Handbook of Educational Research for Beginners

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Preface

This book focuses on educational research for college students, teachers, and beginner educational researchers. It can guide researchers to get an overall understanding of what research is, what education research entails, and how teachers can design, implement, and evaluate a study to understand the effectiveness of an instructional strategy or improve student learning. It has an introductory level, easy to understand with plenty of examples. Teachers can find relevant materials to learn methods to guide their students by using different forms of research tools in data collection and analysis. Readers are exposed to craft research topics and research questions. Instructors can organize individual and group study programs for their students. The book suggests the readers to read published research articles to explore what has been done on educational research and draw links between the similarities between scientific research and educational research. It is great to cover different research designs to collect and analyze data and consider ethical considerations in research. A teacher or instructor can use this book to provide support and case studies to his/her students to get deeper insights into research and applications in real classroom settings. The book can support learners and teachers to see the continuity and coherence across the elements of educational research throughout the chapters. Readers can understand how to develop and refine a research proposal by the end of the book.

Contents

INTRODUCTION to EDUCATIONAL RESEARCH

- By the end of this chapter, students will be able to
  - o explain the process of scientific research.
  - o explain the sections and format of an educational research paper.
  - o identify research problems, purposes, questions, hypotheses in a research paper.
  - o generate a research question on a selected topic.

There are some misconceptions about research processes: Some people believe that research is merely gathering information or an exercise for self-enlightenment or transporting facts from one location to another or fact transcription, documentation, organization, and summarization. If these definitions do not refer to the definition of research, what is research? Research includes data collection and analysis, interpretation of findings, and communicating the results in different ways. The research process starts with a problem to solve and continues with selection of theoretical perspectives and definition of procedures for data collection and analysis. Educational research is necessary to contribute to academic knowledge, school curriculum, teacher development, and student learning. Research on teacher professional development can enhance their instructional practices, implement alternative approaches, and their students' learning in different ways. Research on educational issues addresses problematic situations to inform policymakers to develop new standards for low-achieving students or define national standards on education.

The research process needs to have a goal or purpose to define the research problem and subproblems based on the gaps within the literature. The literature review is an inevitable component of research problems to address the limitations of published work. In doing the research, the researcher should consider the factors influencing the research process such

as grade level, age, background knowledge. For example, a researcher may assume that both class-A and class-B have similar mathematical backgrounds before teaching through different instructional strategies in each class. In other words, students' sixth grade exam scores are valid to investigate the influence of gamification (Class-A) and traditional (Class-B) instruction in these classes.

When we ask a research question, we need to check whether this question has been explored before and to consider what makes this question unique to explore. The researcher should conduct a literature review to understand what has been done on the topic and what needs to be explored. The literature review would guide the researcher to find tentative explanations as hypothesis to answer the research questions. The researcher states the hypothesis to develop a plan for data collection and analysis and interpretation of findings.

The research process is iterative and cyclic; it is not a linear process to follow the steps. The researcher can move back and forth between the steps continually to resolve the question. In general, these steps are defined as to identify the research problem and question (1), to design the study to collect and analyze data (2), and to interpret findings based on the theoretical perspectives (3) to understand whether our prediction is supported by the research findings. In an iterative process, for example, we define the research question, design a qualitative study to collect and analyze data. While analyzing data, we may realize the need to collect more interview data from the participants for further analysis.

Sometimes, we may find results that do not agree with hypothesis of the study, or we may have a small number of participants that may not give adequate data to answer the research question. In these situations, we need to reconsider the research questions and data collection measures. Research questions should not be too broad, or all questions cannot be answered or may not be appropriate research questions. Our research questions should be narrow and focus on a few variables. In measuring variables such as attitudes or beliefs, data collection methods should be valid and reliable. Besides data collection measures, there are other tools that we need to use in the research process such as observation protocols or technology. Lastly, the participants' rights and confidentiality should be considered since educational research cannot be separate from human involvement and ethics.

In this section, we will explore the definition and characteristics of science and scientific methods. We will explore the following questions:

a. What is research? What is scientific research and educational research?

b. What is the scientific method? What are the types of scientific methods and their characteristics?

c. What is science and scientific research method? What is the process of research?

Activity-1: What is research?

A science instructor at a high school had several incidents in the school that involved students showing inappropriate behaviors:

- The teacher found a 12th grader missing science classes regularly.
- A 10th-grade student broke the lab materials in the last two weeks without any excuse.
- Most students do not finish the weekly homework before they come to the class.
- Most students' exam grades in science class are low, below average.

These incidents alarm the teacher and school administration to develop guidelines about how to respond to these inappropriate behaviors. The science teacher understands the significance of addressing these problems as part of her graduate program's research study requirement. Where does the teacher begin? The teacher must balance the dual roles of being a teacher and graduate student. What was her research situation?

- The teacher understands that there is a need to examine and address high school students' attitudes towards science. She realizes that students are disinterested in science classes and show inappropriate behaviors, which results in low exam grades. What should this teacher do as a teacher and researcher?
- But the teacher is worried about how to plan and conduct a research study. How should she manage the research in her school for an important problem? The problem may be seen large, but she should manage it in smaller steps. If you were this teacher who wants to address the problem in practice, what kind of research would you conduct? What is the meaning of research in these conditions?

Activity-2: Scientific Method

A group of students randomly selected for a research study. Many students come to college with background knowledge from high school. The data given below provides the information about students' high school and college GPA grades. Examine the table and answer the questions:

Student	1	2	3	4	5	6	7	8	9	10
High school GPA	2.4	3.4	3.0	3.5	3.8	3.3	2.2	2.9	3.6	3.9
College GPA	2.1	3.1	2.0	3.2	3.5	3.9	2.7	2.1	3.8	3.9

1. What patterns do you observe on the information in Table?
2. Develop a hypothesis relating to the high school GPA and college GPA achievement based on the published literature.
3. What would your experimental approach be to test this hypothesis?
4. What would be the independent and dependent variables?
5. What would be your control?
6. What type of graph would be appropriate for this data set? Draw the graph.
7. Interpret the graph: What does the graph tell you about the data?

Activity-3: Concept map

Please draw a concept map to define the scientific research process.

Activity-4: Hypothesis & Assumption

What is the difference between hypothesis and assumption?

In the text below, please describe the hypothesis and assumptions of the given study.

a. Baxter & Wright (2000) (p. 1): The general-case glass ceiling conceptualization states that not only is it more difficult for women than for men to be promoted up levels of authority hierarchies within workplaces but also that the obstacles women face relative to men become greater as they move up the hierarchy. Gender-based discrimination in promotions is not simply present across levels of hierarchy but is more intense at higher levels. Empirically, this implies that the relative rates of women being promoted to higher levels

compared to men should decline with the level of the hierarchy. This article explores this hypothesis with data from three countries: the United States, Australia, and Sweden. The basic conclusion is that while there is strong evidence for a general gender gap in authority—the odds of women having authority are less than those of men—there is no evidence for systematic glass ceiling effects in the United States and only weak evidence for such effects in the other two countries.

b. Eichler & Albanese (2007) (p. 1): Through a critical review of the literature, this paper identifies four implicit premises which underlie much of the empirical literature on housework: that housework is performed exclusively by couples within their own homes; that it consists primarily of a set of repetitive physical tasks; that it includes childcare, but not care of adults; that it remains largely stable over the life course. Using data from a Canadian study, these premises are examined and shown to be false. A new definition of household work is proposed. It identifies four dimensions of household work: physical, emotional, mental and spiritual, integrates housework with care work, includes all those who contribute to household work, whether on a paid or unpaid basis, acknowledges cross-household exchange of work and its changing nature over the life course. Using this definition of household work would lead to new questions as well as to a reinterpretation of some currently accepted generalizations.

Activity-5: Broad, Narrow, Manageable topic

Please identify whether the below expressions represent broad, narrow or manageable topic.

Statement	Type
What is the impact of problem-based learning on students' test scores?	
How does the use of educational technology improve the learning of mathematics?	
How does the use of GeoGebra graphing software lead to better understanding of geometry concepts for low-readiness students?	
How does the shift from written to e-documentation (electronic notes/ work) improve the student's learning?	
The purpose of our study is to gain an understanding of how alternative conceptions of Dynamics differ from 13 to 18 years old.	
How does the use of technology affect the learning of students?	
How does the use of Notion for notetaking improve the student's learning?	
What are the major factors of late coming to school?	

Activity-6: Write a manageable topic.

Select a research topic that you are interested in. Think about your previous learning experiences or your experiences as a college student. If your topic is too broad, you will need to look up too many information that you will need to summarize, but if you select a narrow topic, it will be difficult to ask a good research question. Please find a manageable topic referring to broad and narrow ideas.

		Manageable
Too broad topic		
Too narrow topic		

Activity-7: Write research questions on your manageable topic:

A good research question guides the research process. Please ask your questions with "who, what, where, when, why, and how."

Activity-8: Discuss different types of writing about different topics. Please explain where you can use these types of writings and provide an example:

Type of writing	Definition	Example
Research		
Literature review		
Theoretical discussion		
Opinion paper		
Program description		
Fiction writing		
Poetry		

Activity-9: Consider the following abstracts and define whether the articles are reports for a research study? Why or why not?

a. An abstract written by Apthorp (2006, p. 67):

The author examined the effectiveness of vocabulary intervention that employed structured, supplemental story read-aloud and related oral-language activities. Within each of 7 Title I schools across 2 sites, 15 third-grade teachers were randomly assigned to either use the intervention (treatment condition) or continue their usual practice (control condition). Trained test examiners administered oral and sight vocabulary pre- and posttests and reading achievement posttests. At 1 site, students in treatment, compared with control, classrooms performed significantly higher in vocabulary and reading achievement. In the other site, the intervention was not more effective. Contextual factors and student characteristics appeared to affect the results.

b. An abstract written by Carrington, Templeton, and Papinczak (2003, p. 211) :

This qualitative study investigated the perceptions of friendship faced by teenagers diagnosed with Asperger syndrome. This research aimed to provide teachers with an insight into the social world of Asperger syndrome from a student perspective. A multiple–case study approach was used to collect data from 5 secondary school students in Australia. Data was collected using semi-structured interviews. An inductive approach to data analysis resulted in several broad themes in the data: (a) understanding of concepts or language regarding friendships, (b) description of what is a friend, (c) description of what is not a friend, (d) description of an acquaintance, and (e) using masquerading to cope with social deficits. The insights provided by the participants in this study are valuable for teachers, parents, and anyone else involved in inclusive education.

Activity-10: What is the difference between a tool and methodology? Consider the following sentence in defining the function of these terms and fill-in-the-blanks:

In research, we use specific strategies or mechanisms as research ……for data collection, manipulation and interpretation. We should have a/an ……. by using some ……. to manage the research project. The ……. can be library resources or technology, and the …… can be a case study, correlational research, or phenomenology.

a. Which tools are appropriate to use in research? Please list.

QUIZ

1. A characteristic of good research study is not to:
   a. fill a gap in literature.
   b. add to the literature base through proving or disproving the former findings.
   c. address or suggest an improvement or advancement.
   d. replicate the previous studies to find the same results.

2. A suitable definition of research is related to:
   a. Collect different forms of information to present.
   b. Find something unknown to answer a question.
   c. Collect and analyze data systematically to answer a question.
   d. Find definitions of variables to identify certain characteristics.

3. Please choose one of the following responses as an example of research.
   a. You will write a short article about the influence of children's books on students' attitudes towards socioscientific in elementary school. You need to search for articles on this topic to write your paper.
   b. The population of one type of turtle has declined in the Mediterranean region where they live most. A researcher goes to the laboratory in the south to conduct a systematic search: collect data of weather conditions, soil and water samples and search for the existence of other lively beings that may affect their survival.
   c. You will ask a tutor to teach mathematics to your child. You want to pay sufficient money for the tutor's work. You ask several parents about the tutoring payments.
   d. You are asked to synthesize the information given in a series of articles on teacher professional development. From your readings, you will define at least how many hours work is necessary in the design and implement a professional development.

4. Which one of the following is an accurate explanation for the research process?
   a. Data collection and analysis is enough to answer the questions.
   b. Each research question brings a new research problem for further data collection and analysis.
   c. Educational research requires a linear process of inquiry.
   d. Systematic data collection and analysis supports consideration of alternative explanations.

5. The research process involves different and iterative steps to conduct a study. For example, a researcher studies the influence of inquiry-based instruction and traditional instruction to compare students' science achievement. In total, the researcher reaches 300 students who learn science through inquiry-based instruction and 300 students who learn science through traditional instruction. The next step is to compare students' achievement scores in two different groups. What process of research was the researcher interested in at this stage?
   a. Define research problems.
   b. Collect and Analyze data.
   c. Design research plan.
   d. Interpret the findings.

6. Scientific research should not include the following characteristic:
   a. Observation
   b. Hypothesis
   c. Data collection
   d. Personal bias

7. Which tool of the following guides the researcher to use quantitative analysis methods for analysis of educational data?
   a. Statistics
   b. Technology
   c. Measurement
   d. Library

8. Why do researchers prefer using articles from academic journals rather than using Internet sources directly?
   a. Academic journals include peer-reviewed resources.
   b. Academic journals include a few resources.
   c. Internet resources include variety of information.
   d. Internet resources are much reliable.
9. Scientific method does not include:
   a. Observations
   b. Hypothesis
   c. Experimentation
   d. Personal bias
10. What is science? How do you define scientific research? How do you define scientists' work or practices

PARADIGMS IN EDUCATIONAL RESEARCH

By the end of this chapter, students will be able to

- compare the types of research paradigms in education.
- recognize the main differences in research designs.
- provide examples of different types of research designs.

Crotty (1998) made a foundational work on research paradigms in education and focused on three main questions (Creswell, 2002):

1. How does the researcher establish knowledge claims and use theoretical framework?

2. How does the research design inform the methods and procedures?

3. Which methods will the researcher use for data collection and analysis?

Research paradigms in education have great importance to determine the nature of research- to define the strategies and methods to conduct research. Creswell (2002) defines educational research paradigms as positivist (post-positivist), constructivist or interpretivist, critical, and postmodernist paradigms.

Positivism defines knowledge as absolute and true facts and constructed as certain methods to verify knowledge claims; positivists believe that nature involves objective, certain and unchanged laws. Positivism rejects the existence of alternative explanations and depends on mathematical or quantitative explanations of the problems. Positivism is generally used in natural sciences such as physics, chemistry, and mathematics, but it also shows its acceptance in social and educational sciences using quantitative methods. These methods are deductive methods that research starts with a general explanation or hypothesis or observation to test the theory quantitatively and systematically. However, some researchers are called postpositivist scientists since they believe in true objectivity in data collection

and analysis, but they may bring their biases to measure certain variables or to make inferences.

Interpretivist or constructivist paradigm focuses on understanding the nature of events and situations through exploring subjective experiences by defining the categories of complex meanings or multiple realities given by individuals. Although the positivist paradigm is objective, interpretivism is interested in subjective experiences through open-ended questioning to understand individuals' views on a phenomenon. Creswell (2002) states: "Qualitative researchers seek to understand the context or setting of the participants through visiting the context and gathering information personally" (p.10). This process occurs through an inductive approach to develop an understanding and meaning of the complex data through categorization and interpretation of findings based on a theoretical perspective.

The critical paradigm focuses on the research and evaluation of status-quo and power relations (e.g. class, race, gender, economy, religion etc.) to emphasize the factors causing the inequality and establish democratic society for everyone. Critical paradigm evaluates political agenda, social and economic issues, historical events or topics related to empowerment, inequality, morality, domination, oppression etc. to initiate a change through giving a voice to the participants and raising consciousness of the topic. This paradigm supports social justice to promote equality. Feminist perspectives, racialized discourses, or Disability inquiry can be used as a critical approach through participatory action research or ethnographic studies.

According to Neuman (2014), post-modernists believe in nihilism, reject the systematic experimental observation and doubt on generalizability and accumulation of knowledge claims in social world since they believe in knowledge as context-specific depending on various shapes, areas, and specific places. Post-modernism supports the evaluation based on intuition, imagination, and personal experience, and believes that there are diverse ways of interpretation. In post-modernist research, the answers to research questions present the researchers' subjectivity in a theatrical and dramatic way.

Pragmatism includes both quantitative and qualitative research methods. Quantitative methods include concrete data or quantitative data in the form of numbers, qualitative methods include abstract data in the form of words, sentences, or pictures. Quantitative and qualitative methods differ from each other through paradigms, beliefs and assumptions that they belong to. Quantitative research involves quantitative measurement procedures,

structured surveys, experiments, or correlational data for large scale statistical studies. Qualitative research consists of semi-structured or open-ended interviews and observations to understand the behaviors, experiences or attitudes of a smaller number of specific cases or participants. Quantitative research is deductive, verifiable, and based on positivist paradigm, whereas qualitative research is inductive, explanatory, and based on constructivist or critical paradigm.

Educational research is conducted through quantitative, qualitative or mixed-method studies. The type of research methodology differs according to the research problem, research questions, and previously published literature. The researchers' philosophical perspective defines the way to ask the research purposes, questions, and review the literature to define the hypothesis or assumptions of the study. The definition of the research methodology also clarifies or guides the research design to determine the sampling method, data gathering and interpretation procedures.

Activity-1: Please complete the chart to understand the characteristics of qualitative and quantitative research.

	QUANTITATIVE RESEARCH	QUALITATIVE RESEARCH
What are the main characteristics of …?		
What are the strengths of …?		
What are the weaknesses of …?		
What kind of questions or problems can be defined for …?		
What types of research designs can be studied in …?		
What types of sampling strategies can be used in …?		
What types of data collection instruments can be used in ….?		
What types of data analysis methods can be used in …?		
What is the main terminology to use in …?		

Activity-2: Read the following study sections and list the characteristics of suggested research.

a) "Divorce is a personal experience, often negative, and each couple experiences it differently. However, the divorce experience may provide opportunities for personal growth. The purpose of [this study] was to understand the challenges and growth opportunities women who have divorced experience from their own perspective" (Thomas & Ryan, 2008, p. 210).

b) "School violence and weapons at school are a major concern for community members, school administrators, and policy makers. This research examines both student-level and school-level variables that predict middle school students' willingness to report a weapon at school under several reporting conditions" (Wylie et al., 2010, p. 351).

c) "This research investigated the effect of a three-week school based nutrition education program on the nutrition knowledge and healthy food choices of 187 fifth graders who were randomly divided into a control (n = 97) or an experimental (n = 90) group. The control group received no nutrition education while the experimental group received 45 minutes of nutrition education, 4 days a week for 3 weeks. Nutrition knowledge scores and 3-day food records were collected at the beginning of the study and after 3 weeks" (Kandiah & Jones, 2002, p. 269).

d) "A [multiple case] study is described which explored the experiences of four families each of which contained a young person who had suffered with anorexia nervosa... Individual interviews were conducted with the young person with anorexia, a key sibling, both parents, and a joint family interview was also conducted" (Dallos & Denford, 2008, p. 305).

e) "Consistent with the authors' hypotheses, victimization history was associated with both increased stress and an increased use of avoidant coping strategies. In addition, avoidant coping partially mediated the link between victimization and stress. These findings suggest that avoidant coping may develop as an adaptive response to uncontrollable stress but that, in the long term, these strategies are a maladaptive approach to coping that acts to prolong stress" (Newman, Holden, & Delville, 2011, p. 205).

f) "Thematic analysis revealed three prominent themes: (a) the free and busy me highlights the increased freedom in later life enabling choices regarding activities the women would like to engage in; (b) the secret is being positive and pragmatic emphasizes the importance of adopting a pragmatic acceptance of growing older; and (c) narratives of growth and stagnation highlights the pursuit of growth among older women in order to enhance the current self. Findings emphasize the construction of later life as one of liberation, resilience and growth" (Terrill & Gullifer, 2010, p. 707).

g) The following abstract is about a study on autism: Smith, Greenberg, and Seltzer (2012). Please examine and list the characteristics of quantitative research in this study.

