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Conducting and Writing Quantitative and Qualitative Research

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ABSTRACT

Comprehensive knowledge of quantitative and qualitative research systematizes scholarly research and enhances the quality of research output. Scientific researchers must be familiar with them and skilled to conduct their investigation within the frames of their chosen research type. When conducting quantitative research, scientific researchers should describe an existing theory, generate a hypothesis from the theory, test their hypothesis in novel research, and re-evaluate the theory. Thereafter, they should take a deductive approach in writing the testing of the established theory based on experiments. When conducting qualitative research, scientific researchers raise a question, answer the question by performing a novel study, and propose a new theory to clarify and interpret the obtained results. After which, they should take an inductive approach to writing the formulation of concepts based on collected data. When scientific researchers combine the whole spectrum of inductive and deductive research approaches using both quantitative and qualitative research methodologies, they apply mixed-method research. Familiarity and proficiency with these research aspects facilitate the construction of novel hypotheses, development of theories, or refinement of concepts.

Keywords: Deductive Reasoning; Inductive Reasoning; Qualitative Research; Quantitative Research; Study design

INTRODUCTION

Novel research studies are conceptualized by scientific researchers first by asking excellent research questions and developing hypotheses, then answering these questions by testing their hypotheses in ethical research.[1-3] Before they conduct novel research studies, scientific researchers must possess considerable knowledge of both quantitative and qualitative research.[2]

In quantitative research, researchers describe existing theories, generate and test a hypothesis in novel research, and re-evaluate existing theories deductively based on their experimental results.[1,4,5] In qualitative research, scientific researchers raise and answer research questions by performing a novel study, then propose new theories by clarifying their results inductively.[1,6]

Disclosure

The authors have no potential conflicts of interest to disclose.

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RATIONALE OF THIS ARTICLE

When researchers have a limited knowledge of both research types and how to conduct them, this can result in substandard investigation. Researchers must be familiar with both types of research and skilled to conduct their investigations within the frames of their chosen type of research. Thus, meticulous care is needed when planning quantitative and qualitative research studies to avoid unethical research and poor outcomes.

Understanding the methodological and writing assumptions[7,8] underpinning quantitative and qualitative research, especially by non-Anglophone researchers, is essential for their successful conduct. Scientific researchers, especially in the academe, face pressure to publish in international journals[9] where English is the language of scientific communication.[10,11] In particular, non-Anglophone researchers face challenges related to linguistic, stylistic, and discourse differences.[11,12] Knowing the assumptions of the different types of research will help clarify research questions and methodologies, easing the challenge and help.

SEARCH FOR RELEVANT ARTICLES

To identify articles relevant to this topic, we adhered to the search strategy recommended by Gasparyan et al.[7] We searched through PubMed, Scopus, Directory of Open Access Journals, and Google Scholar databases using the following keywords: quantitative research, qualitative research, mixed-method research, deductive reasoning, inductive reasoning, study design, descriptive research, correlational research, experimental research, causal-comparative research, quasi-experimental research, historical research, ethnographic research, meta-analysis, narrative research, grounded theory, phenomenology, case study, and field research.

AIMS OF THIS ARTICLE

This article aims to provide a comparative appraisal of qualitative and quantitative research for scientific researchers. At present, there is still a need to define the scope of qualitative research, especially its essential elements.[13] Consensus on the critical appraisal tools to assess the methodological quality of qualitative research remains lacking.[14] Framing and testing research questions can be challenging in qualitative research.[2] In the healthcare system, it is essential that research questions address increasingly complex situations. Therefore, research has to be driven by the kinds of questions asked and the corresponding methodologies to answer these questions.[15] The mixed-method approach also needs to be clarified as this would appear to arise from different philosophical underpinnings.[16]

This article also aims to discuss how particular types of research should be conducted and how they should be written in adherence to international standards. In the US, Europe, and other countries, responsible research and innovation was conceptualized and promoted with six key action points: engagement, gender equality, science education, open access, ethics and governance.[17,18] International ethics standards in research[19] as well as academic integrity during doctoral trainings are now integral to the research process.[20]

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POTENTIAL BENEFITS FROM THIS ARTICLE

This article would be beneficial for researchers in further enhancing their understanding of the theoretical, methodological, and writing aspects of qualitative and quantitative research, and their combination.

