such as reliability and validity (DeVellis, 2017; Streiner et al., 2014). This includes assessing the instrument's internal consistency, which measures the degree to which the items on the instrument are interrelated, and its construct validity, which measures the extent to which the instrument measures the intended construct(s) or variable(s).

  > *In the quantitative evaluation stage, the researcher would analyze the data collected from the instrument and evaluate its psychometric properties. They might use statistical techniques to assess the internal consistency of the instrument and its construct validity. For example, they might calculate Cronbach's alpha to assess the instrument's reliability and perform a factor analysis to examine the underlying factor structure of the questions.*

Expert Validation

Validation of research instruments in educational research is performed by experts (*academics*, *practitioners*, or *professionals*) in the field of education or the specific topic area being studied (Beaton et al., 2000; DeVellis, 2017; Streiner et al., 2014). This helps ensure that the results obtained using the instrument are accurate and reliable. The experts review the research instrumentation for clarity, completeness, and relevance to the research question and may also provide feedback on the format and structure of the instrument.

Examples:

> *If the research instrument is a test designed to measure reading comprehension in elementary school students, it would be validated by experts in reading instruction, such as literacy coaches or reading specialists.*

If the research instrument is a survey designed to measure teacher attitudes toward the use of technology in the classroom, it would be validated by experts in educational technology, such as instructional technology specialists or education researchers focusing on technology integration.

If the research instrument is an observation tool designed to assess teacher classroom management skills, it would be validated by experts in classroom management and teacher education, such as teacher educators or researchers focusing on classroom behavior management.

Avoiding Instrumentation Bias

Researchers can further minimize bias in their surveys or questionnaires and ensure that the data collected is accurate and unbiased. Here are some additional tips for avoiding bias in research instrumentation, specifically for surveys or questionnaires:

- *Use clear and concise language*: Employ easy-to-understand language and avoid technical jargon or complicated terms (Dillman et al., 2014). This will help ensure that participants can understand the questions and respond accurately.

- *Avoid leading or loaded questions*: Avoid questions designed to elicit a specific response or bias the participant's answer (Diersch & Walther, 2016). For example, instead of asking, "*Don't you think that education is important*?", ask, "*How important do you think education is*?".

- *Use various question types*: Use various question types, such as multiple-choice, Likert scale, or open-ended questions, to reduce response bias (Dillman et al., 2014). This will help ensure that participants can express their opinions or thoughts most comfortably and accurately.

- *Randomize question order*: Randomize the order of questions to avoid order effects or bias due to question placement (Fowler, 2013). This will help ensure that the responses are not influenced by the order in which the questions are presented.

- *Avoid social desirability bias*: Social desirability bias is when participants respond in a socially acceptable or desirable way rather than providing their true opinions or experiences (Tourangeau & Yan, 2007). To avoid this, reassure participants that their responses are confidential and anonymous, and avoid asking questions that may elicit socially desirable responses.

- *Pilot-test the survey or questionnaire*: Pilot-test the survey or questionnaire with a small sample of participants to identify any issues or areas of potential bias (Dillman et al., 2014), regardless of whether it is adopted or adapted [modified] from previously published scholarly publications or developed by the researcher. This will allow the researcher to make any necessary modifications before administering the survey or questionnaire to a larger sample.

- *Consider cultural or linguistic differences*: Consider cultural or linguistic differences when designing the survey or questionnaire. Make sure that the questions are appropriate and relevant for the

population being studied, and consider translating the survey or questionnaire into different languages if necessary.

- *Monitor for bias*: Continuously monitor for bias throughout the instrument's planning, construction, and validation.

> *Note*: *When conducting research, it is nearly difficult to eliminate biases that can potentially influence the data and, consequently, the findings reached. Good researchers display integrity by recognizing that biases may have influenced their findings. In survey research, for example, the percentages of those who consented and refused to participate, such as those who agreed and refused to be interviewed or those who did not return questionnaires, should always be mentioned* (Leedy & Ormrod, 2016). *Upon completing their study, the researchers must indicate such concerns in the limitations section.*

Helpful Applications/Software

Many applications and software are available to create and administer surveys or questionnaires. Here are some popular options:

Note:
Some applications may have free and paid versions with different features and limitations.

- *Google Forms*: https://www.google.com/forms/about/
  A free online survey tool that allows users to create and share surveys easily.
- *SurveyMonkey*: https://www.surveymonkey.com/
  A popular online survey tool that provides a wide range of question types and customization options.
- *Qualtrics*: https://www.qualtrics.com/
  A comprehensive survey software platform that offers a range of advanced features and options for research instrumentation.
- *SurveyGizmo*: https://www.surveygizmo.com/
  A customizable survey tool that allows users to create and analyze surveys in real time.
- *Typeform*: https://www.typeform.com/
  A modern survey tool that provides a user-friendly interface and a wide range of question types.
- *LimeSurvey*: https://www.limesurvey.org/
  An open-source survey tool that allows users to create and share surveys with a variety of features and customization options.
- *SurveyLegend*: https://www.surveylegend.com/
  A mobile-friendly survey tool that provides a range of question types and data visualization options.
- *Formstack*: https://www.formstack.com/
  A form-building tool that allows users to create custom forms and surveys with a range of integrations and automation options.
- *Zoho Survey*: https://www.zoho.com/survey/
  A survey tool that provides a range of question types and customization options, as well as integration with other Zoho apps.

- *QuestionPro*: https://www.questionpro.com/
  A survey tool that provides a range of question types and customization options, as well as advanced data analysis and reporting features.

- *SoGoSurvey*: https://www.sogosurvey.com/
  A survey tool that provides a range of question types, customization options, and advanced data analysis and reporting features.

- *Microsoft Forms*: https://www.microsoft.com/en-us/microsoft-365/forms/survey-software
  A free online survey tool that integrates with other Microsoft apps and provides a range of question types and customization options.

Conclusion

Researchers must carefully select a quantitative research instrument fit for their research question and context. Surveys/questionnaires, tests/assessments, observations, existing datasets, interviews, focus groups, and biometric measures are some of the most often used quantitative research instruments. Quantitative research instruments can be adopted or adapted [modified] from previously published scholarly publications or created entirely by the researcher. Each instrument has its strengths and limitations. Researchers should remember them when selecting an instrument to ensure that data collection is efficient and relevant to their study objectives.

In an example (Leedy & Ormrod, 2016), suppose an educational researcher is interested in learning about the types of goals that students aim to achieve at school. Numerous motivation researchers have theorized that students may be preoccupied with either grasping classroom subject matter or obtaining good grades using any means possible. As a result, they created and distributed rating-scale questionnaires with statements like "*I work hard to understand new ideas*" (showing a desire to master a topic) and "*I occasionally copy someone else's homework if I do not have time to do it myself*" (reflecting a desire to get good grades). However, in one study (Dowson & McInerney, 2001), researchers questioned middle school children about what tasks they felt were most important to do at school. Several participants focused on social goals rather than academic goals, such as being with and supporting peers and avoiding behaviors that would jeopardize their status.

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