The present study investigated the impact of social support on the psychological well-being of mothers of adolescents and adults with ASD [autism spectrum disorders] (n = 269). Quantity of support (number of social network members) as well as valence of support (positive support and negative support) were assessed using a modified version of the "convoy model" developed by Antonucci and Akiyama (1987). Having a larger social network was associated with improvements in maternal well-being over an 18-month period. Higher levels of negative support as well as increases in negative support over the study period were associated with increases in depressive symptoms and negative affect and decreases in positive affect. Social support predicted changes in well-being above and beyond the impact of child behavior problems. Implications for clinical practice are discussed. (Smith et al., 2012, p. 1818)

h) The following abstract is about a study on autism: Tozer, Atkin, and Wenham (2013). Please examine and list the characteristics of qualitative research in this study.

Sibling relationships are usually lifelong and reciprocal. They can assume particular significance when a brother or sister has a learning disability. Until recently, adult siblings of people with disabilities such as severe autism have been ignored by policy, practice and research. This qualitative study contributes to an emerging literature by exploring how adult siblings, who have a brother or sister with autism (plus learning disability) and living in England, give meaning to their family (and caring) relationships and engage with service delivery. We spoke to 21 adult siblings using semi structured interviews and met with 12 of their siblings with autism. Our analysis, using a broad narrative approach, demonstrates the continuity of the sibling relationship and an enduring personalized commitment. The nature of this

relationship, however, is sensitive to context. How do non-disabled adult siblings relate to their childhood experience is fundamental when making sense of this, as is their need to fulfil other social and family obligations, alongside their "sense of duty" to support their disabled brother or sister. Sibling experience was further mediated by negotiating their "perceived invisibility" in social care policy and practice. Our work concludes that by understanding the way relationships between siblings have developed over time, adult siblings' contribution to the lives of their brother or sister with autism can be better supported for the benefit of both parties. Such an approach would support current policy developments. (Tozer et al., 2013, p. 480)

Activity-3: You have examined studies designed with quantitative and qualitative methodologies. Now, I want you to reconsider the mixed methods design and answer the following questions:

1) What is the nature and purpose of mixed methods design study?
2) According to the type of data collection, how do mixed-methods design differ from quantitative or quantitative research?
3) According to the sequence of data collection, how do mixed-methods design differ from quantitative or quantitative research?
4) According to analysis techniques, how do mixed-methods design differ from quantitative or quantitative research?

Activity-4: Explore the following questions and complete the chart.

a. What are the main characteristics of quantitative or qualitative research?
b. What are the strengths of quantitative or qualitative research?
c. What are the weaknesses of quantitative or qualitative research?
d. What kind of questions or problems can be defined for quantitative or qualitative research?
e. What types of quantitative or qualitative research designs can be studied?
f. What types of data collection instruments can be used in quantitative or qualitative designs?
g. What types of data analysis methods can be used in quantitative or qualitative designs?

h. What is the main terminology to use in quantitative or qualitative research?

	Quantitative	Qualitative
Research Purpose		
Research Process		
Sampling		
Data collection		
Data analysis		
Research report		
Common terminology		

Activity-5:

Creswell (2010) categorizes the research designs associated with quantitative research based on the requirement of intervention and non-intervention research. Intervention research focuses on an intervention or a treatment that may affect one group in comparison to another group. These studies are called experimental research or group comparison studies. Non-intervention research focuses on the relationship between two or more variables through correlational research. Causal-comparative research design is also a non-interventional study and is interested in determining the cause or reasons of differences between variables. Another non-interventional study focuses on describing trends for a group of people through survey research. The author also emphasizes the significance of qualitative research studies to collect and analyze in-depth data on a phenomenon or experience of a person or a group. One type of qualitative research design aims to generate a general theory derived from views of participants and their actions and interactions. This design is called grounded theory. Historically, ethnography as qualitative research is used to understand cultural and ethnic patterns, beliefs, and actions in their natural settings or contexts. A researcher may focus on story-based research or collecting stories to describe the participants' experiences through narrative research. Quantitative and qualitative research designs can be combined to address a research problem through mixed methods design. Action research or case study designs may include both quantitative and qualitative data collection to resolve a problem in practice or analyze a case.

Please identify type of the design suggested with each of typical research questions:

Research question	Research Design
How do eight-grade students study for the high school entrance examination?	
How will college students vote for the president elections?	
What is the relationship between anxiety and exam score in physics?	
How does parents' education level influence students' math achievement at first grade?	
How does the use of virtual laboratories and hands-on laboratories influence students' attitude toward science?	
What is the Black student culture in a metropolitan university?	
How do Chinese students adapt to the college in their freshman years in US colleges?	
How do African American women come to a leadership position after college?	
How do middle school students conceptualize the energy sources as related to health and fitness?	
How does the middle school science teacher integrate inquiry-based instruction to enhance students' attitudes towards science?	

QUIZ:

1. Which philosophical assumption states, "Objective scientific research can agree with a hypothesis to uncover true cause-and-effect relationships between variables"?

a. postpositivism.

b. positivism.

d. constructivism.

e. pragmatism

2. Qualitative researchers deal with textual data with open-ended inquiry to develop an explanation. Qualitative research most commonly aligns with which of the following philosophical approaches to research?

a. positivism

b. postpositivism

c. constructivism

d. pragmatism

3. Which paradigm focuses on cultural and hegemonic relations in education?

a. Postpositivism

b. Critical Theory

c. Constructivism

d. Positivism

4. Research design can be defined as

a. Defining a methodology to collect and analyze data.

b. Does not have to be framed by a theory.

c. Making a choice between quantitative, qualitative and mixed method

d. Does not have a specific style to present.

5. Please explore the ways of conducting mixed-method research.

6. Which one of the following defines the quantitative research design?

a. The scientific literacy of pre-service science teachers

b. Pre-service mathematics teachers' attitudes toward internship

c. College students' experiences of living on campus

d. The comparison between students' daily study hours and exam scores

7. Which one of the following is not a characteristic of qualitative studies?

a. Deductive reasoning

b. Open-ended questions

c. Inductive reasoning

d. Using interviews

8. Which one of the following is not the strength of quantitative research?

a. The sample includes many participants to generalize the results.

b. The research steps are fixed.

c. Deductive reasoning for data collection and analysis

d. Context-dependent

9. A qualitative researcher conducts a study and states which one of the following: After the professional development program,

a. I will conduct interviews with the participants about their experiences.

b. I will ask the participants to complete a restricted-item test.

c. I will compare their post-test scores with the pre-test scores.

d. I will compare participants' years of experience with their learning gain.

10. Which of the following is an explanation of a quantitative researcher?

a. For the research project, we made observations of social interactions and dialogues in groups.

b. We have two sets of data: one group was taught through inquiry-based instruction and the second group was taught through lecturing. Now, we will compare their test scores after instruction.

c. After the district decided to encourage science teachers to enact argumentation-based activities, district administration wanted to know science teachers' approach or perspective to teach science through argumentation.

d. We collected stories of experienced physics professors in studying particle physics.

STATEMENT OF THE PROBLEM

By the end of this chapter, students will be able to

- Recognize the statement of the problem in a research design.
- Identify the hypothesis, assumptions, and variables of the problem.
- Distinguish the research problems for quantitative and qualitative studies.
- Write a research problem and sub-problems.

Basic research is related to natural and social sciences to explore nature, space, species, human psychology or society, and there may be practical applications of basic research to solve problems. The purpose of the research should not be to clarify some misconceptions or to gather lots of information on a topic. The purpose of the research is to contribute to the research literature or add to the literature rather than repetition of what is already known. The research aims to answer complex questions rather than "yes or no" questions to analyze a case or a situation or a relationship with multiple sets of data and in-depth analysis.

You are asked to choose an appropriate problem or question to research. What kinds of questions are you interested in? You should be a good observer to determine possible problems in practice like Galileo did in 17th century about celestial objects; you should ask what, how, and why questions to clarify the topic. Not only observations in practice but also published literature guides researchers to identify the gaps or implications for future studies. Existing literature also helps to learn more about theoretical or conceptual perspectives and different data collection methods. In every research, researchers should not hesitate to ask a question to an expert about the research process. Mentor's conference studies or talks can help beginning researchers to learn how to conduct a research study by asking questions, defining the methodology and methods, and communicating the results in different ways. The researcher should always be interested in the topic or choose interesting, motivating, desirable, and realistic topics to study.

As you think there is a problem to research, you need to consider for what purposes you are focusing on the problem. Your research purpose should be clear to identify the data collection and analysis methods in addressing the problem. Purpose statements should be clear and include the variables and participants of the study. Your problem in practice must be clear, researchable, interesting, and manageable. For example, "Students' attitudes towards science" has lack clarity, and it is a topic statement; but we can expand the problem in this statement for clarification as, "What effect does inquiry-based course materials have on college students' attitudes towards science?" We should first select the topic, then clarify the research problem to write a research purpose and a research question. For example, we can define the topic as "Sports education," the research problem as "Lack of students attending sports classes," the purpose of research as "to explore the factors influencing college students' attitudes towards sport activities," and finally the research question can be stated as "What factors influence college students' attitudes toward sport activities?" Research problems can be expanded by doing literature review to clarify the problem. Research problems can include researchable and clear sub-problems to contribute to the solution of the overarching problem. For example, the previous question can be divided into two: "Which type of sports do college students attend most? Which type of sports do college students attend least? Why?"

After defining the research problem, the researcher should consider the relevant research design, theoretical or conceptual framework, define the hypothesis, assumptions, variables, and possible limitations of the study. A theoretical perspective or conceptual framework provides a lens or background for the study design to analyze data, interpret and make sense of research findings. Hypothesis are used in research as educated guesses or propositions as a guide to the investigation of research. Research should include a research hypothesis and null hypothesis to test the hypothesis. Research hypothesis indicates a difference between the variables, null hypothesis indicates no difference. For example:

- Research hypothesis: Students in private middle schools have higher scores in the national exam than students in public middle schools.
- Null hypothesis: There is no difference in national exam scores of private and public middle school students.

These hypotheses can be directional or non-directional: the statement can include an expected direction of the relationship between variables such as higher or lower-directional, the statement can simply define the relationship without giving a direction. In writing the hypothesis,

researchers should be aware of the variables in the study as a variable can be characteristic, experience, behavior, belief, skill, or achievement scores. Simply, in experimental studies, there are at least two variables: independent and dependent variables. Independent variables can be directly manipulated, but independent variable is manipulated by the dependent variable. For example, as the temperature increases the amount of ice in water decreases. Independent and dependent variables may not be directly related, there may be mediating or intervening individual variables that control the relationship between them. For example, students' self-efficacy may result in high exam performance, but students' daily study time may work as a mediating variable. Moreover, there are moderating variables to increase the direction and strength of cause-and-effect relationship between manipulated and fixed variables. For example, students may have a good middle school background to perform well in high school, but there may be moderating factors such as parent support or socioeconomic status to moderate or control the relationship between variables.

Activity-1: What is a research problem? How do you identify a research problem in a study?

Activity-2: Do the following items refer to a research problem?

- The effects of earthquake on people's lifestyle.
- High use of cell phones by youth.
- The advantages and disadvantages of having standardized testing in all levels of schooling.
- The education level of women in developing countries.
- The consequences of low levels of physical activity in children between 9-15 years of age.

Activity-3: Please identify the research topic, research purpose, research problem, and research question for the suggested studies on the table.

Research Topic	Distance Learning
Research Problem	There is an increase in students' less attendance for distance learning classes due to their working conditions (Chen et al., 2010)
Research Purpose	To investigate why students do not attend distance education classes at a community college
Research Question	What factors influence students' attendance to distance education classes? Does the use of Web Site technology in the classroom deter students from enrolling in a distance education class?
Xu & Liu (2010): What is its	
Research topic?	
Research problem?	
Research purpose?	
Research question?	
Tucker et al. 2011: What is	
Research topic?	
Research problem?	
Research purpose?	
Research question?	
Wang et al. (2021): What is	
Research topic?	
Research problem?	
Research purpose?	
Research question?	

Activity-4: What are some questions that a researcher should ask in stating a problem?

- For example: What is the specific controversy or issue that I need to address?

Activity-5: Look at and review the Activity-3 on the table and review the research problems. Are these good research problems? Why? Discuss the characteristics of good research problems. What are the characteristics of good research problems?

Activity-6: Define whether the following research questions are broad or narrow or manageable:

1. What factors influence cognitive development?
2. How do the recent national standards influence the development of science literacy?
3. How is elementary students' use of technology related to their attendance in a technology related major?
4. How does children's cognitive development change between 0-9 years of age?
5. In what ways do science teachers address suggestions of national standards to enhance scientific literacy?
6. How does children's use of technology influence their success in primary school?
7. How are black holes formed?
8. How does the population of girl kids change over 100 years?
9. Was homework beneficial for your study?
10. How much do environment have an impact on language development?
11. What factors influence homesickness in college students?
12. What is the nature of education of women in 3rd world countries?
13. How does parents' involvement in school meetings affect students' achievement?
14. How does using concept maps influence students' science learning?
15. What is the relationship among mathematical reasoning and mathematic achievement of middle school students?

16. What is the effect of using GeoGebra for teaching functions to 9th grade students on their attitudes towards mathematics?
17. What are the developmental characteristics of children living in urban areas, who are abused and neglected by their families?
18. What is the most effective way of teaching fractions?
19. How does teachers' violence affect primary school students' academic achievement in reading?

Activity-7: Please answer the following questions:

- What are the characteristics of quantitative research problems?
- What are the characteristics of qualitative research problems?

Activity-8: Define the topic and problem statement of the following studies:

- Raved & Assaraf (2011)
- Hermann & Menzel (2013)
- Kind (2014)
- Hand, Wallace, & Yang (2004)
- Wu & Tsai (2007)

Activity-9: You observed that quantitative research stated the research problem and research question to test a theory in a deductive approach. In stating research hypothesis, we defined directional or non-directional, research or null hypothesis statements. Check the following examples and identify the variables to be studied. Please define whether the hypothesis is directional or non-directional. What are independent and dependent variables in the following statements? Please consider the definition of independent and dependent variable.

1. The purpose of the study is to investigate the effectiveness of inquiry-based instruction on 8th grade students' exam scores.
    a. What is its directional hypothesis?
    b. What is its null hypothesis?
    c. What are dependent and independent variables?

2. The purpose of this study is to investigate the influence of scaffolding on first grade elementary school students' reading comprehension.
   a. What is a directional hypothesis?
   b. What is its null hypothesis?
   c. What are dependent and independent variables?
3. The purpose of the research is to investigate the effectiveness of different assessment techniques on 12th grade high school students' attitudes toward mathematics.
   a. What is a directional hypothesis?
   b. What is its null hypothesis?
   c. What are dependent and independent variables?
4. The purpose of this study is to examine the relationship between kindergarten attendance and reading comprehension at the end of the first grade.
   a. What is a directional hypothesis?
   b. What is its null hypothesis?
   c. What are dependent and independent variables?
5. The purpose of the study is to explore the function of a course on conflict resolution techniques over using punishment to reduce students' aggressive behaviors.
   a. What is a directional hypothesis?
   b. What is a null hypothesis?
   c. What are dependent and independent variables?
6. Do you realize a model or formula for writing hypothesis? What is the formula that you suggest? Identify the independent and dependent variables to define the formula.

Activity-10: The following are purpose statements for quantitative research projects. They include independent variables and dependent variables; they may also include mediating or moderating variables. Your task is to define independent and dependent variables, mediating and/or moderating variables. Think about the definition of mediating and moderating variables in defining them in these purpose statements. Please

specify independent, dependent, mediating, moderating variables separately.

1. In this study, I will examine the possible side effects of a new drug on reducing the blood tension on testing animals.
2. In this study, I will investigate the extent to which increasing the number of physical education classes influences middle school students' attitudes toward schooling.
3. In this study, I will investigate the relationship between the amount of computer-use at work and the level of eye-healthiness.
4. I aim to study the level of students' self-esteem may influence their exam scores by changing the time separated to study.
5. The study will examine how the level of student-teacher relationship reduces the negative impact of socioeconomic status on students' academic achievement.
6. I will investigate the degree to which male and female high school students choose culture stereotypical careers in three different countries: Turkey, USA, and Japan.
7. In this study, I will investigate the possible relationship between body mass index and visiting a psychiatrist-physician along with image quality.

Activity 11: General questions and their sub-questions should have the characteristics below:

- Researchable
- Connected to the overarching question to interpret the data.
- Dividing the general problem into pieces to answer the larger research question.
- Not extending beyond the problem

Considering the characteristics of the research questions, please review the given research questions for published studies and define at least two sub-questions for each of them or provide an overarching question for the given sub-questions. You can see the example below.

- To what extent are a teacher's beliefs about inquiry-based instruction embedded in routine classroom practice?
    - To what degree do science teachers believe in the effectiveness of inquiry-based instruction?

- What instructional strategies does a science teacher use in the classroom?
- What factors influence the integration of inquiry-based instruction into classroom practices?

1. Mozzer and Justi (2012) investigated students' analogical reasoning as a creative process where an environment was set up to foster the students' generating and explaining their own analogies. The research question of their study was: How do students draw their own analogies about a given topic before and after the teaching of that topic? Please write down the sub-questions
2. Cavagnettoa, Hand, and Norton-Meier (2010) aimed to determine the nature of student interactions in small groups in an elementary classroom utilizing the Science Writing Heuristic approach. Their overarching research question was: What is the nature of student-to-student talk while generating claims and evidence when using the SWH approach? Please write down the sub-questions.
3. Turkka, Haatainen, and Aksela (2017) aimed to understand science teachers' art integration in regular lessons. Their guiding question was: How is art integrated in science lessons? Please write down the sub-questions.
4. Kaleli-Yılmaz and Hanci (2016) aimed to determine how the TIMSS mathematics success of the 8th grade students differentiates according to the school type, gender, mathematics report mark, parents' education level, cognitive domains and cognitive domains by gender. Their guiding question was: How are the differences between TIMSS math successes of 8th grade students show in terms of different variables? Please write down the sub-questions.
5. Ryana, Fitzmauriceband, and Johnson (2022) investigated mathematics anxiety among mature students learning service mathematics in Ireland. Their guiding research question was: What is the extent and nature of mathematics anxiety among mature students studying service mathematics?
6. Skarstein & Skarstein 2020 aimed to investigate how students developed the common plant and animal identification skills. What is their overarching research question with the following sub-questions?
   a. How well do the students identify common plant and animal species, and how well are their identification skills retained after passing their obligatory species identification exams?

b. How and in what contexts (if any) have the students had use of species knowledge in their practical training periods in kindergartens?

c. What are the students' views on the importance of species knowledge for EC teachers?

d. What are the students' views on the importance of species knowledge for sustainable development?

7. Chia and Zhang (2023) explored Malaysian mathematics teachers' and students' values in mathematics learning. What is their overarching research question with the following sub-questions?

a. What did Malaysian secondary teachers value in mathematics learning? Is there any difference in grade levels?

b. What did Malaysian secondary students value in mathematics learning? Is there any difference in grade levels?

c. What were the similarities and differences between secondary school mathematics teachers and students valued in mathematics learning?

Activity 12: Please identify the following items for the topic that you are interested in.

1. Select a topic in your area of expertise.

1.a: Example: I am interested in the impact of distance learning on college students' achievement and motivation.

2. Please indicate whether this topic is selected considering a theory, personal experience or problem, replication of a study, a library search, or an academic discussion.

2.a: Example: The topic is selected due to a problem experienced during the distance education during COVID-19.

3. Please state your research problem.

3.a. Example: The problem is related to different effects of online instruction on students' achievement and motivation.

4. What are your research questions?

4.a. Example:

(i) What is the effect of distance education on college students' attitudes towards learning?

(ii) How do different instructional strategies influence students' achievement in distance education?

(iii) How do online materials influence students' achievement?

5. You can answer the following questions for this activity:
    a. What broad topic are you interested in? You may need to do some background research to find out more about it.
    b. What specific part of the topic are you interested in? Brainstorm or do a library search to identify possible sub-topics.
    c. List a few possible questions about your specific topic area.
    d. Choose one to be your main research question.
    e. Make your question as clear and specific as possible.
    f. Create a preliminary hypothesis.