Moreover, this article reviews the basic features of both research types and overviews the rationale for their conduct. It imparts information on the most common forms of quantitative and qualitative research, and how they are carried out. These aspects would be helpful for selecting the optimal methodology to use for research based on the researcher's objectives and topic.

This article also provides information on the strengths and weaknesses of quantitative and qualitative research. Such information would help researchers appreciate the roles and applications of both research types and how to gain from each or their combination. As different research questions require different types of research and analyses, this article is anticipated to assist researchers better recognize the questions answered by quantitative and qualitative research.

Finally, this article would help researchers to have a balanced perspective of qualitative and quantitative research without considering one as superior to the other.

TYPES OF RESEARCH

Research can be classified into two general types, quantitative and qualitative.[21] Both types of research entail writing a research question and developing a hypothesis.[22] Quantitative research involves a deductive approach to prove or disprove the hypothesis that was developed, whereas qualitative research involves an inductive approach to create a hypothesis.[23-26]

In quantitative research, the hypothesis is stated before testing. In qualitative research, the hypothesis is developed through inductive reasoning based on the data collected.[27,28] For types of data and their analysis, qualitative research usually includes data in the form of words instead of numbers more commonly used in quantitative research.[29]

Quantitative research usually includes descriptive, correlational, causal-comparative / quasi-experimental, and experimental research.[21] On the other hand, qualitative research usually encompasses historical, ethnographic, meta-analysis, narrative, grounded theory, phenomenology, case study, and field research.[23,25,28,30] A summary of the features, writing approach, and examples of published articles for each type of qualitative and quantitative research is shown in **Table 1**.[31-43]

QUANTITATIVE RESEARCH

Deductive approach

The deductive approach is used to prove or disprove the hypothesis in quantitative research.[21,25] Using this approach, researchers 1) make observations about an unclear or new phenomenon, 2) investigate the current theory surrounding the phenomenon, and 3)

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Table 1. Types, features, writing, and examples of quantitative and qualitative research

Research	Type	Methodology feature	Research writing pointers	Example of published article
Quantitative	Descriptive research	Describes status of identified variable to provide systematic information about phenomenon	Explain how a situation, sample, or variable was examined or observed as it occurred without investigator interference	Östlund AS, Kristofferzon ML, Häggström E, Wadensten B. Primary care nurses' performance in motivational interviewing: a quantitative descriptive study. *BMC Fam Pract* 2015;16(1):89. https://doi.org/10.1186/s12875-015-0304-z[31]
	Correlational research	Determines and interprets extent of relationship between two or more variables using statistical data	Describe the establishment of reliability and validity, converging evidence, relationships, and predictions based on statistical data	Díaz-García O, Herranz Aguayo I, Fernández de Castro P, Ramos JL. Lifestyles of Spanish elders from supervened SARS-CoV-2 variant onwards: A correlational research on life satisfaction and social-relational praxes. *Front Psychol* 2022;13:948745. https://doi.org/10.3389/fpsyg.2022.948745[32]
	Causal-comparative/ Quasi-experimental research	Establishes cause-effect relationships among variables Uses non-randomly assigned groups where it is not logically feasible to conduct a randomized controlled trial	Write about comparisons of the identified control groups exposed to the treatment variable with unexposed groups Provide clear descriptions of the causes determined after making data analyses and conclusions, and known and unknown variables that could potentially affect the outcome	*Causal-comparative*: Sharma MK, Adhikari R. Effect of school water, sanitation, and hygiene on health status among basic level students in Nepal. Environ Health Insights 2022;16:11786302221095030. https://doi.org/10.1177/11786302221095030 [The study applies a causal-comparative research design][33] *Quasi-experimental*: Tuna F, Tunçer B, Can HB, Süt N, Tuna H. Immediate effect of Kinesio taping® on deep cervical flexor endurance: a non-controlled, quasi-experimental pre-post quantitative study. *Cranio* 2022;40(6):528-35. https://doi.org/10.1080/08869634.2020.1816407[34]
	Experimental research	Establishes cause-effect relationship among group of variables making up a study using scientific method	Describe how an independent variable was manipulated to determine its effects on dependent variables Explain the random assignments of subjects to experimental treatments	Hyun C, Kim K, Lee S, Lee HH, Lee J. Quantitative evaluation of the consciousness level of patients in a vegetative state using virtual reality and an eye-tracking system: a single-case experimental design study. *Neuropsychol Rehabil* 2022;32(10):2628-45. https://doi.org/10.1080/09602011.2021.1974496[35]
Qualitative	Historical research	Describes past events, problems, issues, and facts	Write the research based on historical reports	Silva Lima R, Silva MA, de Andrade LS, Mello MA, Goncalves MF. Construction of professional identity in nursing students: qualitative research from the historical-cultural perspective. *Rev Lat Am Enfermagem* 2020;28:e3284. http://dx.doi.org/10.1590/1518-8345.3820.3284[36]
	Ethnographic research	Develops in-depth analytical descriptions of current systems, processes, and phenomena or understandings of shared beliefs and practices of groups or culture	Compose a detailed report of the interpreted data	Gammeltoft TM, Huyền Diệu BT, Kim Dung VT, Đức Anh V, Minh Hiếu L, Thị Ái N. Existential vulnerability: an ethnographic study of everyday lives with diabetes in Vietnam. *Anthropol Med* 2022;29(3):271-88. https://doi.org/10.1080/13648470.2021.1994334[37]
	Meta-analysis	Accumulates experimental and correlational results across independent studies using statistical method	Specify the topic, follow reporting guidelines, describe the inclusion criteria, identify key variables, explain the systematic search of databases, and detail the data extraction	Oeljeklaus L, Schmid HL, Kornfeld Z, Hornberg C, Norra C, Zerbe S, et al. Therapeutic landscapes and psychiatric care facilities: a qualitative meta-analysis. *Int J Environ Res Public Health* 2022;19(3):1490. https://doi.org/10.3390/ijerph19031490[38]
	Narrative research	Studies an individual and gathers data by collecting stories for constructing a narrative about the individual's experiences and their meanings	Write an in-depth narration of events or situations focused on the participants	Anderson H, Stocker R, Russell S, Robinson L, Hanratty B, Robinson L, et al. Identity construction in the very old: a qualitative narrative study. *PLoS One* 2022;17(12):e0279098. https://doi.org/10.1371/journal.pone.027909[39]
	Grounded theory	Engages in inductive ground-up or bottom-up process of generating theory from data	Write the research as a theory and a theoretical model. Describe data analysis procedure about theoretical coding for developing hypotheses based on what the participants say	Amini R, Shahboulaghi FM, Tabrizi KN, Forouzan AS. Social participation among Iranian community-dwelling older adults: a grounded theory study. *J Family Med Prim Care* 2022;11(6):2311-9. https://doi.org/10.4103/jfmpc.jfmpc_1775_21[40]
	Phenomenology	Attempts to understand subjects' perspectives	Write the research report by contextualizing and reporting the subjects' experiences	Green G, Sharon C, Gendler Y. The communication challenges and strength of nurses' intensive corona care during the two first pandemic waves: a qualitative descriptive phenomenology study. *Healthcare (Basel)* 2022;10(5):837. https://doi.org/10.3390/healthcare10050837[41]
	Case study	Analyzes collected data by detailed identification of themes and development of narratives written as in-depth study of lessons from case	Write the report as an in-depth study of possible lessons learned from the case	Horton A, Nugus P, Fortin MC, Landsberg D, Cantarovich M, Sandal S. Health system barriers and facilitators to living donor kidney transplantation: a qualitative case study in British Columbia. *CMAJ Open* 2022;10(2):E348-56. https://doi.org/10.9778/cmajo.2021004[42]
	Field research	Directly investigates and extensively observes social phenomenon in natural environment without implantation of controls or experimental conditions	Describe the phenomenon under the natural environment over time	Buus N, Moensted M. Collectively learning to talk about personal concerns in a peer-led youth program: a field study of a community of practice. *Health Soc Care Community* 2022;30(6):e4425-32. https://doi.org/10.1111/hsc.1384[43]

hypothesize an explanation for the observations. Afterwards, researchers will 4) predict outcomes based on the hypotheses, 5) formulate a plan to test the prediction, and 6) collect and process the data (or revise the hypothesis if the original hypothesis was false). Finally, researchers will then 7) verify the results, 8) make the final conclusions, and 9) present and disseminate their findings (**Fig. 1A**).