Activity 13: Please write research and null hypothesis and directional and non-directional hypothesis for the provided statements below:

1. The purpose of the study is to examine the relationship between freshman students' attitudes towards calculus courses and their course grades.
2. There is a positive relationship between pop-quizzes and 7th grade students' math scores.
3. There is a significant difference between instruction through virtual laboratories and traditional format for 9th grade physics students.

Activity 14: You are given the following model for writing hypothesis. How do you write a hypothesis according to this model?

People who gets a treatment (Independent variable) do better on math problems (dependent variable) than People who do not get treatment.

Activity 15: You are given the following questions: Please define whether they are researchable or non-researchable and whether they are broad, narrow or manageable questions. Please also describe the research design of the study.

1. What is the relationship between mathematical reasoning and mathematical achievement of middle school students?
2. How do pre-service math teachers perceive their teaching internship experiences?

3. What is the most effective way of teaching fractions?
4. How do middle school students' attitudes towards sports relate to their grades in science?
5. Are inexperienced teachers unsuccessful?
6. How does high school students' math anxiety depend on their personal characteristics such as socioeconomic status, gender, and parents' education level?
7. What is the 8th grade students' misconceptions in seasonal changes?
8. How do seventh grade students' learning of Solar System change through traditional and inquiry-based instruction?
9. What strategies influence students' motivation to learn positively?
10. How do virtual labs in physics classes influence high school students' physics grades and attitudes towards science depending on grade and gender?

QUIZ:

1. Which one of the following questions does not refer to a good research question?
   a. How does high school students' perceptions of college education differ for 9th, 10th, 11th and 12th grades?
   b. Is there any significant difference in student achievement between attending classes in large auditoriums and small-group discussion classes?
   c. How does college student achievement differ in online classes from face-to-face classes?
   d. Which social science class is more interesting, Humanity or World Languages?
2. "What is the percentage of infants who died during the COVID-19 process in your country?" The problem with this question is that:
   a. The problem is unclear.
   b. The problem requires a definition.
   c. The problem refers to in-depth exploration.
   d. The problem is unresearchable.

3. "Are personality characteristics of teachers, who work in urban schools, related to their interactions with African American, Latino American, and Asian American students? Which one of the following choices is a subproblem for this research problem?

   a. Do teachers make any discriminated based on students' origin?

   b. What is the most common characteristics of teachers?

   c. How do teachers communicate with these students?

   d. Is interviewing a well-suited method to collect data?

4. A null hypothesis differs from a research hypothesis. Which one of the following is an example of null hypothesis?

   a. Students who received support from counseling office have higher motivation to study for the university examination.

   b. There is no significant difference between students who attended tutoring classes for math lesson.

   c. Attending nutrition classes enhanced biology majors' persistence to go to graduate school.

   d. Students who receive free-lunch at school are more motivated to attend to school.

5. Which one of the following is an example of a research hypothesis?

   a. There is no significant difference between students' socioeconomic status and standardized test scores.

   b. College students learn physics through hands-on experiments

   c. Does attending kindergarten enhance elementary school students' adaptation to school?

   d. Students in the college football team have significant differences in running speed than students in the college volleyball team.

6. Which one of the following does best describe a good research question?

   a. Research question should be long.

   b. Research question should be closed-ended.

   c. Research question should be open-ended.

   d. Research question should be based on a theory.

7. A teacher educator designs a professional development course for science teachers focusing on argumentation-based instructional model. The instructor gives a pre-test at the beginning, a post-test at the end of the program. After six month of the professional development program, the instructor met the teachers again and gave the test again as a delayed-post test. At the end, the instructor compared the pre-test, post-test, and delayed-post test results.

   What is the dependent variable in this study?

   The dependent variable in this study was the:

   a. Teachers' test scores.

   b. Teachers' interest to teach.

   c. Type of teaching.

   d. Time took for the program.

8. Please explore the characteristics of moderator and mediating variables. Please provide at least one example for each.

9. Kamil investigated the relationship between elementary school students' motivation and reading ability. The results showed that that students with higher motivation could read better and earlier than other students. He also found that students who read earlier and better had educated parents. In this case, an educated parent can be considered as:

   a. an independent variable.

   b. a dependent variable.

   c. a mediating variable.

   d. a moderating variable.

10. Lara conducted a study on snack consumption. She found that middle school students who consume snacks twice a day are more likely to get weight in adolescence. In this study, students' weight is:

    a. an independent variable.

    b. a dependent variable.

    c. a mediating variable.

    d. a moderating variable.

REVIEW OF LITERATURE

- By the end of this chapter, students will be able to
  - o describe the purposes and role of literature review.
    - recognize the significance of doing literature review.
    - identify keywords related to the research topic.
  - o conduct research to find relevant literature.
    - use relevant resources and databases.
    - write a report through organizing, evaluating, and synthesizing the literature related to a research problem.

In the previous discussions, we emphasized that our research topic should be specific and narrow, not broad, to clearly describe the research problem and research purpose. In doing literature review, a researcher should systematically identify the relevant resources by defining keywords and journals in the field to locate and analyze the documents to explain what has been discussed on the research problem so far. Why is literature review important? The researcher should know the published literature related to the research topic and problem very well. First, the literature review helps the researcher understand what other researchers have studies on similar topics, problems, and subproblems that may provide new ideas or approaches on similar topics. Looking into what has been studied so far will show the gaps or problematic issues to study. In addition, previous literature provides sources and examples of research methodologies and methods as well as sampling methods and measurement instruments. After data collection and analysis process to write the results, published literature is referred to discuss the strengths and weaknesses of the results. A researcher should review enough recent articles to ensure that they demonstrate the problem and the purpose of the study.

How can we conduct literature review? The review process first requires the identification of keywords and sources to synthesize and evaluate their

relevancy to the research problem. This requires the development of a topic to search the literature. You need to define quality research in your discipline from library databases and journals: The databases and internet resources include unreviewed articles or reports. Please make sure that you choose peer-reviewed research articles in your review. To use appropriate library databases, you need to prepare relevant keywords to monitor the process of literature review. Keywords can be words or phrases summarizing the research topic. For example, "How does gamification relate to seventh grade students' achievement in geometry?" is a research question, and the literature review can be conducted through "gamification, achievement, geometry, middle school" keywords. The search can include different cycles to find the sources: First, "gamification and achievement" can be searched; second, "gamification, geometry, and achievement" can be used, and third, the school level can be added to specify the sources. You can identify the quality of resources by looking at their abstract to organize and analyze the studies based on how they addressed the research topic.

We can find resources by using the library catalogue, online databases, and reference list of sources or articles. In this chapter, we will mainly focus on searching via online databases in a variety of ways. For example, the search can focus on keyword, or title, or year, or language. Educational Resources Information Center (ERIC), Web of Science, SCOPUS, PsycINFO and ProQuest Dissertation and Theses are main databases indexing articles in education and education-related topics. After selecting a database to research, the researchers should follow tasks: SCAN the potential articles for literature review, SKIM the articles for content selection, and MAP the articles for data organization under themes. While using the keywords, the researchers can use some operators to narrow (AND) or to expand (OR) or to exclude (NOT) resources. For example, we can narrow our search through using "gamification AND achievement" keywords, expand the search through using "gamification AND achievement OR game-based learning" and exclude the search through using "gamification AND achievement OR game-based learning NOT high-school AND middle school." You need to narrow the scope of your search to break down the articles to clarify the participants and context of the study and to categorize and synthesize the studies based on the themes. The literature review may start with a main idea or key term, but the literature may provide sub-concepts or sub-themes to be mapped and identify their relationship. The researcher may need to develop a concept map or table to show the relationships between main and sub-themes; table may compare the details of each source such as purpose, participants, research design, and findings. The researcher should

focus on the research topic to identify which articles to include and how understanding of the topic changes and to compare the findings to describe the trends throughout the literature review process. The essential question in this chapter is: How do we conduct the review of literature in educational sciences?

Activity-1: Identify the research topic and relevant keywords for the following research questions or research purposes:

1. What are pre-service science teachers' perceptions of using technology in the traditional classroom? How do pre-service teachers integrate technology in their teaching?
2. How do high school students' perceptions toward schooling differ in three countries: Turkey, England, Japan? How do high school teachers' perceptions of their students' motivation differ in three countries: Turkey, England, Japan?
3. How do pre-school teachers approach to teach climate change for students at age five or six?
4. How do middle school students' attitudes towards science relate to their science achievement at eighth grade after controlling by gender and socioeconomic status?
5. How do Malaysian high school female students' mathematics competency relate to their self-esteem while controlling for socioeconomic status?
6. How do science instructors perceive teaching in a flipped learning environment?
7. In what ways are gifted students fairly selected to the special classes? What kind of thinking skills do these students engage in?

Activity-2: You are given the following articles:

- Marszalek, J. M. (2022). Getting in the flow: adolescent test-takers, motivation, and optimal performance. *Educational Assessment, Evaluation and Accountability*, *34*(2), 241-273. https://doi.org/10.1007/s11092-021-09377-5
- Giambo, D. A. (2017). " I Will Study More... and Pray": Metacognition about High-Stakes Test Preparation among Culturally & Linguistically Diverse Students. *Multicultural Education*, *24*, 26-34. https://files.eric.ed.gov/fulltext/EJ1162648.pdf

- Block, C. R. (2015). Examining a public Montessori school's response to the pressures of high-stakes accountability. *Journal of Montessori Research*, *1*(1), 42-54. https://files.eric.ed.gov/fulltext/EJ1161298.pdf
- Rutkowski, D., & Wild, J. (2015). Stakes matter: Student motivation and the validity of student assessments for teacher evaluation. *Educational Assessment*, *20*(3), 165-179. https://doi.org/10.1080/10627197.2015.1059273
- Abrams, L. M., Pedulla, J. J., & Madaus, G. F. (2003). Views from the classroom: Teachers' opinions of statewide testing programs. *Theory into practice*, *42*(1), 18-29. https://doi.org/10.1207/s15430421tip4201_4
- Marchant, G. J. & Paulson, S. E. (2005, January 21). The relationship of high school graduation exams to graduation rates and SAT scores. Education Policy Analysis Archives, 13(6). Retrieved [date] from http://epaa.asu.edu/epaa/v13n6/

1. Please select three of them and review them by comparing their keywords, research questions and purposes, research design, and findings. You can prepare a table, a map or concept map or graphic organizer. A sample table can be prepared as below. You can prepare the table on a separate sheet.

Article	Keyword	Purpose	RQ	Research Design	Findings
Marszalek (2022)					
Giambo (2017)					

2. Remember you need to compare the studies and categorize them based on the themes.
3. Please write your review in one or multiple paragraphs.

Activity-3: Now your turn!

1. You need to select a research topic and state your tentative research question and purpose.

Tentative research topic:

Tentative research question:

Tentative research purpose:

Possible Keywords:

2. Then, you need to select one of the databases.

ERIC: https://eric.ed.gov/

SCOPUS: https://www.scopus.com/

Web of Science: https://www.webofscience.com/wos/

Other: Please ask the instructor.

3. Write your keywords with appropriate operators (AND-OR-NOT) to search within the selected database.
4. Select at least 5 (ideally 10) articles from peer-reviewed journals. List their citations[1] here.

4a.

4b.

4c.

4d.

4e.

5. Review these articles by preparing a table, concept map or graphic organizer.
6. Compare and synthesize your review by
   a. Categorize your articles based on their focus.
   b. Write one or several paragraphs about your review.
   c. After you have done the review, you can state the research problem based on the published literature. Revise and rewrite your research statement below:
      i. Keywords:
      ii. Research topic:
      iii. Research problem:
      iv. Research question:

1 You can write citations by going to Google Scholar and typing the title of the study. After finding the article, you should go to "Cite" button and select "APA format" to cite your source. Please write your citation of each source above.

v. Research purpose:

Activity-4: You are given two articles designed with quantitative and qualitative methodologies. Please review their literature reviews and analyze how literature reviews are different for quantitative and qualitative studies. You can show your results on a table or chart.

- Quantitative: Hsu, Y. S., & Thomas, R. A. (2002). The impacts of a web-aided instructional simulation on science learning. *International Journal of Science Education*, *24*(9), 955-979.
- Qualitative: Haj-Yahya, A., & Olsher, S. (2022). Preservice teachers' experiences with digital formative assessment in mathematics. *International Journal of Mathematical Education in Science and Technology*, *53*(7), 1751-1769.

Activity-5: You selected a topic in this class to do a literature review. You can continue to study the same topic, or you can select a new topic (referring to Activity-3). Please conduct your research with at least 10 relevant articles. You can construct a table or map to organize your work. Please indicate the following items on Part A, and then write a short review including the items on Part B. You can see the example review attached to this paper.

Part-A: First items to consider:

a. Keywords

b. Research topic

c. Research question

d. Research purpose

Part-B: After you conduct research, you should write the following parts of your short proposal. Your short proposal can be maximum 1000 words.

a. Introduction (background and research purpose)

b. Statement of the problem

c. Literature Review

d. Statement of Hypothesis and Guiding questions

e. References

QUIZ:

1. Punter et al. (2011) is interested in searching for "Spanish Secondary School Students' Notions on the Causes and Consequences of Climate Change." Which of the following keywords would not the authors use in a database search?

   a. Climate Change

   b. Misconceptions

   c. Secondary School Students

   d. Teachers

2. Vosniadou & Skopeliti (2017) are interested in exploring students' misconceptions about day/night cycle. Which of the following keywords would be used in database search for this topic? You can select more than one:

   a. Misconceptions

   b. Mountain

   c. Earth

   d. Sun

   e. Comprehension

3. McNeill et al. (2016) aimed to explore the factors impacting teachers' argumentation instruction in science classrooms. Which of the following would not be a good keyword to use in a database search?

   a. Argumentation

   b. Teacher practice

   c. Science classrooms

   d. Student learning

4. The literature review process is important to understand what has been done or studied on the selected topic before you define your research problem to study. In doing your research, you can identify the keywords, select a database to conduct the research, and identify relevant journals to include in your research. Which one of the following items should be reported and emphasized in the literature review part of a paper? You can select more than one:

   a. the participants included in the study.

   b. the procedures for data collection.

   c. the research problem of the study.

   d. the discussion of the data collection conducted.

   e. the discussion of data analysis method

5. Why is it important to identify a relevant and appropriate resource for the literature review?

   a. To check the participants of the study

   b. To address the research problem

   c. To determine a recently published resource

   d. To identify similar data collection methods

6. Which of the following characteristics should not be a characteristic of selected source for review?

   a. The article should be a research article with data collection and analysis.

   b. The article should have an approximate or average length.

   c. The article should be chosen from a journal that is reviewed by experts.

   d. The article should be a review of other studies on the research problem.

7. Alara's study addresses a current topic in education, climate change. Alara is concerned about the articles that she selected for the review. She selected recently published peer-reviewed journals, but a few of them were collection of other journals on this topic without collecting systematic data to analyze and report findings. What should be the concern for her research?

   a. She was not able to find any relevant resources.

   b. She could find a few review articles to eliminate.

   c. She could find popular magazine articles.

   d. She was not able to collect data on her topic.

8. How should the report of the literature review be organized? (Select all that apply)

   a. It should include an abstract of the study.

   b. It should refer to the overarching conclusion of the study.

   c. It should present the studies with similar results.

   d. It should discuss the essential problem of the study.

   e. Other? Please indicate:

9. Yoon et al. (2014) aim to research on the efficacy of problem-based learning in an analytical chemistry laboratory course. Which of the following keywords will these researchers select in their search?

   a. College students

   b. Problem-based learning

   c. Science laboratory

   d. Teaching methods

10. In literature review of research articles, you are suggested to use peer-reviewed journals to select your resources. Why? Please explain.
    a. Why is it not suggested for a class textbook, chapter from a book, or magazine article?

11. Why does your instructor suggest you use online databases such as ERIC, SCOPUS, or Web of Science rather than Google or Google Scholar?

12. What questions should a researcher ask in a literature review process?

QUANTITATIVE RESEARCH-1

- By the end of this chapter, students will be able to
  - o distinguish quantitative research plan from qualitative research plan.
    - ▪ recognize the purpose of research plan components for quantitative study.
  - o explain the research design of a quantitative study.
  - o distinguish different quantitative research designs based on their functions and procedures.

Remember, in the previous chapter, you were given some activities to write the introduction section of your research plan. In the introduction section, you discussed what has already been done on the topic, wrote the statement of the problem, hypothesis (quantitative designs), central phenomenon (qualitative designs), and guiding questions of your research. In the following weeks, we will discuss the research design to define the general strategy of the study and focus on method section to understand how to select participants for a specific study, which instruments to prepare for data collection, and how to analyze data with relevant strategies. At the end, we will focus on assumptions, limitations, and ethical considerations of the study.

In this chapter, we start discussing the research design of a quantitative study. What is a research design? Plano Clark and Creswell (2015) defined that researchers utilized a set of methods and procedures for data collection and analysis to write the report of the findings in a research study. In quantitative studies, the research design aims to collect and analyze numerical data to test hypotheses of specific variables and answer research questions. Research process in quantitative research starts with a problem through an extensive literature review to set the hypothesis, determine the study plan to collect and analyze data and report the results. What kind of research designs are common in quantitative research? We will discuss survey design,

experimental design, correlational design, and causal comparative research. These common designs in quantitative research are categorized in terms of the intent, manipulation of variables, and procedures as experimental and non-experimental research designs: the former one investigates the effect of an intervention or treatment while manipulating conditions, whereas the later one aims to describe the variables without any manipulation.

Experimental research design has different types according to its intent and procedures. Experimental research can differ according to the type and intent of the study:

- In experimental research, at least one independent variable is manipulated, other related variables are controlled, and the influence of dependent variables is observed. An experiment consists of commonly two groups (sometimes one group or three or more groups) to compare.
- True experimental research is used to understand the effect of the treatment. Individuals are randomly assigned to the treatment groups to test the impact of treatment as manipulated variable on the outcome variable. This type of design calls for a test of intervention in pre-test and post-test control group design or post-test only control group design to compare different approaches: two separate approaches, a new approach with an existing approach, varying amounts of a single approach.
    - For example, "Does individualized tutoring sessions from a mentor have more impact to improve students' scores in statistics than whole class instruction?" Independent variable: type of instruction -individualized or class instruction- Dependent variable: scores in statistics
        - Characteristics: both selected groups do not have any experience or have the same experience on both instruction types, and selected randomly
    - In another example, is there an effect of reinforcement on students' reading comprehension in elementary school? Independent variable is "type of reinforcement: positive, negative, no reinforcement" Dependent variable is reading comprehension.
        - Characteristics: Three groups of elementary students can be grouped randomly for experimentation.

- True-experimental design also combines pretest-posttest control group design and posttest-only control group design in a randomly assigned four-group study. Four group study is also called as Solomon four group design. These four groups receive posttest, only two groups receive pretest, one of the pretested groups receives treatment and one of the groups who does not receive pretest receives treatment. The other groups (second pretest taker and non-pretest taker) serve as control groups.
- In quasi-experimental studies, it may not be possible to group participants through random assignment, so researchers conduct quasi-experimental designs with intact groups throughout the study. Selecting intact groups means to assign existing groups, but not assign individuals randomly to the different situations.
    - o In one example, two groups of students in a school are selected to have pretest, receive the same treatment, and have posttest. The assignment is done randomly within the group, but not random within individuals. The same study can be conducted through giving treatment on one group but controlling the second group to assess the effectiveness.
    - o Quasi-experimental design can have Time-Series Design or Repeated measures design that includes a series of pre-testing to make the pretest scores stable. After having stable scores, group gets the treatment and then post-test repeatedly to observe the effectiveness of treatment. Look at the graph. These designs may have more than two groups with more than two treatments. Counterbalanced designs offer these same treatments in different orders to each group with a post-test after each treatment.
- There may be more than one independent variable as a factor as a combination of one or more other variables and nonmanipulated variables or control variables such as gender, age, years of experience or aptitude. For example, the influence of personalized instruction and traditional instruction can be investigated on high and low aptitude students (2x2 factorial design). Another study may be interested in testing three factors: reinforcement (positive, negative, no reinforcement), ability (high, average, low), and gender (male, female) as 3x3x2 factorial design.
- Does experimental research always include many participants or groups of participants? Is there single-subject experimental research

design? In contrast to true and quasi-experimental designs that use a control group for comparison with a treatment group, a single subject can be only a control variable in the experiment to be able to collect lots of data about the change in behaviors or scores in a time period of time. Single-subject design research tests the effect of one or more treatments on an only individual or a few participants (groups design) in psychology or psychiatry. The design focuses on the intervention and measuring the effects before, during, and after the intervention. For example, A-B-A withdrawal design include a baseline of initial measurements (A), then in the B phase, treatment starts, and each treatment is followed by a measurement in a series of sets, and then baseline of final measurements are conducted at the end (A) to observe the effectiveness of treatment. There may be multiple-baseline designs to include more types of behaviors, participants, or contexts as a type of intervention. Mills and Gay (2016) states, "With multiple-baseline design, data are collected on several behaviors for one subject, one behavior for several subjects, or one behavior and one subject in several settings" (p. 325). This can change the type of A-B-A cycle to assess the effect of multiple interventions on different behaviors.

Activity-1: How do components of a research plan differ for quantitative and qualitative studies?

Quantitative	Qualitative
Jong (2019)	Jin et al. (2021)

Activity-2: Show schematic diagrams to explain the differences in experimental designs.

Research Design	Schematic model
True-Experimental design	
Quasi-Experimental design	
Solomon-four group design	
Time-series design	
Factorial Design	
Single-Subject Design	

Activity-3: We found the following studies, which had experimental research design. Please complete the Table on the next page, explain the type of experimental design of each study and its characteristics including research questions, participants, and types of data collection instruments.

- Aaron Price, C., & Chiu, A. (2018). An experimental study of a museum-based, science PD programme's impact on teachers and their students. *International Journal of Science Education*, *40*(9), 941-960. https://doi.org/10.1080/09500693.2018.1457816
- Konvalina, J. (1981). An experimental study in basic mathematics concerning self-assessment, achievement, and confidence. *International Journal of Mathematical Education in Science and Technology*, *12*(3), 271-277. https://doi.org/10.1080/0020739810120303

- Alaj ääski*, J. (2006). How does Web technology affect students' attitudes towards the discipline and study of mathematics/statistics? *International Journal of Mathematical Education in Science and Technology*, *37*(1), 71-79. https://doi.org/10.1080/00207390500226002
- Bryce, T. K., & Blown, E. J. (2007). Gender effects in children's development and education. *International Journal of Science Education*, *29*(13), 1655-1678. https://doi.org/10.1080/09500690701278420
- Chang, P. T. (1986). Academic performance, sex difference and attitudes toward mathematics of small groups as factors in college developmental mathematics courses. *International Journal of Mathematical Education in Science and Technology*, *17*(2), 157-168. https://doi.org/10.1080/0020739860170205
- Oladunni, M. O. (1998). An experimental study on the effectiveness of metacognitive and heuristic problem-solving techniques on computational performance of students in mathematics. *International Journal of Mathematical Education in Science and Technology*, *29*(6), 867-874. https://doi.org/10.1080/0020739980290608
- Liang, L. L. & Gabel, D. L. (2005) Effectiveness of a Constructivist Approach to Science Instruction for Prospective Elementary Teachers, International Journal of Science Education, 27:10, 1143-1162, https://doi.org/10.1080/09500690500069442
- Di Mauro, M. F., & Furman, M. (2016). Impact of an inquiry unit on grade 4 students' science learning. *International Journal of Science Education*, *38*(14), 2239-2258. https://doi.org/10.1080/09500693.2016.1234085
- Li, I., Onaga, E., Shen, P. S., & Chiou, H. H. (2009). Temperament characteristics and science achievement: A longitudinal study of elementary students in Taiwan. *International Journal of Science Education*, *31*(9), 1175-1185. https://doi.org/10.1080/09500690701793923
- Kern, P., Wolery, M., & Aldridge, D. (2007). Use of songs to promote independence in morning greeting routines for young children with autism. *Journal of autism and developmental disorders*, *37*, 1264-1271. https://doi.org/10.1007/s10803-006-0272-1

- Elliott, L., Henderson, M., Nixon, C., & Wight, D. (2013). Has untargeted sexual health promotion for young people reached its limit? A quasi-experimental study. *J Epidemiol Community Health*, *67*(5), 398-404. http://dx.doi.org/10.1136/jech-2012-201034

Study #	Experimental Design Type	Variables	Research Questions	Participants	Data collection
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					

Activity-4: You are given the following studies to explore. Select one of these studies and write the type of the experimental design by modeling on a Table (see example Table).

Example: A study is designed with posttest-only control group design. A pretest was not necessary. The group of students were randomly assigned to two groups and each group included 30 students. Each group received a different type of instruction, they are post-tested at the end of the course.

Type of Design		*True Experimental: posttest-only control group design*	
Group	Assignment	Treatment	Posttest
A	Random	*Argumentation Instruction*	*Physics test*
B	Random	*Traditional Instruction*	*Physics test*

- Zacharia, Z. C., Lazaridou, C., & Avraamidou, L. (2016). The use of mobile devices as a means of data collection in supporting elementary school students' conceptual understanding about plants. *International Journal of Science Education*, *38*(4), 596-620. https://doi.org/10.1080/09500693.2016.1153811
- Grooms, J., Sampson, V. & Golden, B. (2014) Comparing the Effectiveness of Verification and Inquiry Laboratories in Supporting Undergraduate Science Students in Constructing Arguments Around Socioscientific Issues, International Journal of Science Education, 36:9, 1412-1433, https://doi.org/10.1080/09500693.2014.891160
- Lin, Y. R. (2022). The influence of students' position on argumentation learning through online and face-to-face environments. *International Journal of Science Education*, *44*(17), 2632-2657. https://doi.org/10.1080/09500693.2022.2141082
- Chen, S., Jamiatul Husnaini, S., & Chen, J. J. (2020). Effects of games on students' emotions of learning science and achievement in chemistry. *International Journal of Science Education*, *42*(13), 2224-2245. https://doi.org/10.1080/09500693.2020.1817607
- Self-Brown, S. R., & Mathews, S. (2003). Effects of classroom structure on student achievement goal orientation. *The Journal of Educational Research*, *97*(2), 106-112. https://doi.org/10.1080/00220670309597513

Activity-5: Cihak, Kessler and Alberto (2008) conducted a study to understand how students with moderate and severe intellectual disabilities made transition independently through the use of a handled prompting system. In this study, four students who have moderate to severe intellectual disabilities selected to examine the effectiveness of handheld prompting system with a multiple-baseline design across participants. According to the paper, the design included sequential application, comparison effectiveness, and replication of findings across participants. The phases included baseline (to teach hand-held prompting system), handheld prompting (selecting tasks to perform), and maintenance phases (follow-up programs after the performance). The table below defined the tasks assigned to each student. The figure presented the results. Please explain the results and how four participants differ from each other.

	Students			
Tasks	Aaron	Bill	Cate	Doug
1	Gathering carts	Gathering carts	Straightening mushrooms	Preparing coleslaw
2	Stocking milk	Stocking milk	Stocking bananas	Preparing broccoli
3	Vacuuming	Vacuuming	Stocking pineapples	Skewering shrimp
4	Preparing rolls	Preparing rolls	Cleaning fitting room	Preparing tea
5	Putting back returns	Putting back returns	Cleaning registers	Rolling silverware
6	Stocking cans	Stocking cans	Clothes processing	Bussing tables
7	Making cookies	Making cookies	Sweeping	Setting tables
8	Cleaning registers	Cleaning registers	Cleaning windows	Sweeping
9	Cleaning windows	Cleaning windows	Stocking picture frames	Cleaning windows
10	Sweeping	Sweeping	Dusting shelves	Taking out trash

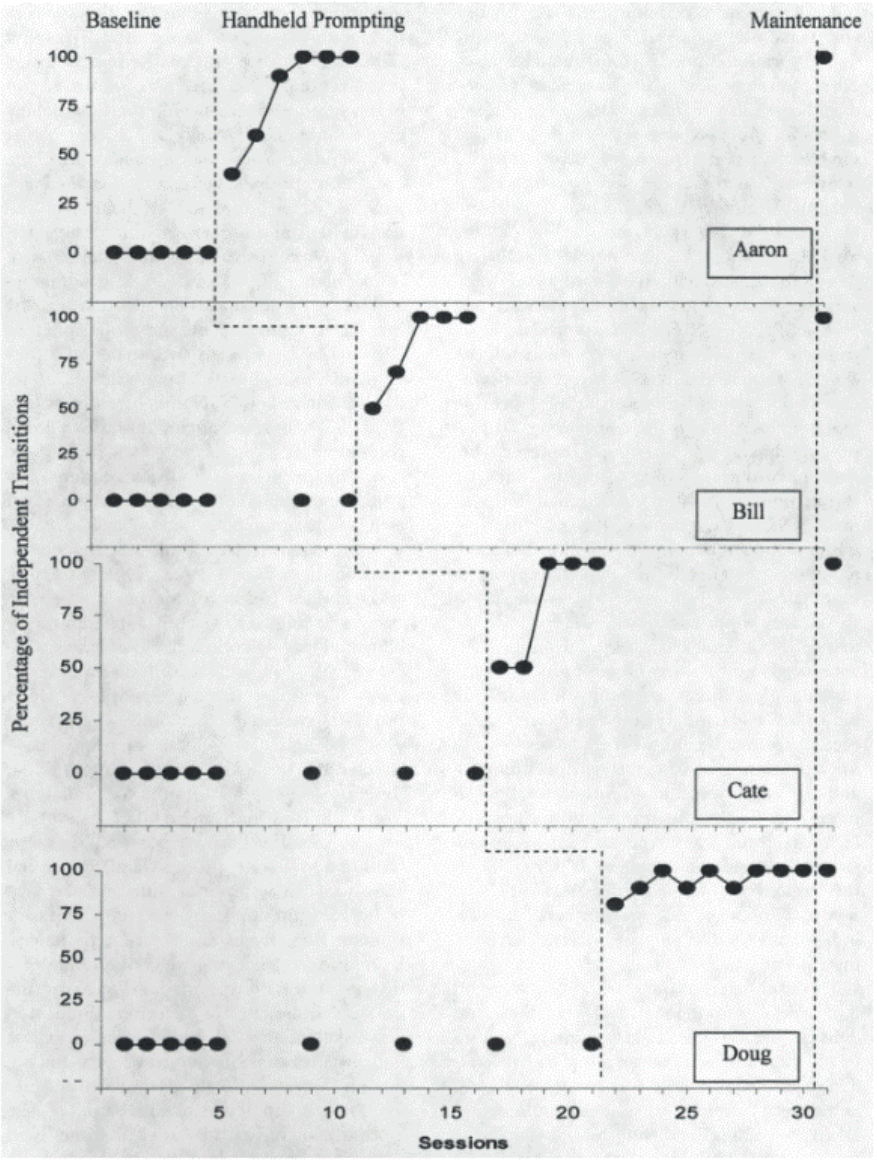


Figure 1. Number of independent tasks transitions across students.

Figure. Number of independent tasks transitions across students

Activity-6: Cihak (2009) conducted another study on the use of video modeling via handheld computers to improve geometry skills for high school students with learning disabilities. Please review this study and explain the research design and its results by using the results of the study.

CHAPTER 6

QUANTITATIVE RESEARCH-2

- By the end of this chapter, students will be able to
  - o explain the research design of a quantitative study.
  - o distinguish different quantitative research designs based on their functions and procedures.

According to Plano Clark and Creswell (2015), quantitative research designs can be classified based on their purposes, manipulation of variables, and procedures to collect and analyze data. We have discussed experimental research design that investigates the effect of manipulated independent variables on the dependent variables in different structures; it is interested in the cause-and-effect outcomes. However, non-experimental research designs aim to describe variables in a population or describe relationships between variables without manipulating the conditions.

Survey designs aim to investigate opinions, attitudes, characteristics and beliefs of participants through questionnaires, surveys, observational protocols, or numerical data for statistical analysis. Survey designs do not provide any treatment during the research. This type of design aims to describe the trends in the data from a representative sample to refer results to a population and support further research designs. For example, Kesamang and Taiwo (2002) investigated 395 junior secondary school students' attitudes towards and achievements in science in Botswana through survey design. Another example is done by Ertekin, Yazici, and Delice (2014) to determine pre-service mathematics teachers' concept definitions of images.

Survey designs may differ based on the time range to collect data about attitudinal and behavioral characteristics. When the researchers aim to collect data about current beliefs, attitudes, or practices at one point in a short amount of time, they conduct *cross-sectional survey design* to define the current characteristics, needs, demographics across groups or for a national assessment. For example, Said, Summers, Abd-El-Khalick & Wang (2016) conducted a cross-sectional survey research in Qatar to assess students'

attitudes toward science from grade 3 to grade 12 at different school types. This kind of study aims to define the needs of community and to evaluate the quality of the programs for policy development. There are also consensus studies to determine the current dimensions of science education in the national standards. For example, Banilower et al. (2018) collected survey data from science teachers at K-12 level to understand their beliefs about teaching and learning science and their classroom practices.

A researcher can collect data through a longitudinal survey design from the same population over time. In this design, the group of people or sample may change from the same population within the period of data collection in different time points. For example, a longitudinal survey design would be conducted by a science education researcher to assess pre-service science teachers' views of nature of science before they graduate and 1, 2, 5 years after they graduate when they become a teacher. These longitudinal survey designs can focus on a population to examine the changes and trends within the population over time (Trend study). This can be applied to assess the changes in high school or college students' attitudinal characteristics as they move to higher grades (from freshman to senior years). However, instead of a population, a subgroup is determined from a population as a cohort who carries the common characteristics, and this subgroup can be studied over time at different time points (Cohort study). For example, cohort may include 17-year-old high school students in 2021, where age is the characteristic. The study may start in 2021, and five years later, 23-year-old students or individuals can be surveyed about their attitudes to COVID-19. The group of students may change, but the characteristic stays the same in cohort studies. In panel studies, the research includes the same group of people or participants within the longitudinal study period to study the same college students' beliefs about learning from freshman to senior years.

Besides defining the variables and trends over time, a research question may address the relationship between two or more quantifiable variables to make predictions. For example, university administration may be interested in the following question: "How do high school GPA scores relate to college students' GPA when they graduate?" The answer to this question will provide a prediction about how the degree of high school GPA relates to college GPA when they graduate. This type of research differs from experimental studies since the researcher does not control or manipulate variables or administer different conditions or provide cause-and-effect relationships but focuses on the variables of interest to determine the association between them for one group of participants. For instance, a researcher is interested in first-grade elementary school students' reading comprehension level and its relation to

parents' education level. Correlational studies describe the level of association between variables in a range of -1.00 to +1.00, where (-1,0) range indicates negative correlation (as students' reading comprehension level increases, parents' education level decreases), but (0, +1) range indicates positive correlation (as reading comprehension level increases, parents' education level increases). This relationship does not suggest a causation between two variables but explains the level of association between variables.

On the other hand, causal-comparative research aims to figure out the cause or reason for discrepancies of participant characteristics. This type of research design includes participants with varying characteristics to compare or relate to the dependent or outcome variable or to investigate whether one characteristic is the cause of the outcome. For example, Shongwe (2022) aimed to study the relationship between content knowledge and spatial visualization of two groups of pre-service primary mathematics teachers (one group had pure school mathematics background, one group had high school mathematical literacy background. Another study by Aytekin & Isiksal-Bostan (2019) investigated the following question, "How do male and female elementary students' attitudes toward technology in mathematics lesson differ?" as an example of causal-comparative research design. Cause-effect relationships are limited to determined characteristics in causal-comparative designs; experimental research designs are used to determine true cause-and-effect relationships. Another example question is from Mills and Gay (2016): What differences exist between full-day kindergarten and half-day kindergarten students in mathematics and reading abilities as they progress through elementary school?

Activity-1: Please review the following studies and determine the purpose of the study, research questions, participants, type of quantitative research design, data collection and analysis methods. You can show your results on a table or chart.

- Jungić, V., Kaur, H., Mulholland, J., & Xin, C. (2015). On flipping the classroom in large first year calculus courses. *International Journal of Mathematical Education in Science and Technology*, *46*(4), 508-520. https://doi.org/10.1080/0020739X.2014.990529
- Hill, J. L., & Hunter, J. (2023). Examining the mathematics education values of diverse groups of students. *International Journal of Mathematical Education in Science and Technology*, 1-20. https://doi.org/10.1080/0020739X.2023.2184280

- Rodger, S., Stephens, E., Clark, M., Ash, S., Hurst, C., & Graves, N. (2012). Productivity and time use during occupational therapy and nutrition/dietetics clinical education: A cohort study. PLoS ONE 7(8): e44356. https://doi.org/10.1371/journal.pone.0044356
- Cole, D., Kitchen, J. A., & Kezar, A. (2019). Examining a comprehensive college transition program: An account of iterative mixed methods longitudinal survey design. *Research in Higher Education*, *60*, 392-413. https://doi.org/10.1007/s11162-018-9515-1
- Suprapto, N. (2019, February). Demographic sources as a local wisdom: Potency of Indonesian physics education researchers in conducting survey research. In *Journal of Physics: Conference Series* (Vol. 1171, No. 1, p. 012003). IOP Publishing. https://doi.org/10.1088/1742-6596/1171/1/012003
- Kiwanuka, H. N., Van Damme, J., Van den Noortgate, W., & Reynolds, C. (2022). Temporal relationship between attitude toward mathematics and mathematics achievement. *International Journal of Mathematical Education in Science and Technology*, *53*(6), 1546-1570. https://doi.org/10.1080/0020739X.2020.1832268
- Faretta, R. S. (2016). *A causal-comparative inquiry into the significance of implementing a flipped classroom strategy in nursing education*. Liberty University.

Activity-2: Suggest one study for

a. Correlational research

b. Causal comparative research

c. Experimental research

d. Survey research

Please state the research question and purpose for each study.

Study #	Purpose-Research Question	Research Design	Participants	Data Collection	Data analysis
a					
b					
c					
d					
e					
f					
g					

QUIZ

1. Which one of the following study types is appropriate for a quantitative study?
   a. A study that investigates how students spend time on a typical Saturday in our school's special education program
   b. A study that explores the students' achievement for students who were taught in traditional classes and laboratory classes
   c. A study of 9 first-year students from an urban community on adaptation to the college life
   d. A study addresses the experiences of minorities in the white universities during the 1980s-2000s

2. Which is an example of a survey research question?
   a. Is there any effect of treatment to improve students' problem-solving in mathematics?
   b. Do running distance and age have any relationship?
   c. How do science teachers perceive teaching through simulations?
   d. Does socioeconomic status (SES) influence students' attitudes toward schooling?

3. Survey data are often collected via which of the following?
   a. interviews
   b. multiple-choice tests
   c. questionnaires.
   d. rating scales

4. Longitudinal design refers to:
   a. Studies at far distances from research's region.
   b. Studies to take long time to read.
   c. Studies including multiple groups to study.
   d. Studies to explore a phenomenon in a long time period.

5. A teacher is interested in tracing the pattern of students' exam scores throughout elementary school in the south region of the country. This is an example of a:

   a. Cross sectional study

   b. Longitudinal study

   c. Exploratory study

   d. Experimental study

6. Please define the differences between cross-sectional and longitudinal studies.

7. Which of the following is true about the multiple-baseline design?

   a. It should only include two groups, control and treatment

   b. In this design, the independent variable has more than two levels.

   c. It should always make a comparison among individuals

   d. In this design, the dependent variable is divided among five groups

8. "How do advertisements on snacks influence the consumption rater?" is a typical question in what type of research design?

   a. Survey research

   b. Time-series research

   c. Experimental research

   d. Correlational research

9. Which one of the following is not a characteristic of experimental design?

   a. Having intervention for experiments

   b. Having controlled variables

   c. Changing parameters for independent variables

   d. Changing parameters for dependent variables

10. Terry graphs the results of her experiment which had a factorial design and notices that her lines are parallel. Which of the following can Terry conclude from looking at her graph?

    a. There is no interaction between her factors

    b. There is a strong interaction between her factors

    c. There is a positive interactions between her factors

    d. There is a negative interaction between her factors

11. Which of the following is an example of a causal-comparative question?

    a. Are there any socioeconomic differences in the effectiveness of tutoring program in mathematics?

    b. Is there a relationship between the use of modeling curriculum in chemistry and students' conceptual understanding?

    c. How does the use of simulations influence students' understanding of electric circuits in comparison to traditional methods?

    d. What specific teaching strategies have played a role in students' conceptual understanding?