Types of quantitative research

The common types of quantitative research include (a) descriptive, (b) correlational, c) experimental research, and (d) causal-comparative/quasi-experimental.[21]

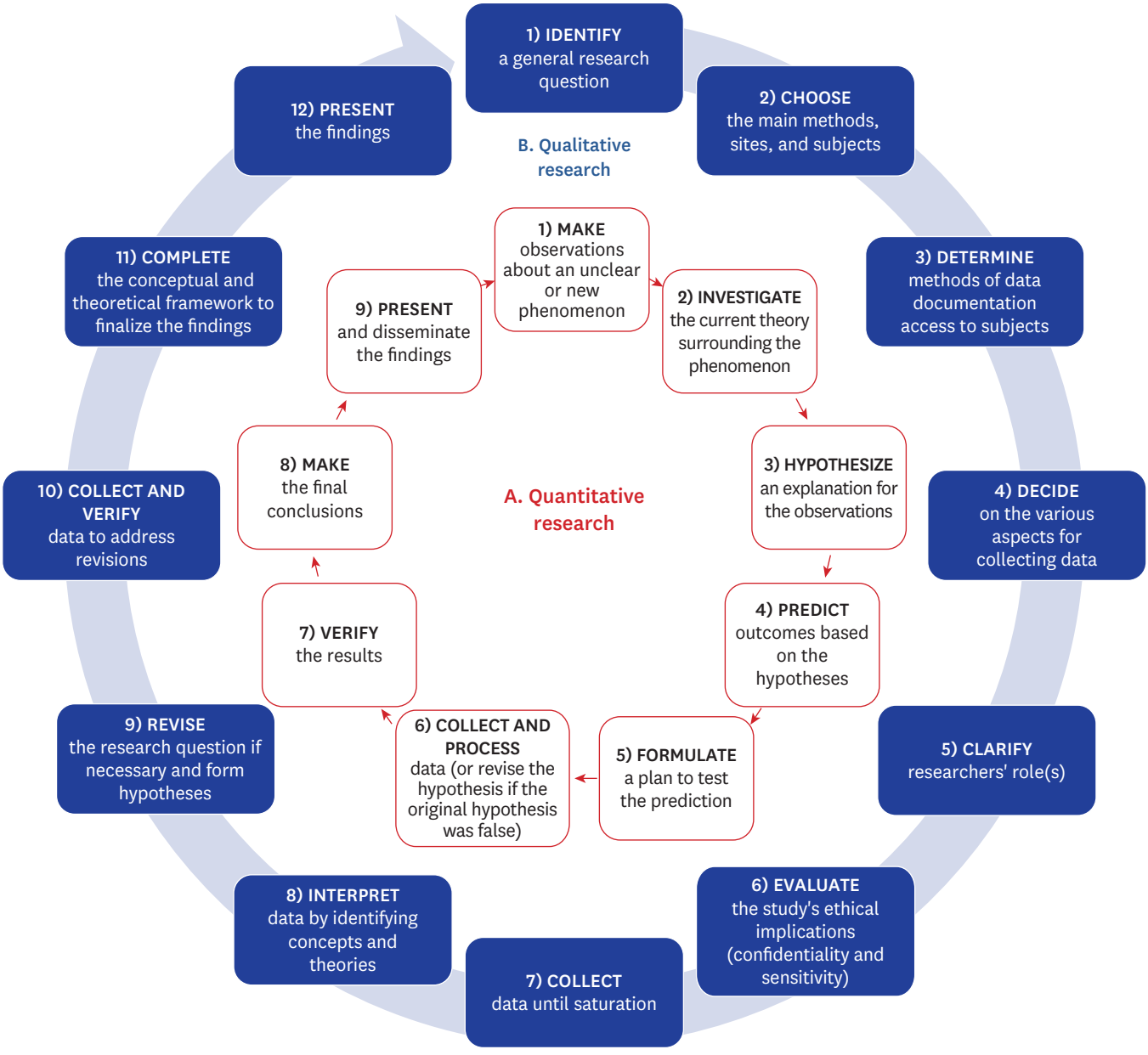

Fig. 1. Schematic diagrams of qualitative and quantitative research methodologies.

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Descriptive research is conducted and written by describing the status of an identified variable to provide systematic information about a phenomenon. A hypothesis is developed and tested after data collection, analysis, and synthesis. This type of research attempts to factually present comparisons and interpretations of findings based on analyses of the characteristics, progression, or relationships of a certain phenomenon by manipulating the employed variables or controlling the involved conditions.[44] Here, the researcher examines, observes, and describes a situation, sample, or variable as it occurs without investigator interference.[31,45] To be meaningful, the systematic collection of information requires careful selection of study units by precise measurement of individual variables[21] often expressed as ranges, means, frequencies, and/or percentages.[31,45] Descriptive statistical analysis using ANOVA, Student's *t*-test, or the Pearson coefficient method has been used to analyze descriptive research data.[46]

Correlational research is performed by determining and interpreting the extent of a relationship between two or more variables using statistical data. This involves recognizing data trends and patterns without necessarily proving their causes. The researcher studies only the data, relationships, and distributions of variables in a natural setting, but does not manipulate them.[21,45] Afterwards, the researcher establishes reliability and validity, provides converging evidence, describes relationship, and makes predictions.[47]

Experimental research is usually referred to as true experimentation. The researcher establishes the cause-effect relationship among a group of variables making up a study using the scientific method or process. This type of research attempts to identify the causal relationships between variables through experiments by arbitrarily controlling the conditions or manipulating the variables used.[44] The scientific manuscript would include an explanation of how the independent variable was manipulated to determine its effects on the dependent variables. The write-up would also describe the random assignments of subjects to experimental treatments.[21]

Causal-comparative/quasi-experimental research closely resembles true experimentation but is conducted by establishing the cause-effect relationships among variables. It may also be conducted to establish the cause or consequences of differences that already exist between, or among groups of individuals.[48] This type of research compares outcomes between the intervention groups in which participants are not randomized to their respective interventions because of ethics- or feasibility-related reasons.[49] As in true experiments, the researcher identifies and measures the effects of the independent variable on the dependent variable. However, unlike true experiments, the researchers do not manipulate the independent variable.

In quasi-experimental research, naturally formed or pre-existing groups that are not randomly assigned are used, particularly when an ethical, randomized controlled trial is not feasible or logical.[50] The researcher identifies control groups as those which have been exposed to the treatment variable, and then compares these with the unexposed groups. The causes are determined and described after data analysis, after which conclusions are made. The known and unknown variables that could still affect the outcome are also included.[7]

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QUALITATIVE RESEARCH

Inductive approach

Qualitative research involves an inductive approach to develop a hypothesis.[21,25] Using this approach, researchers answer research questions and develop new theories, but they do not test hypotheses or previous theories. The researcher seldom examines the effectiveness of an intervention, but rather explores the perceptions, actions, and feelings of participants using interviews, content analysis, observations, or focus groups.[25,45,51]

Distinctive features of qualitative research

Qualitative research seeks to elucidate about the lives of people, including their lived experiences, behaviors, attitudes, beliefs, personality characteristics, emotions, and feelings.[27,30] It also explores societal, organizational, and cultural issues.[30] This type of research provides a good story mimicking an adventure which results in a "thick" description that puts readers in the research setting.[52]

The qualitative research questions are open-ended, evolving, and non-directional.[26] The research design is usually flexible and iterative, commonly employing purposive sampling. The sample size depends on theoretical saturation, and data is collected using in-depth interviews, focus groups, and observations.[27]

In various instances, excellent qualitative research may offer insights that quantitative research cannot. Moreover, qualitative research approaches can describe the 'lived experience' perspectives of patients, practitioners, and the public.[53] Interestingly, recent developments have looked into the use of technology in shaping qualitative research protocol development, data collection, and analysis phases.[54]

Qualitative research employs various techniques, including conversational and discourse analysis, biographies, interviews, case-studies, oral history, surveys, documentary and archival research, audiovisual analysis, and participant observations.[26]

Conducting qualitative research

To conduct qualitative research, investigators 1) identify a general research question, 2) choose the main methods, sites, and subjects, and 3) determine methods of data documentation access to subjects. Researchers also 4) decide on the various aspects for collecting data (e.g., questions, behaviors to observe, issues to look for in documents, how much (number of questions, interviews, or observations), 5) clarify researchers' roles, and 6) evaluate the study's ethical implications in terms of confidentiality and sensitivity. Afterwards, researchers 7) collect data until saturation, 8) interpret data by identifying concepts and theories, and 9) revise the research question if necessary and form hypotheses. In the final stages of the research, investigators 10) collect and verify data to address revisions, 11) complete the conceptual and theoretical framework to finalize their findings, and 12) present and disseminate findings (**Fig. 1B**).