12. Which of the following is an example of a correlational study?

    a. What are the attitudes of teachers about new nation standards on science and mathematics education?

    b. Is there a relationship between students' exam scores and daily study time?

    c. Are there differences between boy and girl students' attitudes toward doing homework?

    d. How many hours does a 12th grade student study for the exam on average?

13. A teacher explores the effectiveness of question types on students' learning. She randomly assigns students to equal groups and gives multiple choice or open-ended questions to work. Then, the teacher assesses the effects of question types on students' learning through a complex question after the group work. What kind of research is described in this study?

    a. Survey

    b. Correlational

    c. Experimental

    d. Causal-comparative

14. Experimental research and causal-comparative research are different because

    a. Only causal-comparative research deals with statistical relationships between variables.

    b. Only experimental research may require data collection from different groups.

    c. Only experimental research manipulates the independent variable.

    d. Only causal-comparative research establishes cause-effect relationships.

15. A researcher asks the following research question: How do students' exam scores compare depending on participating in a particular intervention or no-intervention? What type of study should be conducted for this research question?

    a. Survey

    b. Correlational

    c. Experimental

    d. Causal comparative

16. In a causal comparative study, a researcher examines the differences in knowledge of mathematics between female and male parents. Dependent variable in this study is
    a. Knowledge
    b. Female
    c. Male
    d. Parent

17. Which of the following is the weakest correlation coefficient?
    a. -1.8
    b. 1.0
    c. .33
    d. 0.7

18. Which of the following is the moderate correlation coefficient?
    a. 1.0
    b. 0.85
    c. .70
    d. -.42

19. Causal-comparative and correlational research have similar characteristics in terms of
    a. Type of explanatory research.
    b. Relying on causes.
    c. Utilizing the same methods.
    d. Focusing on random events.

20. Experimental research and causal-comparative research have similar characteristics in terms of
    a. Relying on causes
    b. Focusing on different groups
    c. Using interventions or treatments
    d. Making random assignment

QUALITATIVE RESEARCH

- By the end of this chapter, students will be able to
  - o identify and understand the research design of a qualitative study.
  - o distinguish the characteristics of different qualitative research designs.

Educational research does not only deal with numerical data to provide statistical results. Educational research also aims to explore the individuals' approaches, settings, contexts, and interactions in-detail with a general purpose and open-ended research questions. These questions can be descriptive to explain what happened or exploratory to explain how and why something happened. Qualitative research may focus on the following questions: What is the nature of a phenomenon within a unit of analysis (case study)? Or What is the nature of a person's or group's cultural perspectives or behaviors within a given context (ethnography)? Or how can a researcher derive a theory through collecting multiple sets of qualitative data in a long-term period? Or what is the nature of participants' experiences of a particular situation, training or practice (phenomenology)? or What stories can people tell about their life experiences (narrative study)? In all these qualitative designs, there are key procedures to collect qualitative data through interviews, textual data, field notes, written notes, observation notes and analyze them through developing codes, identifying common categories and themes.

Qualitative research designs may differ based on the central phenomenon of interest (such as group's culture or individual's story or experience), purpose of research (such as to describe and interpret or to develop a theory), or the methods or techniques (such as data collection and analysis techniques) utilized throughout the study. Qualitative approach has various advantages: It can help researchers gain insight about a topic or phenomenon in complex ways considering interactions, boundaries, processes, and contexts to develop new theoretical perspectives, to identify the particular problems in

practices, and to evaluate the quality of innovations, alternative pedagogies, and policy enactments. Qualitative research design requires data collection to include qualitative or textual evidence from participants' experiences or observations of participants' practices.

Case study design focus on an individual or a group of participants within a bounded system to describe and interpret what is happening. This unit of analysis as bounded system can be "an individual teacher, a classroom, a group of teachers, a type of school." Case study designs include single or multiple case study through multiple data collection techniques. For example, the following research question can be studied through multiple case study design: "How do three beginning science teachers manage to teach through distance education at a new private school?" Another study done by Koerner and Abdul-Tawwab (2006), the research can focus on studying a program: "How can an urban university's teacher education program begin to form a relationship with its surrounding communities in order to improve the preparation of teachers?" The study aimed to make a connection between teacher education programs and preservice teachers' placements for teaching. Another example by Stevenson & Nerison-Low (2002) focused on case studies of forth, eight, and twelfth grade students in three different countries, Germany, Japan, and United States.

Grounded theory aims to collect qualitative data from a person, group or an institution systematically to establish a theory based on the processes or interactions on the topic. This process may require longitudinal data collection to understand their systematic activities and processes to make a generalization. For example, Turkish graduate school students' experiences in Japan can be explored through a grounded theory design to analyze multiple interactions and influential factors. Another example done by Freeman (2009) focused on how Japanese counselors adapt Western type counseling education into their practices in Japan. The researcher's grounded theory methodology provided four constructs as important to consider in counselor education in Japan: identity development, cultural or societal elements, counselor elements, and global elements.

Narrative research aims to collect data from stories of people through narrative data collection such as chronological interviews over time. The narrative data includes the storytelling, autobiographical and biographical writing or stories from the words of the participants and analyzes through the use of story elements. For example, Schlosser (2001) conducted a narrative study of twelve Finnish Women to understand their success stories. The analysis of interview data presented that these women were self-confident,

high-achievers or equipped with high knowledge of content and acting interdependently from their peers and family members. Another study by Cho (2018) explored how music supported the lives of three older Korean immigrant in the United States. Participants' narratives indicated that music helped them recognize their personality, communicate emotionally, and understand the social-cultural differences between where they live and where they come from.

Phenomenology also focuses on individuals' experiences to describe the meaning from their experiences. This is different from narrative research since it is not interested in a series of chronological stories to understand a long-term experience. For example, Ueda & Sakugawa (2009) explored the students' perceptions of volunteer experiences in terms of their purpose in life. The study suggested that volunteer activities should include practical communication with others to the growth of volunteers. Another study by Anderson et al. (2021) explored secondary students' experiences in out-of-school time science research and found that students' experiences included opportunities to explore their own interests, learning and applying science, and being supported by mentors and other professionals.

Ethnography studies the culture of people within a context such as in their homes or school or work to understand how they live, behave, think, and talk within a culture. In this type of research, it is important to examine the shared values, attitudes, and beliefs on a particular group on a phenomenon; a culture-sharing group can be framed to study such as a family and school and to report a cultural portrait and personal reflections. For example, Parson (2018) focused on exploring the culture of an institution to understand experiences of undergraduate women in math and physics through faculty and student interviews, observations, and textual analysis. Another study by Shah & Khurshid (2019) focused on lived experiences of educated Muslim women from low-income communities of Pakistan and India to examine what empowerment means for them. Ethnographic research suggests researchers to be active or passive participants of the research process to engage in the activities and understand the experiences of the subjects of the study.

Activity-1: Detienne, Baker, Vanhille and Mougenot (2017) conducted the research below.

Abstract: Engineering students need to learn to collaborate, to create and to innovate in culturally diverse socio-organizational contexts. However, research on intercultural differences provides results that are not

specifically grounded in collaborative and creative engineering education practices. Based on the quality collaboration method, the study contrasted French and Japanese engineering students' qualitative evaluations of: (1) ideal collaboration in design; (2) quality of collaboration with respect to actual cases of collaborative design in France and in Japan (as shown on videos). Results showed a common French Japanese culture of collaboration across the engineering students with respect to aspects of design relating specifically to the domain of engineering, yet differences with respect to appraisals of dimensions of group work (task/group orientation and argumentation). These results conclude with prospects for elaborating an operational transcultural concept of institutional culture of collaboration, and implications for training engineering students, especially for multicultural collaboration.

a. Please discuss the methodology of the study. Which methodology should be used in this study? Why? Please explain.

b. What is the central phenomenon and intent of the study?

c. Who are the participants of the study?

d. Which procedures or data collection methods should be used in this study?

e. What does the results of the study suggest about the research design?

f. Which research questions do you suggest for this study?

Activity-2: Huang (2017)'s study is explained as below:

This study undertakes comparative research on major aspects of university curriculum and instruction-teaching activities of academics, their role in curriculum development, and their perceptions of these activities—between a mass and a universal higher education system. Major findings from the Academic Profession in Asia surveys administered in the two countries in 2011–2012 with a similar questionnaire provide hard data. However, the study also explores other contextual factors and drivers which might have affected the teaching activities undertaken by academics, their involvement in curriculum development, and their views of relevant activities. The paper argues that, although differences can be found in some aspects of the curriculum and instruction and academics' participation in these activities during the shift from the mass to universal phase of higher education, it is less clear that the differences show the impact of transforming from mass to universal education. The national contextual factors, especially the origins of higher education and ongoing national policies in both countries, appear to

play a significant role in how current academics perceived the curriculum development and instruction, and their participation in these activities. More importantly, as fundamental changes do not necessarily occur in all aspects of the curriculum and instruction, as well as the academics' views across universal and mass higher education systems, research on these areas can only be partly applied to the analysis of the curriculum and instruction in both countries.

a. Please discuss the methodology of the study. Which methodology should be used in this study? Why? Please explain.

b. What is the central phenomenon and intent of the study?

c. Who are the participants of the study?

d. Which procedures or data collection methods should be used in this study?

e. What does the results of the study suggest about the research design?

f. Which research questions do you suggest for this study?

Activity-3: Yanagi & Takaoka (2022) conducted the study below:

Abstract: Despite considerable efforts to improve the reporting of child maltreatment in schools, little research has been conducted to examine the hesitance to do so. This study developed a hypothetical model to provide a systematic understanding of hesitance to report maltreatment in schools. Interview data were collected from 17 staff members at Japanese schools who had experienced child protection issues and analyzed using the qualitative approach. Our analysis shows that school culture often presents difficulties in detecting child maltreatment. In cases where child maltreatment had been discovered, parents' and children's reactions aroused school staff's anxieties. Moreover, the school administrators' reactions made school staff hesitant to report such issues, resulting in an inadequate relationship with the child guidance center. The school staff's behavioral suppression may be attributed to the occurrence of cognitive dissonance. The school culture of behavioral restraint could be the result of pluralistic ignorance, leading to general misjudgment. Using this model, the process of school staff's hesitance to report child abuse in schools is illustrated with reference to social psychology. These results may be useful in cases of child abuse.

a. Please discuss the methodology of the study. Which methodology should be used in this study? Why? Please explain.

b. What is the central phenomenon and intent of the study?

c. Who are the participants of the study?

d. Which procedures or data collection methods should be used in this study?

e. What does the results of the study suggest about the research design?

f. Which research questions do you suggest for this study?

Activity-4: Dean (2021) wrote a thesis on Chinese International students:

As higher education leaders, it is vital to understand who is attending our schools and know how to provide the support they need. The number of Chinese international students studying abroad has increased by 600% over the last two decades. Higher education institution leaders need to understand this growing segment of their student population and meet their unique needs. Unfortunately, regional data is lacking concerning antecedent factors of acculturative stress for Chinese international students. The purpose of this qualitative study was to understand Chinese international students' perceptions of the factors, if any, that may lead to acculturative stress while attending a four-year public university in the southeastern United States. The research question was, how do Chinese international students understand their cultural and academic experiences at a public, four-year university in the southeastern United States? The participants included three Chinese international students enrolled full-time at a public, four-year university in the southeastern United States. The key conclusions were (a) university interactions in the southeastern United States are largely positive, with a few exceptions; (b) cultural differences have a powerful influence on Chinese international students' acculturative experiences in the southeastern United States; (c) current political and social conditions in the United States are causing heightened stress among Chinese international students; and (d) language challenges are the single greatest stressor for Chinese international students in the southeastern United States.

a. Please discuss the methodology of the study. Which methodology should be used in this study? Why? Please explain.

b. What is the central phenomenon and intent of the study?

c. Who are the participants of the study?

d. Which procedures or data collection methods should be used in this study?

e. What does the results of the study suggest about the research design?

f. Which research questions do you suggest for this study?

Activity-5: Varma, Volkmann, & Hanuscin (2009) focused on pre-service science teachers:

Given the critical role that preservice teachers' own beliefs and perspectives play in shaping their learning, the study sought to better understand from their perspective the influence of the methods courses and field experiences on their understanding of inquiry and inquiry-based teaching and learning. Therefore, the research question that guided this research was as follows: What do elementary preservice teachers' perceptions indicate regarding their understanding of inquiry and inquiry-based pedagogy for teaching and learning science as completing requirements for their degree?

a. Please discuss the methodology of the study. Which methodology should be used in this study? Why? Please explain.

b. What is the central phenomenon and intent of the study?

c. Who are the participants of the study?

d. Which procedures or data collection methods should be used in this study?

e. What does the results of the study suggest about the research design?

Activity-6: Angela Johnson (2007) focused on the research below:

This study examined how 16 Black, Latina, and American Indian women science students reacted to their undergraduate science classes. I focused on the meanings they made of the common features of university science documented by large, competitive, fast-paced classes, poor teaching, and an unsupportive culture. I also explored their responses to the values manifested in their science classes and laboratories. The research took place at a large, predominantly White research university; participants were recruited from a science enrichment program for high-achieving students. I interviewed the participants and attended science classes and laboratories with them. I analyzed the data using qualitative method and validated it through triangulation and member-checking. The women in the study found three features of science classes particularly discouraging: the size of the lecture classes, asking and answering questions in class, and (in some cases) engaging in undergraduate research. They were negatively impacted by two cultural values: a narrow focus on decontextualized science and the construction of science as a gender-, ethnicity-and race-neutral meritocracy.

a. Please discuss the methodology of the study. Which methodology should be used in this study? Why? Please explain.

b. What is the central phenomenon and intent of the study?

c. Who are the participants of the study?

d. Which procedures or data collection methods should be used in this study?

e. What does the results of the study suggest about the research design?

f. Which research questions do you suggest for this study?

QUIZ:

1. Which of the following questions are appropriate for a qualitative study?

   a. Is there any relationship between family composition and student achievement?

   b. What is the relationship between compulsory school attendance and students' test scores?

   c. What factors are effective in the implementation of argumentation-based instructional model for experienced biology teachers?

   d. How do students' with autism disorder reading ability change by the amount of study hours?

2. For an ethnographic study, a qualitative researcher aims to collect data on schooling after 90s in Hiroshima, Japan. What type of data does the researcher collect?

   a. Sending surveys to the individuals who were a student or teacher after 90s.

   b. Conducting in-depth interviews with volunteer students, teachers, and administrators

   c. Examining students' achievement scores from the district information site

   d. Using a rating scale to evaluate the characteristics of schooling

3. What are the characteristics of qualitative research study?

4. Which type of qualitative research focuses on studying a unit of study or bounded system?
   a. Phenomenology
   b. Descriptive
   c. Ethnography
   d. Case study

5. What is one difference between a quantitative and qualitative study?

6. Which of the following is a key characteristic of qualitative research in educational research?
   a. Hypothesis testing
   b. Emphasis on statistical significance
   c. Exploration of lived experiences
   d. Large sample sizes

7. What is the central focus of phenomenology in qualitative research?

8. In qualitative research, which methodology focuses on understanding the essence and meaning of the experiences of individuals or groups?
   a. Case study
   b. Ethnography
   c. Grounded theory
   d. Phenomenology

9. In qualitative research, which methodology emphasizes an in-depth exploration of cultural dynamics, social interactions, and contextual nuances within a specific educational setting?
   a. Grounded theory
   b. Phenomenology
   c. Case study
   d. Ethnography

10. In qualitative research, which methodology is characterized by the development of theories grounded in the data, allowing patterns and concepts to emerge during the research process?

    a. Case study

    b. Phenomenology

    c. Grounded theory

    d. Ethnography

SAMPLING STRATEGIES

- By the end of this chapter, students will be able to
  - o define sampling strategies in quantitative and qualitative research designs.
  - o define random and non-random sampling techniques in different research designs.
  - o determine an appropriate sample for a research study design.
    - identify how to select an appropriate sample for the study.
    - distinguish the sample from the population.
    - differentiate target population from accessible population.

When we design a study, we need to have the participants to collect data to analyze and make conclusions about the research questions. These participants should be selected carefully among the individuals or groups who are representative to obtain the information and address the characteristics of a larger population. A population includes individuals with the certain characteristics to generalize the results of the study. For example, all beginning science teachers comprise of a population to study their first five-year experiences. Or all elementary school teachers in Turkey or All fifth-grade classrooms in the city of Ankara. It may be difficult to study the entire population all the time. When we define the certain characteristics of population, we choose a target population to study. Then, we can select a representative sample of a larger group to study and generalize about the target population. For example, you may select 50 engineering students as a sample among 1000 students who are majoring engineering at a public university. Another example is studying students who own automobiles or women students who live in campus dormitories. A sample of students living in campus dormitory represents the students living in all campus dormitories.

There are several different sampling strategies in quantitative and qualitative research studies. Probability sampling requires random selection of participants or unit of analysis such as groups or schools from a larger population. First, simple random selection means that each individual or participant of a study can be selected with equal and independent chance. This would be happened through assigning random numbers to the members of the population, generate numbers at random to choose a simple random sample. For example, if the sampling procedure is random, as a student of 500 college students at a community college, I have a chance of being selected as 1 in 500. Or the researcher writes the name of each member of the target population on a separate identical paper to randomly select 50 sample. Second, another type of random sampling is systematic sampling to randomly select a starting point and continue with selecting every nth individual in the population. For example, for a population of 300 and a sample of 50, a researcher can select every 6th member of the population until reaching to 50 members as sample. Third, stratified random sampling is used when the population includes subgroups such as gender, income, age, education, occupation to select a simple random from each group systematically to combine them as a sample of the study. For example, a company wants to select 100 sample among its 2000 workers at different age groups as shown on the table. These groups can be defined for male and female students as well: in a population of 400 first year college students (240 female, 160 male), how can we select a total of 100 students?

Age	# of workers in each stratum	Number of people from the strata in the sample
20-29	520	(100/2000) *520= 26
30-39	560	(100/2000) *560= 28
40-49	580	(100/2000) *580= 29
50+	340	(100/2000) *340= 17

Sometimes, it may be difficult to select individual samples from a population, but the researcher may need to select a sample of a group or cluster. A researcher may select 10 schools randomly among 50 schools in a district. Cluster sampling can be combined with simple random sampling to first select the clusters, then randomly select the individuals from the clusters. For example, instead of choosing 200 science teachers from a population of 2000 science teachers in 500 schools, a researcher can first

select 100 schools among 500 schools, and then select two teachers from each school randomly. Why should this two-stage sampling be preferred instead of choosing 5 classes randomly?

In qualitative studies, researchers select individuals through non-probability sampling that chooses individuals according to their availability, convenience, and appropriateness for the purpose of the study. Convenient sampling is not a probability sampling to select individuals based on their availability and voluntary participation to provide answers. For example, a professor can make a survey to understand students' experiences in an educational research methods course. Convenience sampling depends on participants' interest and voluntary participation, so it may provide biased responses, or it may be unrepresentative of the whole population. An alternative to convenience sampling is snowball sampling that aims to select a few participants first, then ask these participants to identify other potential participants. For example, when we make a survey among school administrators, we may contact a few school administrators and ask them to send the copies of survey to other administrators at the same district. Purposeful sampling is different from convenience sampling since the sample is chosen among the participants who are believed to possess the necessary information about the purpose of the study. For example, a researcher aimed to understand the mathematics teachers' experiences with using tablets at a new private school. The researcher decides to interview with three mathematics teachers at school about their experiences in using tablets in classes. Lastly, the sample size should be enough for statistical purposes. For example, Plano Clark and Creswell (2015) suggested that an experimental study could include nearly 15 participants, a correlational study could include nearly 30 participants, and a survey study could include nearly 400 participants. For study in this class, please discuss how many participants you will need.