Types of qualitative research

The different types of qualitative research include (a) historical research, (b) ethnographic research, (c) meta-analysis, (d) narrative research, (e) grounded theory, (f) phenomenology, (g) case study, and (h) field research.[23,25,28,30]

Historical research is conducted by describing past events, problems, issues, and facts. The researcher gathers data from written or oral descriptions of past events and attempts to recreate the past without interpreting the events and their influence on the present.[6] Data is collected using documents, interviews, and surveys.[55] The researcher analyzes these data by describing the development of events and writes the research based on historical reports.[2]

Ethnographic research is performed by observing everyday life details as they naturally unfold.[2] It can also be conducted by developing in-depth analytical descriptions of current systems, processes, and phenomena or by understanding the shared beliefs and practices of a particular group or culture.[21] The researcher collects extensive narrative non-numerical data based on many variables over an extended period, in a natural setting within a specific context. To do this, the researcher uses interviews, observations, and active participation. These data are analyzed by describing and interpreting them and developing themes. A detailed report of the interpreted data is then provided.[2] The researcher immerses himself/herself into the study population and describes the actions, behaviors, and events from the perspective of someone involved in the population.[23] As examples of its application, ethnographic research has helped to understand a cultural model of *family and community nursing* during the coronavirus disease 2019 outbreak.[56] It has also been used to observe the organization of people's environment in relation to cardiovascular disease management in order to clarify people's real expectations during follow-up consultations, possibly contributing to the development of innovative solutions in care practices.[57]

Meta-analysis is carried out by accumulating experimental and correlational results across independent studies using a statistical method.[21] The report is written by specifying the topic and meta-analysis type. In the write-up, reporting guidelines are followed, which include description of inclusion criteria and key variables, explanation of the systematic search of databases, and details of data extraction. Meta-analysis offers in-depth data gathering and analysis to achieve deeper inner reflection and phenomenon examination.[58]

Narrative research is performed by collecting stories for constructing a narrative about an individual's experiences and the meanings attributed to them by the individual.[9] It aims to hear the voice of individuals through their account or experiences.[17] The researcher usually conducts interviews and analyzes data by storytelling, content review, and theme development. The report is written as an in-depth narration of events or situations focused on the participants.[2,59] Narrative research weaves together sequential events from one or two individuals to create a "thick" description of a cohesive story or narrative.[23] It facilitates understanding of individuals' lives based on their own actions and interpretations.[60]

Grounded theory is conducted by engaging in an inductive ground-up or bottom-up strategy of generating a theory from data.[24] The researcher incorporates deductive reasoning when using constant comparisons. Patterns are detected in observations and then a working hypothesis is created which directs the progression of inquiry. The researcher collects data using interviews and questionnaires. These data are analyzed by coding the data, categorizing themes, and describing implications. The research is written as a theory and theoretical models.[2] In the write-up, the researcher describes the data analysis procedure (i.e., theoretical coding used) for developing hypotheses based on what the participants say.[61] As an example, a qualitative approach has been used to understand the process of skill development of a nurse preceptor in clinical teaching.[62] A researcher can also develop a theory using the grounded theory approach to explain the phenomena of interest by observing a population.[23]

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Phenomenology is carried out by attempting to understand the subjects' perspectives. This approach is pertinent in social work research where empathy and perspective are keys to success.[21] Phenomenology studies an individual's lived experience in the world.[63] The researcher collects data by interviews, observations, and surveys.[16] These data are analyzed by describing experiences, examining meanings, and developing themes. The researcher writes the report by contextualizing and reporting the subjects' experience. This research approach describes and explains an event or phenomenon from the perspective of those who have experienced it.[23] Phenomenology understands the participants' experiences as conditioned by their worldviews.[52] It is suitable for a deeper understanding of non-measurable aspects related to the meanings and senses attributed by individuals' lived experiences.[60]

Case study is conducted by collecting data through interviews, observations, document content examination, and physical inspections. The researcher analyzes the data through a detailed identification of themes and the development of narratives. The report is written as an in-depth study of possible lessons learned from the case.[2]

Field research is performed using a group of methodologies for undertaking qualitative inquiries. The researcher goes directly to the social phenomenon being studied and observes it extensively. In the write-up, the researcher describes the phenomenon under the natural environment over time with no implantation of controls or experimental conditions.[45]

DIFFERENCES BETWEEN QUANTITATIVE AND QUALITATIVE RESEARCH

Scientific researchers must be aware of the differences between quantitative and qualitative research in terms of their working mechanisms to better understand their specific applications. This knowledge will be of significant benefit to researchers, especially during the planning process, to ensure that the appropriate type of research is undertaken to fulfill the research aims.

In terms of quantitative research data evaluation, four well-established criteria are used: internal validity, external validity, reliability, and objectivity.[23] The respective correlating concepts in qualitative research data evaluation are credibility, transferability, dependability, and confirmability.[30] Regarding write-up, quantitative research papers are usually shorter than their qualitative counterparts, which allows the latter to pursue a deeper understanding and thus producing the so-called "thick" description.[29]

Interestingly, a major characteristic of qualitative research is that the research process is reversible and the research methods can be modified. This is in contrast to quantitative research in which hypothesis setting and testing take place unidirectionally. This means that in qualitative research, the research topic and question may change during literature analysis, and that the theoretical and analytical methods could be altered during data collection.[44]

Quantitative research focuses on natural, quantitative, and objective phenomena, whereas qualitative research focuses on social, qualitative, and subjective phenomena.[26] Quantitative research answers the questions "what?" and "when?," whereas qualitative research answers the questions "why?," "how?," and "how come?."[64]

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Perhaps the most important distinction between quantitative and qualitative research lies in the nature of the data being investigated and analyzed. Quantitative research focuses on statistical, numerical, and quantitative aspects of phenomena, and employ the same data collection and analysis, whereas qualitative research focuses on the humanistic, descriptive, and qualitative aspects of phenomena.[26,28]

Structured versus unstructured processes

The aims and types of inquiries determine the difference between quantitative and qualitative research. In quantitative research, statistical data and a structured process are usually employed by the researcher. Quantitative research usually suggests quantities (i.e., numbers).[65] On the other hand, researchers typically use opinions, reasons, verbal statements, and an unstructured process in qualitative research.[63] Qualitative research is more related to quality or kind.[65]

In quantitative research, the researcher employs a structured process for collecting quantifiable data. Often, a close-ended questionnaire is used wherein the response categories for each question are designed in which values can be assigned and analyzed quantitatively using a common scale.[66] Quantitative research data is processed consecutively from data management, then data analysis, and finally to data interpretation. Data should be free from errors and missing values. In data management, variables are defined and coded. In data analysis, statistics (e.g., descriptive, inferential) as well as central tendency (i.e., mean, median, mode), spread (standard deviation), and parameter estimation (confidence intervals) measures are used.[67]

In qualitative research, the researcher uses an unstructured process for collecting data. These non-statistical data may be in the form of statements, stories, or long explanations. Various responses according to respondents may not be easily quantified using a common scale.[66]

Composing a qualitative research paper resembles writing a quantitative research paper. Both papers consist of a title, an abstract, an introduction, objectives, methods, findings, and discussion. However, a qualitative research paper is less regimented than a quantitative research paper.[27]

Quantitative research as a deductive hypothesis-testing design

Quantitative research can be considered as a hypothesis-testing design as it involves quantification, statistics, and explanations. It flows from theory to data (i.e., deductive), focuses on objective data, and applies theories to address problems.[45,68] It collects numerical or statistical data; answers questions such as how many, how often, how much; uses questionnaires, structured interview schedules, or surveys[55] as data collection tools; analyzes quantitative data in terms of percentages, frequencies, statistical comparisons, graphs, and tables showing statistical values; and reports the final findings in the form of statistical information.[66] It uses variable-based models from individual cases and findings are stated in quantified sentences derived by deductive reasoning.[24]