Activity-1: Please define the type of sampling strategy for the stated studies.

Study	Type of Sampling
Names of employees are numbered from 1 to 300 to select 50 employees for a study.	
100 grade 7 students will be selected from a district from different type of schools	
Every 10th name after the first selection will join the sample	
A school is chosen since it was closer to the researchers' home or school to interview with teachers at school.	
A researcher conducts a survey about self-confidence of 12th grade high school students in Turkey. The researcher will select the sample from different cities.	
A researcher aims to interview mothers of students having learning difficulty.	
You aim to understand the satisfaction of swimmers who use the swimming pool regularly. Two swimmers can give the contact information of other swimmers to communicate for the study.	

Activity-2: You are given the following research studies. Please read the abstract and the different sections of the study to identify the following items:

a. What is the research design of the study?

b. What sampling strategies can be used in this study? Please explain the method.

	Research Design	Sampling Strategy
Overman et al. (2014)		
Deslandes & Bertrand (2005)		

Activity-3: You are a group of researchers and given a bag of marbles with different colors. You can consider that these marbles have different sizes and weights. How do you define the population and sample for your study? Please use at least one of the random sampling strategies to select 50 marbles among 250 marbles.

Activity-4: A researcher gives the following information about his/her target population.

Population: Population of the study is the 537 sophomore college students enrolled in the Engineering School at a European University in the fall of 2023. The information about these students is provided on a table and includes their student id number, gender, university entrance rank, high school grade point average, and freshman grade point average at college.

1. With the given information about the population, a representative sample of 30 engineering students for a project study will be selected. Please generate at least two methods to select your sample. Describe the selection of the sample with figures, or an explanation.

Activity-5: Determine a quantitative and qualitative research study in your field to design.

a. Suppose that you choose a quantitative research design. Please include research questions and research purpose below. According to your proposed research, please describe the research design and sampling strategies to use in your research.

   You can use the following steps for quantitative sampling.

   1. Step 1: Define the population size.
   2. Step 2: Use a sample size calculator[2] to select the sample within an appropriate confidence interval (0.95) and margin of error (0.05). For example, please select a sample from a 10000 population.
   3. Step 3: Use the following formula to check the Step-2, where
      - e is the margin of error
      - p is the proportion of population
      - q is 1-p
      - z-value is (1-(1-Confidence interval)/2)

$$n_0 = \frac{Z^2pq}{e^2}$$

b. Suppose that you choose a qualitative research design. Please include research questions and research purpose below. According to your proposed research, please describe the research design and sampling strategies to use in your research.

2 http://www.raosoft.com/samplesize.html

QUIZ

1. When is appropriate to make generalizations from a sample to the population?

   a. A large random sample is used

   b. A small systematic sample is used

   c. The hypothesis is verified without considering the sampling strategy

   d. Cluster sampling is used to make selection from a homogeneous population

2. Bella needs to conduct a survey for the teachers who graduated from East University. She takes the list of all the graduated teachers from the Alumni Office and calls every 5th name on the list. Bella's method of sampling is

   a. stratified random sampling.

   b. cluster sampling.

   c. systematic sampling.

   d. simple random sampling.

3. Fuat wants to select 1000 workers for a company survey by their age and gender. He is interested in comparing age and gender categories for their preferences. He is interested in selecting comparable numbers of children from each group. What is the sampling method that Fuat should use?

   a. Purposeful sampling

   b. Cluster sampling

   c. Stratified sampling

   d. Simple random sampling

4. Jeremy is a superintended at a private middle school. He realized that although boys could develop reading ability in the first semester of the school year, girls had difficulty to develop their ability in one year. To test his hypothesis, he would like to conduct a study with the students in his school. What is the sampling method that Jeremy should use?

   a. Convenience sampling

   b. Stratified sampling

   c. Cluster sampling

   d. Simple random sampling

5. Dr. Eagle is a teacher educator for a research university. He was interested in comparing the pre-service teachers' use of two alternative teaching methods in a teaching methods course. He randomly selects pre-service teachers in different groups to study the suggested teaching method. What is the sampling method that Dr. Eagle should use?

   a. systematic sampling.

   b. stratified sampling.

   c. simple random sampling.

   d. cluster sampling.

6. How is the representative sample selected through random sampling?

   a. Participants can be selected from a fixed interval period of a population

   b. Participants are selected from a location relevant to research topic

   c. Participants have an equal and independent opportunity to be selected

   d. Participants comprise smaller group within the entire population.

7. Dr. Eddington wants to test the effectiveness of a medicine for flu symptoms after COVID-19. She aims to develop this medicine for people from different age groups in her country. She would like to compare her findings according to the age and gender groups, who visited her office in the West Region Public Hospital in a year. She followed the effectiveness of the medicine in two weeks for each participant. What is the sampling method that Dr. Eddington should use?

   a. systematic sampling.

   b. stratified sampling.

   c. simple random sampling.

   d. cluster sampling.

8. A teacher educator wants to study the teacher beliefs in a metropolitan city. The teacher educator aims to study the teachers from public and private schools. He contacts to the National Ministry of Education to get the list of schools from each district. First, he selects two schools randomly from a district, then selects random sample of teachers from the schools. What is the sampling method that the teacher educator should use?

   a. systematic sampling

   b. purposive sampling.

   c. multistage sampling.

   d. snowball sampling

9. Please explore the meanings of and differences among sample, a population, target population, and accessible population.

10. Please explore the meanings of and differences among qualitative sampling methods: convenience, purposeful, snowball, quota sampling etc.

VARIABLES and INSTRUMENTATION

- By the end of the study, students will be able to
  - o describe the characteristics of measurement instruments for quantitative and qualitative data collection.
    - define the construct and variable.
    - describe the type of variables and scales to measure them.
    - recognize the importance of validity and reliability in research designs.
    - determine the validity and reliability measures in a research study.

Construct and variable are two important terms in educational research. Mills and Gay (2016) states that a construct is an abstract phenomenon to explain a behavior although it cannot be detected directly. Intelligence, motivation, achievement, and anxiety are examples of a construct. When a construct is defined in a range of values such as high, medium, low levels of anxiety, they become variables. In most educational studies, participants' gender, ethnicity, test scores, age, and socioeconomic status can be described at different levels. How can we define variables in a study? For example, a high school administrator aims to investigate the factors influencing 12th grade students' success in university entrance examination. Another example would be related to parents' education level and students' high school GPA scores. The first example focuses on a variable as factors influencing students' success, and the second example focuses on variables as parents' education level and students' high school GPA scores.

Variables can be represented in different ways as categorical or noncategorical, as quantitative or qualitative, or as dependent or independent variables. Variables can be used with different measurement scales to organize the data including nominal, ordinal, interval, and ratio scales. Nominal scale is a kind of qualitative or categorical variable to represent a

characteristic of a participant such as sex (female, male), religion (Muslim, Christian etc.), nationality (American, England, Canadian), race (Hispanic, Black, White), or marital status (married, divorced, single). In research studies, nominal categories should be represented in numbers or letters to identify the differences among these categories or groups without having a purpose of ranking. Because ordinal variables have the aim of ranking from the highest to lowest or the lowest to highest, and ranking does not have equal scale intervals. An example of an ordinal variable can be as ranking the average scores of primary school students' reading comprehension test among 94,91,87,85,80 scores in five different schools. On the other hand, interval variables represent values ranked in order by having equal scale intervals in achievement, attitude, motivation test scores without having a true meaning of zero such as temperature. Ratio variables have a true zero point, and measurements in height, time, and distance represent ratio scale. Ordinal, interval, and ratio variables are all quantitative variables to represent test scores, age, class size in numbers.

Remember that we have discussed about dependent and independent variables: a dependent variable depends on or is caused by an independent variable. Please determine the variables in the following research hypothesis: Pre-service mathematics teachers who took a class on gamified instruction are less likely to use this strategy in their classroom. Or there are gender differences in students' exam scores after an inquiry-based physics lesson. What other variables can be considered to monitor the outcomes? (Control variable) Or Are there any other variables that cannot be measured or observed to influence the outcomes? (Confounding variable) Remember we have also talked about moderating variables and intervening variables. Moderating variables determine the interaction between variables to define a new independent variable. Consider the following example and state the moderating variable: Inquiry-based instruction with high interest in science improves final exam scores more than traditional-based instruction with low interest in science. Intervening variable represents the variable mediate the interaction between independent and dependent variables to influence the result. Consider the following example and state the intervening variable: Hours to visit the doctor is available to my class schedule, I am confident to go there in the morning to take a COVID-19 test.

In qualitative and quantitative research studies, what type of measurement instruments can we use to collect data? A researcher can administer a standardized instrument such as achievement tests, aptitude tests or attitude scales. Standardized instruments are developed as valid and reliable measurement instruments to collect data. What is validity? Validity

refers to a test that measures the intended variable in terms of content, construct or criterion measure. Reliability is a measurement procedure to analyze whether the results are consistent across different scoring of multiple raters (inter-rater reliability) or a single rater (intra-rater reliability). If a test is valid, is it also reliable; or if a test is reliable, is it valid or not? Please explain. How do validity and reliability change for self-developed or teacher-prepared instruments?

Activity-1: Please show the variables in the following statements:

- What is the relationship between high school students' GPA score and their choice of science-related career?
- What is the most effective problem between teachers and parents about students?
- Are new curriculum materials for art studies more effective than the previous ones?
- Seven-grade students have statistically higher motivation to study than eighth-grade students.
- Teachers' years of experience has statistically more significant effect on their tendency to attend a graduate school.

Activity-2: Can you identify the variables in the following published research?

- Null hypothesis of Konvalina's (1981) study is stated that there will be no difference in math confidence and basic skill achievement between students in the treatment group and students in the control group.
- The research question of Alajaaski (2006) is stated as How does Web technology as an educational platform affect students' attitudes towards mathematics?
- The hypothesis of Grooms et al. (2014, p. 1416) is stated: "Students who completed the argument-based course would craft stronger arguments and use different types of justifications to support their views if students are able to transfer the skills and habits of mind that they learn in a scientific context."
- Kesamang and Taiwo (2002)'s research hypothesis states that there is a significant relationship between the socio-cultural beliefs help by beginning secondary school students and their attitudes towards science and achievement in science.

- Mauro & Furman (2016)'s research questions suggest that:
  - To what extent did the implementation of an eight-week guided inquiry-based unit focused on the planning of cross-domain and low conceptual load experiments improve the experimental design skills of 4th grade students?
  - How well did the students' improved ability in experimental design endure eight months after the implementation?
- Bryce & Blown (2007)'s research questions suggest:
  - Are there any statically significant differences between boys and girls conceptual acquisition in the domain of astronomy and earth science?
  - Do boys and girls follow similar trends in the cosmological development?
  - Are patterns of knowledge acquisition, cognitive development, and conceptual change in this domain similar for boys and girls across cultures and ethnic groups?
- Andersson et al. (2021)'s research question suggests: How do students perceive the phenomenon of STEM learning through scientific research done outside the classroom?

Activity-3: When you read the following description of a quantitative research study, think about the types of variables being discussed.

A science education researcher is interested in 12th grade high school students' attitudes towards physics. The researcher designs a 10-week special inquiry-based curriculum. One class, Class-A, works on the special curriculum, but the other class, Class-B, works on the usual curriculum that follows the textbook. At the end of the program, she uses an attitude test to measure all students' attitudes towards physics; the test asks for level of students' agreement on a set of statements. The researcher is also interested in students' grade point average, gender, confidence level to achieve in physics, and amount of time to study physics in a week. At the end of the study, the researcher learned that there were a few students whose parents were physics teachers at other high schools. Answer the following questions based on this passage:

a. What is the dependent variable in this study?

b. What is the independent variable in this study? What were the control variables?

c. What confounding variable was identified?

d. What is an example of a variable measured in categories? What is an example of a variable measured as continuous?

e. What is an example of a treatment variable? What is an example of a measured variable?

f. Are there any mediating or moderating variables? Amount of study

Activity-4: What type of scale would a researcher describe as "nominal, ordinal, interval or ratio" and most likely use the following examples to measure? Please complete the table.

Definition	Scale Type	Examples- list #
Scale that measures in terms of names or categories		
Scale that measures in terms of ranking values such as more, less, larger		
Scale that measures in terms of equal intervals without true-zero-point		
Scale that measures in terms of equal intervals with absolute-zero-point		
1. Height of students in cm 2. Students ranked on aggressiveness of classroom behavior 3. Mechanical aptitude 4. Religious preference 5. Writing ability 6. Running speed 7. Weight gain or loss in kilograms over a three period of time 8. Sex/Gender 9. Political affiliation 10. High school students grouped according to grade level 11. Fahrenheit temperature scale 12. Celsius temperature scale 13. Kelvin temperature scale 14. SAT scores 15. TOEFL scores 16. Blood pressure	17. Age 18. Searching for number of bacteria in 1 liter liquid sample 19. Studying college students' engagement at different levels: freshman, sophomore, junior, senior 20. Four groups of workers earn different amount of salary: Group A has 10000 TL, Group B has 18000 TL, Group C has 24000 TL, and Group D has 28000 TL. 21. The difference between 15 points and 35 points has the same effect as the difference between 65 points and 85 points. 22. Ranking the level of help you received from the teaching assistant from never to always. 23. Standardized Test or achievement test 24. Amount of money 25. Regional zip code	

Activity-5: When you read the following description of a quantitative research study, think about the types of variables being discussed.

A researcher is interested in adolescents' attitudes about smoking tobacco. She designs a special health curriculum about smoking and has some students complete the special curriculum and other students complete the usual curriculum. At the end of the year she measures the students' attitudes about smoking tobacco by asking about their level of agreement with a series of questions. She also measures their gender and parental tobacco use (user, pre-user, or non-user) since she expects those may also be important variables to know. Unfortunately she did not know that the theater club had decided to produce a play about smoking this year, so the students who participated in theater were also learning about the issue of smoking. Answer the following questions based on this passage:

a. What is the dependent variable in this study?

b. What is the independent variable in this study? What were the control variables?

c. What confounding variable was identified?

d. What is an example of a variable measured in categories? What is an example of a variable measured as continuous?

e. What is an example of a treatment variable? What is an example of a measured variable?

Activity-6: Validity refers whether the test addresses the sufficient objectives to measure the construct under investigation for certain groups in certain circumstances. A test may be valid test for middle students' views of nature of science, but not valid on testing students' mathematics anxiety. It refers to accurate interpretations and appropriate inferences of the assessments. If a measure has greater validity, it focuses on content, domain of tasks, or important objectives CONTENT, nature of characteristics CONSTRUCT, and the relation of the assessment results to other significant measures CRITERION.

a. How can we establish validity of a physics test on "laws of thermodynamics"?

b. How can we establish validity of a test focusing on "reading ability or creativity"?

c. How can we predict a future performance?

i. A researcher looks at the graph that shows the relationship between a group of students' spring mathematics score and their fall aptitude score. What does this graph tell the researcher?

d. How can we assign overall grade for a course?

e. What factors may influence the validity of a test?

Activity-7: A researcher asks, "Is the score just obtained by Alara the same score on the same test she should get if she took the test tomorrow, or the next day, or the next week?" The test is administered twice and in some intervals between two administrations as a measure of stability. Another question may be asked by a teacher, "Does using the two different forms of the same test represent the true indication of students' knowledge or ability?" In this case, equivalent forms of the same test are used to control for sources of error due to both content variability and time in measuring the same aspects of behavior.

a. It is emphasized that in high reliability, observed score or obtained score most likely reflects the true score with less amount of error score. How can we calculate the observed score? What is the mathematical foundation for reliability considering observed, true, and error scores?

b. What might be the sources of error in reliability?

c. A researcher applies an aptitude test in September and uses the same test in January, and results showed that there is a .90 degree of association between two implementations. What does this result tell us about the reliability?

d. A teacher uses two different forms of an achievement test in January and May on algebraic calculations. The association between two test results is found as .70. What does this result tell us about the reliability?

Activity-8: A test or instrument should include items that are consistent with one another. Testing may change according to scale number: For a 5-scale Likert scale or continuous measures, Cronbach Alpha is calculated. For a dichotomous scale with yes/no answers, Kuder-Richardson 20 K-R-20 is calculated. For even-odd numbers, Split-half reliability or Spearman-Brown correction is calculated by dividing the test in half. For given situations below, please calculate the internal consistency and explain its meaning.

KR-20 = $(\frac{n}{n-1})$ * [1 – $(\frac{\Sigma pq}{\sigma^2})$] where p represents percentage of right answers, q represents percentage of wrong answers, σ^2 is the variance, n is the number of total participants

Alpha= $(\frac{n}{n-1})$ * [1- $(\Sigma\frac{\sigma i^2}{\sigma^2})$] where σ_i^2 is the sum of the variance for the separate test items.

f. Using the data given on Table, calculate the Cronbach Alpha and Kuder-Richardson-20 reliability coefficient and compare and interpret these values.

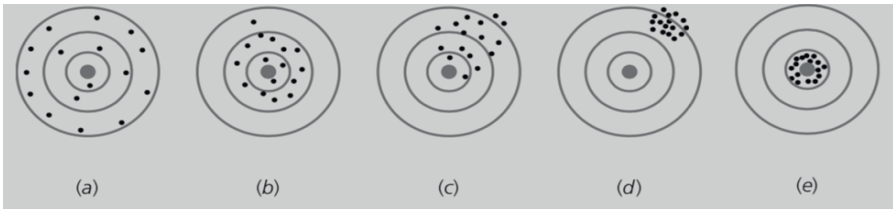
Item	Answer	A	B	C	D	E	F	G	H
1	3	3	3	3	3	2	3	3	3
2	3	3	3	3	3	2	3	3	3
3	3	2	1	1	1	2	3	3	1
4	3	2	2	2	2	4	3	3	4
5	1	4	4	2	4	4	1	1	2
6	3	2	2	3	3	3	3	3	3
7	1	3	1	1	1	3	1	2	1
8	2	3	3	2	3	4	2	1	1
9	4	2	2	3	2	2	4	4	4
10	4	2	4	3	1	4	4	4	4

g. A correlation coefficient of .70 for half of the test items. Please find the Split half reliability or Spearman-Brown correlation. Spearman-Brown correlation= 2*(r/(1+r))

Activity-9: Another type of reliability focuses on the consistency of scores between two or more raters to make judgments about something. For example, a researcher is interested in a science teacher's questioning strategies and trains two raters to make observations and rate the type of questions as open-ended (OP) and closed-ended (CL) questions. Each question is rated by each observer and their judgments were compared to understand the agreement between raters. This is called interrater agreement. How can the researcher calculate the amount of agreement by using the responses on Table?

Teacher questions	Rater-1	Rater-2
1	OP	OP
2	CL	OP
3	CL	CL
4	OP	OP
5	CL	CL
6	CP	OP
7	OP	OP
8	OP	OP
9	CL	OP
10	CL	CL

Activity-10: If a test is valid, it is also reliable. If a test is reliable, it is not valid. What does this sentence tell us about the validity and reliability of tests? Please use the following figure to make interpretations.