In quantitative research, a phenomenon is investigated in terms of the relationship between an independent variable and a dependent variable which are numerically measurable. The research objective is to statistically test whether the hypothesized relationship is true.[68] Here, the researcher studies what others have performed, examines current theories of the phenomenon being investigated, and then tests hypotheses that emerge from those theories.[4]

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Quantitative hypothesis-testing research has certain limitations. These limitations include (a) problems with selection of meaningful independent and dependent variables, (b) the inability to reflect subjective experiences as variables since variables are usually defined numerically, and (c) the need to state a hypothesis before the investigation starts.[61]

Qualitative research as an inductive hypothesis-generating design

Qualitative research can be considered as a hypothesis-generating design since it involves understanding and descriptions in terms of context. It flows from data to theory (i.e., inductive), focuses on observation, and examines what happens in specific situations with the aim of developing new theories based on the situation.[45,68] This type of research (a) collects qualitative data (e.g., ideas, statements, reasons, characteristics, qualities), (b) answers questions such as what, why, and how, (c) uses interviews, observations, or focused-group discussions as data collection tools, (d) analyzes data by discovering patterns of changes, causal relationships, or themes in the data; and (e) reports the final findings as descriptive information.[61] Qualitative research favors case-based models from individual characteristics, and findings are stated using context-dependent existential sentences that are justifiable by inductive reasoning.[24]

In qualitative research, texts and interviews are analyzed and interpreted to discover meaningful patterns characteristic of a particular phenomenon.[61] Here, the researcher starts with a set of observations and then moves from particular experiences to a more general set of propositions about those experiences.[4]

Qualitative hypothesis-generating research involves collecting interview data from study participants regarding a phenomenon of interest, and then using what they say to develop hypotheses. It involves the process of questioning more than obtaining measurements; it generates hypotheses using theoretical coding.[61] When using large interview teams, the key to promoting high-level qualitative research and cohesion in large team methods and successful research outcomes is the balance between autonomy and collaboration.[69]

Qualitative data may also include observed behavior, participant observation, media accounts, and cultural artifacts.[61] Focus group interviews are usually conducted, audiotaped or videotaped, and transcribed. Afterwards, the transcript is analyzed by several researchers.

Qualitative research also involves scientific narratives and the analysis and interpretation of textual or numerical data (or both), mostly from conversations and discussions. Such approach uncovers meaningful patterns that describe a particular phenomenon.[2] Thus, qualitative research requires skills in grasping and contextualizing data, as well as communicating data analysis and results in a scientific manner. The reflective process of the inquiry underscores the strengths of a qualitative research approach.[2]

Combination of quantitative and qualitative research

When both quantitative and qualitative research methods are used in the same research, mixed-method research is applied.[25] This combination provides a complete view of the research problem and achieves *triangulation* to corroborate findings, *complementarity* to clarify results, *expansion* to extend the study's breadth, and *explanation* to elucidate unexpected results.[29]

Moreover, quantitative and qualitative findings are integrated to address the weakness of both research methods[29,66] and to have a more comprehensive understanding of the phenomenon spectrum.[66]

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For data analysis in mixed-method research, real non-quantitized qualitative data and quantitative data must both be analyzed.[70] The data obtained from quantitative analysis can be further expanded and deepened by qualitative analysis.[23]

In terms of assessment criteria, Hammersley[71] opined that qualitative and quantitative findings should be judged using the same standards of validity and value-relevance. Both approaches can be mutually supportive.[52]

CONCLUSION

Quantitative and qualitative research must be carefully studied and conducted by scientific researchers to avoid unethical research and inadequate outcomes. Quantitative research involves a deductive process wherein a research question is answered with a hypothesis that describes the relationship between independent and dependent variables, and the testing of the hypothesis. This investigation can be aptly termed as hypothesis-testing research involving the analysis of hypothesis-driven experimental studies resulting in a test of significance. Qualitative research involves an inductive process wherein a research question is explored to generate a hypothesis, which then leads to the development of a theory. This investigation can be aptly termed as hypothesis-generating research. When the whole spectrum of inductive and deductive research approaches is combined using both quantitative and qualitative research methodologies, mixed-method research is applied, and this can facilitate the construction of novel hypotheses, development of theories, or refinement of concepts.

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