QUIZ:

1. GPA scores are often scaled from 0 to 4. What is the type of measurement?
   a. nominal
   b. ordinal
   c. interval
   d. ratio

2. Marital Status is the _____type of measurement.
   a. nominal
   b. ordinal
   c. interval
   d. ratio

3. The following research question includes dependent and independent variables: "Is there difference for student achievement in physics between taking hands-on experimental physics courses and attending traditional lectures? What type of variable does student achievement represent?

   a. independent variable

   b. Dependent variable

   c. Extraneous variable

   d. Affective variable

4. Which one of the following reliability tests is not a measure of internal consistency reliability?

   a. test-retest reliability.

   b. Cronbach alpha

   c. Split-half reliability

   d. Kuder-Richardson Formula 20

5. Faith is a mathematics teacher and prepares a test on fractions for grade 7 students. Faith was careful in preparing the test to address the learning objectives thoroughly. The teacher uses the test twice with two-week interval to check the consistency in students' responses. Faith assessed which type of reliability?

   a. internal consistency reliability.

   b. alternative forms of reliability

   c. test-retest reliability

   d. interrater reliability

6. Emily and Emma made observations on a student's reading ability by using a rating scale. They made 20 observations, but only 10 of these observations were consistent. What is the type and amount of measure for this comparison?

   a. Internal consistency, 20%

   b. Interrater consistency, 50%

   c. Interrater consistency, 20%

   d. Internal consistency, 50%

7. Why do teachers prefer multiple-choice tests more than essay type tests?

   a. The multiple-choice test is more reliable

   b. The multiple-choice test is less reliable

   c. The multiple-choice test has more questions

   d. The multiple-choice test has less predictive validity

8. Carla develops a 20-question science test to use in her classroom. After she applied the test to her classroom, she evaluated to even and odd numbered questions separately. If she calculates the reliability of two halves, what type of reliability was she interested in?

   a. Split-half reliability

   b. Cronbach alpha reliability

   c. Interrater reliability

   d. Kuder Richardson 20 reliability

9. Please explore the meanings and functions of predictive, concurrent, content, and construct validity.

10. Gabriella developed and applied a chemistry test in her high school classroom. Although she aimed to evaluate students' chemistry content knowledge, she realized that most questions focused on evaluating students' ability of reading compounds or equations. What type of validity was questioned on Gabriella's test?

    a. content

    b. criterion-related

    c. construct.

    d. consequential

DATA COLLECTION

- By the end of this chapter, students will be able to
  - o describe the types of data collection instruments in educational research.
  - o explain the terms "data and instrumentation."

Briefly think and write where you are on the journey and how you have achieved so far. Share your thoughts with your peers. By writing reflections, you start keeping records of your experiences in a journey. As a researcher, you can ask different questions: how do you get enough material or information for your research? How do you make observations? What kind of data do you collect to answer research questions? Data describes the kinds of information researchers obtain on the participants of the research. These data may be related to demographic information, test scores, grade-point average (GPA) scores, interview responses, student essays, or field notes taken by the researcher. Therefore, the data collection process requires the researcher to ask questions related to the location (Where to collect?), time (When to collect?), frequency (how often to collect?), and administration (Who is to collect?) of the process. For example, a researcher may choose to collect data from the first-grade students in the classroom twice a week during the reading comprehension classes. The data collection should be administered in a hospitable environment through encouraging participants to be responsive.

What kind of instruments should a researcher use during the data collection? Firstly, the instruments should be valid because assessment methods measure the intended topic or construct. Valid instruments must allow the researcher to make observations and inferences about the characteristics of certain individuals through the data collection from selected instruments. These valid tools help draw guaranteed conclusions about individuals' traits, such as their abilities, achievements, and attitudes. Secondly, the instruments should be reliable to give consistent results across

different implementations. For example, a group of students can take a math achievement test in one week interval to observe the consistency in their scores. Thirdly, these instruments should provide objective accounts of participants' achievement, attitude or motivation through eliminating bias in both quantitative and qualitative studies. Fourthly, these instruments should be easy to use and administer. They should take an appropriate amount of time, have clear directions, and be appropriate for ethical standards.

Qualitative and quantitative research designs require different types of data sets about participants' perspectives in textual information or performances in numerical information. Most of the tests are developed to obtain numerical and valid data about participants' cognitive (e.g. achievement) and affective (e.g. emotion or motivation) characteristics. Standardized achievement tests such as single subject diagnostic tests or Stanford Achievement Test are examples of cognitive tests. Mental characteristics can be assessed through mental maturity scale, scholastic aptitude test, anxiety questionnaire or other attitude scales such as Guttman Scale. These scales give an opportunity to measure the strength of an opinion in a continuum from strongly agree to strongly disagree (Likert Scale) or from fair to unfair (Semantic differential scale) or from always to never (rating scale). In some research studies, the researcher may focus on gathering authentic information about performance through laboratory demonstration, discussion, presentation, written work, or visuals to understand whether students are progressing.

During the data collection process, these instruments can be completed by either the researcher or the participants. Research questions may require data about the participants cognitive and affective characteristics, and the researcher should use survey instruments including questionnaires, personality inventories, or achievement tests. If the research questions require data about observations, the researcher should use researcher-completed instruments such as rating scales, observation protocols, performance checklists, and time-and-motion logs. For example, the following research question focuses on the observation data: what instructional practices are used by math teachers in NorthWood County Middle School? The researcher can use an observation protocol to record his/her observations and take field notes to understand what is happening in the classroom and which techniques are utilized during the instruction.

We have talked about tests, rating scales, or observation protocols. Qualitative research requires more subjective information from the participants through communicating to get to know their points of view, interpretations, and meanings to gain in-depth information about a central

phenomenon. The interviewer as the researcher can prepare restricted number of questions to conduct structured interviews to rate the responses or add open-ended questions during the interview based on the responses for semi-structured interviews or conduct unstructured interviews. Semi-structured and unstructured interviews can give participants to provide illustrations, interpretations, clarification, and contradictions. For example, my semi-structured interview can be conducted after the classroom observation to learn about the teacher's experiences. This interview can include the following questions: what did you accomplish? How did students' learning look like? What were the strengths and weaknesses of your teaching? What would you change in the lesson for the next class? There are also focus group interviews to interview with participants as a group if the research needs participants' collective thinking.

Activity-1: After you learn different types of data collection methods, now your turn, What type of tool would you use to collect the data you will get for the research question you are aiming to investigate? For given studies, find and list their data collection methods.

Study	Research Design	Question/ hypothesis	Sampling	Data collection
Kahveci et al. (2011) https://eric.ed.gov/?id=EJ926555				
Bayuo et al. (2022) Doi: 10.30935/conmaths/12364				
Sener et al. (2015) Doi:10.11114/ jets.v3i4.771				
Demircali & Selvi (2022) Doi: 10.36681/tused.2022.136				
Wolgemuth et al. (2006) Doi:10.1177/1468794114524222				
Ucar et al. (2021) Doi:10.17718/tojde.1002726				
Liang et al. (2012) Doi: 10.1007/s10956-011-9287-2				
Denman et al. (2015) Doi: 10.31109/14992027. 2015.1070308				
Bisaillon et al. (2023) Doi: 10.1080/03075079.2023.2206431				
Rushton (2018) Doi: 10.1186/s40928-018-0009-y				

Nabayra & Sagge (2022) Doi: 10.53103/cjess.v2i4.47				
Cho (2018) Doi: 10.1177/1321103X18774346				
Zeng & He (2019) Doi: 10.1080/10941665.2018.1541185				
Oliver & Venville (2011) Doi: 10.1080/09500693.2010.550654				
Wong (2012) Doi: 10.1080/09500693.2010.551671				
Akar (2020) Doi: 10.17275/per.20.20.7.2				
Shah & Khurshid (2019) Doi: 10.1080/09540253.2018.1543859				

Activity-2: McGee & Wang (2014) explains the procedures to validate an instrument to measure teachers' self-efficacy for teaching mathematics. Please review the article and explain the procedures conducted to establish the validity (please refer to participants, data collection and analysis).

Activity-3: After you analyze the data collection and analysis methods for different research designs, please select one of the studies above, and answer the following questions briefly and prepare a presentation.

Title:

What are the research questions, purpose, or hypothesis of the study?

What is the research design of the study?

How is the sampling done? Please explain.

What instruments or strategies are used to collect data? How did they collect data? Please explain.

Activity-4: You are given a test to use in data collection. What are the specific characteristics of this test? Please discuss.

http://www.banasthali.org/banasthali/wcms/en/home/admissions/mba_apttest.pdf

a. What do you need to be careful about the instrument to use in your study?

b. For what purposes can you use this test?

Activity-5: What type of tool would you use to collect the data you will get for the research statement you are aiming to investigate? (Questionnaire, rating scale, interview, personality test, achievement test etc.)

a. Elementary school teachers are thinking about a new policy about national standards instituted in all schools in the district.

b. Parents react toward increasing money for school payment in a term after the governmental economy policy.

c. How students who received gamification instruction compare to students who received traditional instruction.

d. Students with visual disabilities have different experiences about schooling.

e. Experiences of an African American college student who was transferred from a community college to a state university.

f. A student's feelings toward his/her interaction with peers.

g. A researcher aims to observe and rate five kindergarten students' behaviors for six months.

h. A high school administrator is interested in exploring 300 students' self-concept.

i. A researcher aims to collect in-depth information about physics teachers' experiences in college.

j. Students are asked to evaluate the quality of a college application.

k. A basketball coach uses a sheet to record different kinds of errors made by the players.

l. Students' ability to answer all test questions correctly.

Activity-6: Please check the following examples for the types of questions included in different instruments. Please review them and give at least one example from other published articles.

1. O'Leary, Fitzpatrick, & Hallett (2017) designed a mixed-method study and surveyed 131 undergraduate students about their experiences with math while also assessing math anxiety.

    a. Sample items from "Math Experience Questionnaire": Each item was ranked on a 5-point scale from Strongly Disagree to Strongly Agree.

        - My math teachers encouraged me to do well in math.
        - I could turn to my teachers when I needed help understanding math concepts.
        - My math teachers were understanding when I asked for help with math.
        - I was frequently left alone to work on math problems.

    b. Sample items from Math Anxiety Rating Scale- Sample (MARS) (Suinn & Winston, 2003): Respondents are asked to rate their level of anxiety on a 5-point Likert scale (1-not at all to 5-very much)

        - taking an examination (quiz) in a math course.
        - listening to a lecture in a math course.
        - totaling up a dinner bill that you think you were overcharged on.
        - calculating the scales tax on a purchase that costs more than $1.00.

2. Mecabe (2010) investigates how parental involvement relate to child's emotional intelligence including child's interpersonal, intrapersonal, adaptability, and stress management skills.

    a. Emotional Intelligence Inventory (Bar'on, 2000)- Sample Items: Not true for me (Never, Seldom), just a little of me (Sometimes), pretty much true of me (Often), very much true of me (Very often)

        - I can understand hard questions.
        - I can come up with good answers to answer hard questions.
        - I can come up with many ways of answering a hard question when I want to.

- I can easily use different ways of solving problems.

3. Hill & Merrell (2004) investigated the characteristics of controversial children through the sample items from the following rating scales for social competence and antisocial behavior:

Social Competence Scale	Antisocial Behavior Scale
Item 1: Cooperates	Item 5: Fights
Item 9: Invites others to participate	Item 14: Temper tantrums
Item 19: Interacts with variety of peers	Item 19: Physically aggressive
Item 21: Skilled at joining peers	Item 20: Insults peers

4. Tsai (2002) explored science teachers' beliefs about teaching, learning, and science with a semi-structured interview including sample questions below:

   a. In your view, science is best taught by which ways?

   b. What makes the most successful science teaching?

   c. In your view, science is best learned by which ways?

   d. What are the main characteristics of scientific knowledge?

QUIZ:

1. A quantitative researcher aims to study the students' attitudes towards statistics. How should the researcher collect data?

   a. Observe students in a statistic class.

   b. Conduct interviews with students about statistics.

   c. Solve questions of statistics.

   d. Find and use a validated test about attitudes toward statistics.

2. When a qualitative researcher explores parents' perceptions of after-school programs, what should the research do?

   a. To conduct interviews with a group of volunteer parents.

   b. To design a test to understand parents' attitudes.

   c. To use a rating scale to record the level of parents' interest.

   d. To make two groups of parents who are interested in after school program and who are not to compare their students' exam scores.

3. What type of data do you need? What is the target size that you are looking at? What type of collection method will provide with the most information that you require for the following studies?

   a. To investigate the reasons behind students' facing difficulties in understanding concepts taught

   b. To investigate if a joyful learning process affected using different teaching strategies, leads to better learning outcomes.

   c. How does students' primary school math grades affect their interest in secondary school math?

   d. How does the use of online graphing software affect student's understanding of simultaneous linear inequalities?

4. Which of the following data collection process can possibly be used in research focusing on studying the effect of the use of sensors in teaching secondary school physics?

   a. Test scores / quiz scores from before and after teaching using sensors

   b. Rating scale by students on understanding of the topic

   c. Feedback Questionnaire on the lessons

   d. Interview the students to find out their experiences

5. In a study aiming to improve grade 4 students' engagement through technology integration in math classes, what would be the most appropriate method for data collection?

   a. Conducting interviews with teachers and administrators about their opinions on technology in education

   b. Analyzing historical student performance data to identify trends in academic achievement

   c. Distributing surveys to students to gather their feedback on the impact of technology on their learning experience

   d. Reviewing relevant literature on educational technology and summarizing key findings.

6. Which one of the following data collection methods is used mainly for quantitative research designs?
   a. Interviews
   b. Documents
   c. Observations
   d. Rating scales

7. An interviewer starts the interview by asking the participant to explain their thoughts and experiences about the problem without depending on a protocol. This type of interview is called as:
   a. Structured
   b. Unstructured
   c. Semi-structured
   d. Formal

8. Which one of the following items is a specific characteristic of a focus group interview?
   a. Collecting rich data
   b. Restricted to respond all questions
   c. Asking structured questions
   d. Easier to manage the data

9. Which one of the following items describes the data collection for qualitative observation?
   a. Field notes
   b. Rating scale
   c. Tally sheet
   d. Time scale

10. Elissa's study describes the behaviors and interactions of kindergarten students with their peers. She uses observations to collect data primarily. Where should she collect the main data for her research?

    a. Children's home

    b. Outside of school

    c. In the school

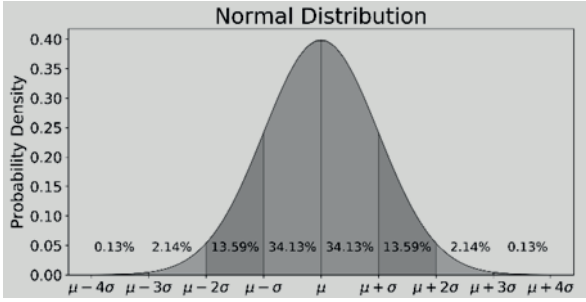
    d. Talking to teachers

CHAPTER 11

DATA ANALYSIS

- By the end of this chapter, students will be able to
  - o identify the types of statistical analysis techniques for a given data set.
  - o determine the analysis techniques for their intended research study.

Educational research is both a process and product to plan, design, and conduct the study and report the results. After a researcher identifies the research problem and objectives to study, the researcher needs to determine data collection procedures. The collected data should be organized, summarized, and data analysis should be carried out to answer and interpret research questions within the specific theoretical framework. Statistical methods are a set of procedures used to understand, classify, and interpret collected quantitative data. In quantitative data, information is given in numbers as test scores, anxiety scores, percentages, ratings or frequencies to represent the variables. Some characteristics may be represented as categorical variables such as ethnicity, gender or type of instruction to indicate the kind or type.



How can we describe the characteristics of data? What type of statistical terms do we need to know? First, a frequency distribution table or chart provides the number of possibilities for each category in a given set of data. Relative frequency describes the proportion of observations within a category to show on a chart or graph, and it is found through dividing number of

frequencies to total number of observations. Second, the distribution of a dataset can represent a normal curve in which the density increases around the mean and its frequency decreases in proportion to the number of deviations as you move away from the mean. Normal curve is symmetrical and bell-shaped to represent three measures of central tendency as mean, mode, and median. Mean means the arithmetic mean of the numerical data in the distribution; The median, on the other hand, represents the midpoint in the distribution when we sort the data obtained; and the mode represents the score obtained by the one with the highest frequency in the numerical data. In normal distribution, mean, median, and mode values are equal to each other and are collected in the middle of the distribution. However, the distribution becomes positively skewed when the mean is greater than the median and mode; and the distribution becomes negatively skewed when mean is smaller than median and mode.

Besides these three measures, the amount of distribution of values in a sequence has standard deviation as a measure of variation. Figure shows the distribution of data from mean to deviation from the mean. Standard deviation (σ) is defined by a set of numbers (x), mean or average of the set of numbers (mean), number or size of the set (n) with the following formula:

$$\sigma = \sqrt{\frac{\sum (x - \text{mean})^2}{n}}$$

Data is normally distributed and randomly selected, parameters are fixed, and parametric tests are used to analyze quantitative data through Pearson's correlation coefficient, t-test for means, analysis of variance (ANOVA), analysis of covariance (ANCOVA) etc. In some quantitative studies, the research question is interested in the relationship between two variables. Correlation coefficients are related to the degree or value of the relationship between two sets of scores which are either interval or ratio scales. Correlations do not imply causation. Correlations can be represented through scatter plot to decide the strength of association between -1 and 1 ($-1 \leq r \leq +1$); strength of the association depends on the linearity, outliers, and amount of data. The correlation coefficient can be calculated by each number in a set of data (x, y) and average values of each data set by using the following formula: Different correlation coefficients have different meanings: Coefficients less than 0.3 indicate weak correlation, coefficients between 0.7 and greater correlate strongly correlated, and coefficients between 0.3 and 0.7 indicate moderate correlation. If the correlation is positive, the variables increase or decrease in parallel. If the correlation is negative, one variable

increases while the other variable decreases. In statistical software such as SPSS, correlation values are defined as Pearson's Correlation Coefficient (r).

$$r = \frac{\sum(X-\overline{X})(Y-\overline{Y})}{\sqrt{\sum(X-\overline{X})^2}\sqrt{(Y-\overline{Y})^2}}$$

SPSS usually requires a probability value (or p-value) to support or reject the hypothesis. The smaller p-values supports the research hypothesis and rejects the null hypothesis. For example, a p-value of 0.0134 means that there is 1.34% chance that the results are random. This value defines the significance levels of the study to represent its probability to occur. Most commonly used significance levels in educational research are 0.1, 0.05, and 0.01 levels. In testing hypothesis, it is important to use one-tailed test of significance for directional hypothesis to represent one side of sampling distribution, and two-tailed test of significance for non-directional hypothesis to represent both sides of sampling distribution.

If the samples have different averages, independent t-test analysis is applied to determine whether the difference between them is significant. For example, significance of the instructional method can be assessed through selecting two random groups of sixth grades 15 students in each group who were taught through two different methods and applying the same achievement test at the end. If it is determined that the average of the sample using method A is greater than the average of the sample using method B, a difference can be obtained between two methods, but we need to test the significance level to understand the level of difference between two teaching methods. Moreover, paired sample t-test is applied when two related samples are compared to determine whether there is a significant difference between them. These two related samples can be pre- and post-test scores of a sample or two different treatments on a group.

"Analysis of variance (ANOVA)" is known as a more advanced form of the t-test. In ANOVA, it is investigated whether there are significant differences between the averages of more than two groups. Generally using it with three or more groups, the variation within and between each of the groups is statistically analyzed and the F-value is obtained. For example, a researcher may aim to investigate the effectiveness of four drugs to relieve colds (with 10 participants in each group) and state a research hypothesis as, "There is a significant difference between groups." Moreover, in a study, groups may be given a pretest related to dependent variable. Analysis of

Covariance (ANCOVA) analyzes a study with a pre-test based on the post-test average scores on the dependent variable for each group to compensate for the differences of the participant groups in the pre-test. The pretest is called the covariate. If two or more dependent variables are added in the same analysis, different from ANOVA and ANCOVA, multivariate analysis of variance (MANOVA) and multivariate analysis of covariance (MANCOVA) are used.

In addition to parametric tests, non-parametric statistics can be used that distribution of the population is unknown or a particular data is not fit to the normal distribution. There are different types of non-parametric statistics such as Spearman's rho, Wilcoxon test, Mann-Whitney U test, and Kruskal Wallis test. Spearman's rho calculates the relationship between two variables. Mann-Whitney U test is a non-parametric alternative to the t-test to analyze an ordered data. Kruskal-Wallis One-way analysis of variance is used when researchers have more than two independent groups to compare. In Mann-Whitney U test and Kruskal-Wallis One-way analysis of variance, data from participants in different groups are grouped and ordered as one group. Wilcoxon signed-rank test is used to test the difference between pre- and post-test data of a sample, and Wilcoxon signed sum test is used to test the difference between two independent groups.

Activity-1: The following scores were obtained by 25 pre-service science teachers from teaching methods course:

72	84	85	65	83
91	84	82	60	65
65	94	79	72	82
82	87	75	67	90
85	85	83	75	63

a. Construct a frequency distribution using an interval with of 5 and 60-64 as the score limits for the lowest interval. Include relative frequency and cumulative frequency in percentages.

b. Construct a histogram showing mean, mode, median, and standard deviation values.

a. What can you say about the shape of the distribution?

c. Would you say the test was easy or difficult? Why?

d. Suppose you scored 75. What percentage of students scored at or below you?

Activity-2: A Coffee Company welcomes its customers from 7:00 am-11:30 pm. The administration office interested in the occupation of its customers and asked a research agency to conduct a survey. A researcher surveyed 80 customers randomly at the coffee shop within a week. The survey asked the participants about their occupation. The following results were obtained:

Teacher	Worker	Electrician	Secretary	Doctor	Driver	Waiter	Doctor
Manager	Worker	Engineer	Police	Dentist	Writer	Soldier	Dentist
Accountant	Manager	Dentist	Police	Teacher	Writer	Police	Salesman
Salesman	Teacher	Doctor	Police	Salesman	Teacher	Photographer	Accountant
Teacher	Engineer	Electrician	Electrician	Architect	Accountant	Architect	Veterinarian
Teacher	Engineer	Carpenter	Carpenter	Engineer	Manager	Housewife	Nurse
Engineer	Architect	Pharmacist	Plumber	Veterinarian	Baker	Teacher	Electrician
Salesman	Doctor	Pharmacist	Pharmacist	Engineer	Nurse	Doctor	Teacher
Worker	Baker	Farmer	Receptionist	Journalist	Musician	Translator	Dancer
Dancer	Farmer	Journalist	Receptionist	Musician	Translator	Dancer	Teacher

a. Construct a frequency distribution of the data and show relative and cumulative frequency on a table.

b. Construct a chart or graph to show the distribution.

c. What is the most common occupation visiting the coffee shop in a day?

Activity-3: The data defines the three subject variables: HEIGHT (in centimeters), WEIGHT (in kilograms), and SEX (1 = male, 2 = female). When you create the variables, designate HEIGHT and WEIGHT as Scale measures and SEX as a Nominal measure (in the far-right column of the Variable View).

HEIGHT (cm)	WEIGHT (kg)	SEX
168	68	1
175	70	1
185	73	1
183	73	1
172	68	1
160	64	1
188	75	1
178	68	1
168	50	2
163	45	2
152	43	2
170	50	2
163	48	2
160	45	2
170	50	2
165	48	2

a. Calculate the mean for each of the three variables[3] (click Analyze, then Descriptive Statistics, then Descriptives).

b. Sketch three types of charts: Bar charts, Pie charts, and Histograms

Activity-4: A science teacher works with a group of students who have difficulty in understanding quantum mechanics. The science teacher uses students' previous exam scores and measures their anxiety by an inventory. The science teacher believes that the inventory score and previous exam score will help to develop new ways to guide students.

Individual	Exam Score	Anxiety Score
1	20	7
2	33	22
3	80	28
4	33	7
5	83	18
6	58	17
7	40	46
8	28	56
9	17	50
10	18	53
11	90	1
12	62	8
13	90	12
14	47	4
15	22	40
16	80	5
17	18	44
18	55	11
19	28	42

a. Present the descriptive analysis of exam and anxiety scores (mean, median, mode, minimum and maximum scores, variance, and standard deviation).

b. Calculate the correlation value from the formula and compare with a Pearson's coefficient of correlation computed via SPSS.

c. Please interpret the relationship between the exam and anxiety scores.

3 You may need to use SPSS Statistics.

Activity-5: I like sugar, but it makes me stressful because of diabetes. In this case, I want to see if sugar makes me stressful. So, my treatment is getting sugar via natural fruits to measure my stress level.

After the participants take the sugar and fruit, I measure the stress level via heart rate variability to get the following data.

Sugar	Fruit
33	13
51	19
25	22
46	24
42	16
37	19
35	15
30	12
28	13
35	16
37	13
40	20

Does the data provide evidence that fruit does, on average, reduce stress level?

Activity-6: A professional development program was conducted to improve the primary school teachers' knowledge of science topics. Data were collected from 20 participants before and after the professional development program.

Test the hypothesis that the program was effective to improve participants' knowledge of science concepts at p= .05.

ID	Pre-test	Post-test
1	63	77
2	69	88
3	76	90
4	78	95
5	80	96
6	89	96
7	90	102
8	92	104
9	103	110
10	112	115
11	73	103
12	74	104
13	76	107
14	84	108
15	84	110
16	86	110
17	92	113
18	95	114
19	103	118
20	115	120

Activity-7: A science teacher was interested in whether different instructional strategies lead to a more positive impact on students' learning. Students were split into four groups and then taken to a classroom to study electric circuits. The four groups saw: Hands-on activity, Simulation, Demonstration, Drama, and Traditional style. After the class, a post-test was taken by each group, and learning levels measured.

Test the hypothesis that some instructional strategies are more effective than others.

Hands-on	Simulation	Demonstration	Drama	Traditional
5	11	5	3	6
9	7	4	2	3
7	8	3	1	4
12	14	3	1	4
10	11	4	3	2
9	10	7	5	6
11	5	6	4	5
13	12	3	2	4
16	6	2	1	3
15	7	3	2	4

Activity-8: A primary school teacher wished to evaluate the effect of positive and negative reinforcement on students' completion of homework in a large classroom. A group of 30 students who do not wish to complete the homework were identified based on their previous records. They were then randomly assigned in equal numbers to one of three study groups: 1. Positive reinforcement when on time, 2. Negative reinforcement when late, 3. No reinforcement.

After a 12-week treatment period, data was collected on the number of being on time over an additional 12-week period. The data below presents the number of times for 12 weeks prior to the intervention and 12 weeks following termination of the treatment on completing homework.

Positive Reinforcement		Negative Reinforcement		No Reinforcement	
Pre	Post	Pre	Post	Pre	Post
4	2	4	4	4	4
5	3	5	4	4	3
5	2	6	4	4	3
6	3	7	6	5	4
7	2	7	5	7	8
8	4	8	6	7	9
8	2	9	7	8	7
9	2	9	8	9	7
10	4	10	8	9	10
11	6	11	7	6	7
12	5	10	5	10	8
8	3	7	4	10	9

Activity-9: A researcher explored pre-service mathematics teachers' internship experience with the following research question: What are beliefs of pre-service teachers in mathematics education about teaching internship in schools? Please read their responses to interview questions and analyze through developing codes and categories.

1. *Since students and teachers ignored me, I didn't want to stay there more. I was observing the same classes because I was there on the same days of the week. Thus, I couldn't observe different classes.*
2. *I learnt how slow learners think and I learnt how to design the lesson while considering these students.*
3. *My mentor teacher told me before my practice teaching that you should prepare advance questions because the level of the class is high.*
4. *I realized a student who is a slow learner, or the situation can be more serious, I don't know, while I was observing students. The teacher of class gave up taking on the student. I gave an exit card to the class, and I asked a basic question about the topic during my practice teaching. When I checked the students' answers, I saw that the student came up with a clever solution. I wasn't expecting it from him. I really like the solution.*
5. *I learnt that group activities are good for students' better learning, but I saw how a group activity can be effective in a real classroom. Students were engaged in the activity; they shared the task among the group members, and they express what they get at the end of the activity in a good way.*

Activity-10: A researcher explored mathematics teachers' perceptions toward question formats with the following research question: What are the differences between public school and private school mathematics teachers' perceptions toward question formats? They responded the following sample interview questions. Please read their responses to interview questions and analyze through developing codes and categories.

- Could you please talk about your experiences when you are solving multiple-choice/ open-ended questions?
- Do you think that solving multiple-choice / open-ended questions causes you to lose time?
- What is your strategy to find and organize information that is given in an open-ended question or multiple-choice question?

- How do you check correctness of the answers when you are solving an open-ended question or a multiple-choice question?
- Do you think studying a lot for the exam includes multiple-choice or open-ended questions?
- Do you feel any happiness, satisfactoriness, inability or regret from time to time when you are solving or using a multiple-choice or an open-ended question?
- How do you test effort when you are using multiple-choice or open-ended questions?

Mathematics Teachers at Private School:

Teacher C: "When students solve open-ended questions, they start question with the part they know better and continue to solver from there. Since open-ended questions are not focused on just outcome, they can continue the question as they want, or they can do how much they know. I believe that in open-ended questions they can reflect their conceptual knowledge and their thinking strategies better."

Teacher D: "They get correct and safe answer when they use multiple solution ways in multiple choice questions. Their self-confidence increases because they see they can do in different ways. They may not fall into distractor by the way because they can get the same result by solving in different ways. They can be surer about their answer."

Teacher D: "Open-ended question does not cause any disadvantages, I believe. It provides advantages for sure. They can learn topic well and gain self-confidence."

Teacher C: "I do not think that multiple-choice questions cause losing time. Even from time to time, it accelerates them. Because if there is something that students cannot figure out, options can be clue for them. They solve in shorter time than open-ended questions."

Teacher F: "We have two kinds of exams in our school. One affects their GPA and other type does not affect. When they take the one that affects their GPA, they tend to control. It depends the importance of the exam. However, they generally control."

Teacher D: "I think they cannot see their mistakes easily in multiple-choice questions. For example; the students mark an option by chance, and it is true. How s/he can see his/her mistakes. If h/she solve the question step by step, then s/he can see the mistakes. When we give feedbacks, they easily their mistakes and we explain all questions one by one."

Teacher C: "It is easier to see their mistakes in open-ended questions because solution way is on their hand. They did not just mark an option; they did all solution. All process is on their hand."

Teacher C: "When they see options, they can think about them and a movement of thought can happen. However, without options they must think and do reasoning. For some group of students both techniques are meaningless since they have no idea about topic. Therefore, it depends on students not options. If the students know strategies for multiple-choice questions, options can be useful, and they can feel comfortable. On the other hand, if students are not familiar with tests, then options do not mean anything. In any cases, if students do not know topic at all, options are meaningless again."

Teacher F: "No, I do not think that multiple-choice questions reflect students' knowledge truly since we cannot observe all steps and pieces. We cannot know in which stage student struggles with. Even s/he can do correct by chance. Therefore, it is the reason for that."

Teacher C: "I believe the effort is related the thing that you offer them in return. If it is grade or any kind of evaluation, they solve with full concentration. On the other hand, if it is a class activity or something that do not affect their grades, they consider it as less important and solve without attention."

Mathematics Teachers at Public Schools:

Teacher A: "In multiple-choice questions, students tend to go over options. They want to reach the result by using easiest way. Also, they sometimes mark the options without writing any operation, they do calculations in their mind. In open-ended questions we want to see all steps, but in multiple-choice questions they think that it is better not to write all calculations. That is the reason of doing much more mistakes in these questions. They can do calculation errors often, when they do operations in their mind or they can be confused without writing. These can happen often."

Teacher B: "One thing is in open-ended questions; students' mental process is taking an active role. They can reflect on paper what they know. Therefore, they can see which part is missing and which part is good in their learnings."

Teacher A: "Multiple-choice question is an advantage not disadvantages. They increase the possibility to do right. They can solve different questions. It is very good."

Teacher A: "Open-ended question is similar what I said in multiple-choice questions part. It widens students' horizon. Solving with multiple ways means that you understand topic well. I encourage my students to do that."

Teacher E: "The logic behind multiple-choice questions is to ask more questions, in a shorter time and reduce separated time for each question. However; I believe it depends on the question. It can cause losing time or not."

Teacher E: "They do not do control in every question. It depends on students, questions or hardness of the question. If the question is hard, then they feel the need to control."

Teacher E: "It depends on student to see their mistakes. Some of them can see, some not. However, the students who use different and multiple ways to solve problems can see their mistakes easily."

Teacher B: "Before every exam what is asked us by students is; "Teacher, is exam open-ended or multiple-choice?". All of them want exam to be multiple-choice because they plan to study less. Some of them thinks that "I can remember when I see options, so I do not have to study." It is not the same thing to study for a multiple-choice exam or for open-ended exam. When the exam is open-ended, the effort that is spent is more."

Teacher A: "Yes, students feel like they need to study harder for open-ended exams. Especially when we say the exam is open-ended, they feel that. However, when we say the exam is multiple-choice, they feel relax and happy. I think that it is their way to reflect they need to study more when the exam is open-ended."

Teacher B: "Multiple-choice questions seem easier to students. They think that they have advantage in multiple-choice questions because they believe they will remember by using options."

Teacher B: "Actually, without options students feel insecure. With options on the contrary, they are extremely relaxed since they think correct answer is one of the options."

QUIZ:

1. Qualitative research studies require researchers to do which one of the following items during the data analysis?
   a. Construct a tentative hypothesis.
   b. Research to collect in-depth information.
   c. Meet the participants once.
   d. Spend short amount of time to collect data.

2. Data analysis of qualitative data can be conducted through:
   a. deductive methods.
   b. inductive methods.
   c. subjective methods.
   d. objective methods.

3. Data analysis of quantitative data can be conducted through:
   a. deductive methods.
   b. inductive methods.
   c. subjective methods.
   d. objective methods.

4. Two researchers analyzed the same data. Their results showed that they explained the research question in different ways. Which characteristic of a qualitative research is emphasized in this situation?
   a. Qualitative research is closed-ended.
   b. Qualitative research is reliable.
   c. Qualitative research is deductive.
   d. Qualitative research is inductive.

5. I. Can I answer the research questions with evidence-based conclusions?
   II. Did I prove the hypothesis?
   III. Do I eliminate personal bias during the data collection?
   IV. Can I use a valid test?
   Which one of the above questions are appropriate for qualitative data analysis?
   a. I-II
   b. I-III
   c. I-IV
   d. II-IV

6. I. Can I answer the research questions with evidence-based conclusions?

   II. Did I prove the hypothesis?

   III. Do I eliminate personal bias during the data collection?

   IV. Can I use a valid test?

   Which one of the above questions are appropriate for quantitative data analysis?

   a. I-II

   b. I-III

   c. I-IV

   d. II-IV

7. The *t* test for independent samples is when:

   a. The formation of the two groups is random.

   b. The dependent variable exists to form the two groups.

   c. The continuous treatment occurs.

   d. There is a pre-post design for two groups.

8. Robert measures significant differences between students' math anxiety scores and two math instructional strategy. Should he reject the the null hypothesis that the groups are different based on the strategy. Robert should then

   a. Reject, use a non-parametric test.

   b. Reject, use a two-tailed test.

   c. Not Reject, use a one-tailed test.

   d. Not Reject, use analysis of variance.

9. A teacher educator is testing whether her professional development improved teachers' motivation to teach through inquiry. The teacher uses a rating scale before and after the intervention to find out whether the intervention is effective. Which analysis should the teacher use?

   a. independent t-test

   b. dependent t-test

   c. ANCOVA

   d. ANOVA

10. Kameron uses a self-confidence scale before and after intervention on physical education. After the intervention, Kameron assesses students' self-confidence. He uses alpha at $p = .01$, and reports that there were significant findings in the study. Which statistical analysis was appropriate for Kameron to use to determine if there were treatment differences in her study?

    a. Pearson r

    b. ANOVA

    c. Spearman rho

    d. *t* test

ETHICAL CONSIDERATIONS

- By the end of the study, students will be able to
  - o recognize the ethical issues in educational research.
  - o explain the role of institutional review boards (IRB) to protect the participants from possible problems in research study.
  - o prepare a research plan and proposal for their intended study.

Researchers need to propose a plan to investigate a research problem for qualitative, quantitative, or mixed methods methodologies. Mills and Gay (2016) stated, "The research report should be written in a clear, simple, straightforward style that reflects scholarship" (p. 585). These proposals generally include an introduction about the general overview, purpose, research questions of the study, review of literature, research design including methods, sampling strategies, data collection and analysis methods. If we write the whole report of the research, there will be results, discussion, and references sections. The proposal should also include the ethical considerations, significant contribution to the literature, timeline and funding opportunities for the proposed study.

In the previous chapters, we discussed how to identify and select participants for a study. Before the sampling and data collection procedures, a researcher should get the necessary permissions from the institutions to conduct the study. These institutions require review board approval to review and approve the research that protects the participants from harm, asks for voluntary and informed participation, keeps the participants' data confidentially, and establishes the honesty among colleagues.

A researcher should learn the process of obtaining approval from the institutional review board on his/her college campus or institution. There are some basic steps for both researchers and PhD students need to complete to get the approval for their research work. Each institution has their own institutional review board (IRB) and requires some documents about the design of the project including sampling and data collection procedures.

The document should discuss the potential risks that may be encountered through that study; most boards require minimal or no risk to protect humans from harm. The informed consent form includes information about the possible benefits and harms of the study, the conditions for participation of the participants in the study, and their rights in the study. The sections in the informed consent form are as follows:

- Research purpose.
- Requirements to participate in the study.
- Voluntary participation is required.
- Potential risks and benefits of the study.
- Any participant data is kept confidential and anonymous.
- Contact information of the researcher to be contact to ask questions or concerns.
- Section for participant's signature and date of appointment to agree to participate in the study.

Confidentiality is important in educational research to respect participants' right to privacy. Participants' name, personal information should be hidden and given codes or pseudonyms while data from interviews are provided to address the research questions. The data should be protected in closed cabinets or protected internet accounts to keep the research data confidential for the protection of participants. During the collaborative research process, data can be shared with other researchers safely. Another important aspect of doing research is writing its results to communicate with other researchers. While writing, researchers use the results of other published literature and discuss the strengths and weaknesses of their findings. Writing process requires authors to acknowledge the work of others through citations without making plagiarism. Authors should acknowledge the others' work, thoughts, ideas or words to establish the ethical standards.

QUIZ:

1. Institutional Review Board approval is important for researchers to
   a. Protect the personal privacy of participants
   b. Make observations
   c. Randomly select the participants
   d. Design the research plan

2. A researcher is conducting a study at a community college with adults on the use of foreign language. If she asks whether she needs to get IRB approval, what would you say to the researcher?

   a. IRB does not require anonymity of participants.

   b. IRB requires the protection of personal privacy.

   c. IRB is not required to collect data via a rating scale.

   d. IRB is required to get permission from parents.

3. Please define why anonymity is important and how anonymity can be established in educational research.

4. During an ethnographic study, what ethical considerations should not be followed:

   a. Not using the real names of the participants

   b. Not using the real name of the University that the study was conducted.

   c. Not giving the informed consent form to the participants

   d. Not creating a safe environment for the participants

5. A doctoral student in mathematics education generally conducts research in a middle or high school. In conducting research, what should the researcher do first?

   a. Get the permission from parents through a consent form.

   b. Get the permission from the formal institutions to enter the school.

   c. Get the permission from the director of the school to enter the classrooms.

   d. Get the permission from the teachers to observe the classrooms.

6. Sarah was a doctoral student and aimed to study eighth grade students' perceptions of high school. Although most students agreed to participate in the study, their parents did not provide their informed consent for the study. Sarah considered students' interest and interviewed with all students in the target school. She promised that all data would be anonymous. What can one conclude about Sarah's research process?

   a. It was ethical to include all students since they were interested in.

   b. It was ethical to include all students since students were at school and safe.

   c. It was unethical to include students since that parents did not give permission.

   d. It was unethical to include students since the interviews were conducted anonymously.

7. Participants of a study is described in which part of a research proposal?

   a. Introduction

   b. Results

   c. Methods

   d. Literature review

8. The literature includes a lot of published research on a given topic. When you would like to compare your research findings with the existing literature, in which part of your paper should it be included?

   a. Introduction

   b. Results

   c. Methods

   d. Discussion

9. What is the role of informed consent form in the process of research?

10. Please explore the process of obtaining Institutional Review Board approval in your institution.

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