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Research Data Analysis Methods in Addressing the K-12 Learning Competency on Data Analysis Procedures among Senior High School Research Courses

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Abstract

The purpose of the research process is to benefit human life in various ways. It is important to consider how research methods are taught; equipping students with these research literacy skills leading to increased research output by an individual, particularly when it comes to the preliminary steps in planning data analysis procedures. It also provides the initiative in K-12 learning on research methods by assisting students in developing and retaining research skills and addressing the K-12 learning competency on data analysis procedures. As data analysis is viewed as the most complex and mysterious phase of a research project, scientific analysis requires an analytical systematic method that collects a large number of data points and is then evaluated to draw a reliable and relevant conclusion. To obtain valid results, data must be handled correctly from the time of collection through to the analysis stage. In this case, this article aimed to provide preliminary research data analysis methods, both in quantitative and qualitative researches for senior high school students. There are a variety of methods that may be utilized to analyze data. Data analysis needs carefully planning, regardless of whether the approach is to be based on qualitative or quantitative techniques.

Keywords: Learning competency, Methods, Research data analysis, Senior high school research courses.

Introduction

Research education and the adoption of uniform formats of scientific writing promotes evidence-based practice by improving information awareness, seeking, and eventual application of new practices as it promotes the uniform conduction, interpretation, and response to research findings reported using familiar standard formats of scientific writing (Aravamudhan & Frantsve-Hawley, 2009; Jerusalem et al., 2017; Tabuena, 2020a). In the emergence of the K-12 curriculum, the students should develop critical thinking and problem-solving skills through research, and one of the performance standards is that the learners should be able to plan data analysis procedures. The teaching of research methods has received a limited amount of attention (Earley, 2014; Wagner et al., 2011). Much of the institutions teaching on research methods focus more on knowledge transfer while giving little or no attention to context and application of the acquired knowledge (Wagner et al., 2011; Gal & Ginsburg, 1994). In this case, this research article takes initiative in research education to help the students in establishing and maintaining the research skills in planning, preparing and writing the data analysis procedures as one of the K-12 learning competencies among senior high school research courses in the research writing process (Tabuena, 2020b).

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Scientific research requires a systematic process that focuses on obtaining a variety of information for review so that the researcher can come to a credible and relevant conclusion. A set of shared information, statistics, or measurements that can be processed is called data. Data is important whenever we perform experiments or studies. Processing the data produces project outcomes that can be used to make decisions. Without a doubt, data analysis is the most complex and enigmatic of all research phases, and the one that receives the least discussed in the article. You need to understand how data are obtained in order to understand the way findings will be analyzed.

Types of Data

Two types of data are observed; respectively, primary data and secondary data. Primary data were obtained by the researcher himself. Those are the author's notes or initial quotations. Data can be obtained via the following: (a) direct observation or measurement, (b) interview and observable data, (c) mass mailing

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of recording forms (via ordinary and special mails, courier services, email, and fax to reach out to distant data providers), (d) experimentation (to find out a cause and effect of a certain phenomenon) and (e) registration (registry of births, deaths, marriages). The latter is regulated by such rules, on the other hand, secondary data are knowledge taken from published or unpublished materials previously gathered by other researchers or agencies such as books, newspapers, magazines, journals, published or unpublished thesis and dissertations, and others in the form of documentaries, clips, films, and other multimedia formats. Primary data collection should be conducted as fully, effectively, and reliably as possible (Ymas Jr. et al., 2003).

Data Quality

Data quality is characterized as the totality of features and characteristics of the data that affect its ability to satisfy the needs of the intended use of data. High-quality data provide complete evidence for correct decision-making and planning. Some parameters were used to identify good results, which were then organized into different categories (Wang et al., 1994): (a) access security: data must be limited and kept safe to avoid unauthorized access and ensure confidentiality and the preservation of civil liberties; (b) data must be readily available or usable; (c) accuracy: data should be correctly presented; (d) the correct amount of data: data should be trusted because it is real and reliable; (e) data must be adequate in width, scope and breadth; (f) the presentation of data must be simple; (g) focus on important points: data must be clear; (h) data must be interpreted within the required units and language; (i) objectivity: data must be impartial; the importance of the data is to the current mission; (j) indicates the data is presented in an ordered and consistent manner; data must come from a reliable source; (k) data must be recorded quickly and used as soon as possible, and (l) data must have value in useful to the study.

There are different characteristics that are associated with high-quality data. The required attributes and a reasonable level of these attributes vary depending on the research situation and environment. It is also important to remember that these attributes are all interconnected. Data that arrives too late, or takes too long to collect, will no longer be important. Data must be interpretable and thus language and units must be understandable.

Ensuring Quality Data

To ensure reliable data, data must be handled during its entire collection, processing, and review phases correctly. The data first must be retrieved and reported correctly on the desired survey or questionnaire. Errors and defective recording must be prevented. To ensure accurate measurements and responses, it is crucial to maintain good relationships with researchers; these way participants are more likely to provide credible responses. It is imperative that data be obtained by residents familiar with the culture and language of the sample population. In order to ensure correct answers, it is also critical that the person conducting the interview undergo adequate cultural sensitivity training, and have legible handwriting and an accurate recording of responses. The data needs to be checked and analyzed for accuracy (Van den Broeck et al., 2007).

Data Analysis

A variety of methods may be used to analyze data. The method of data research differs according to the approach to be taken – quantitative or qualitative. Quantitative information is provided in tables and maps, although this information provides both qualitative and quantitative perspectives. Any technique can be used manually or by using an automated program. There are several statistical packages available, such as Microsoft Excel, which can be used for succinct and streamlined analyses.

On the other hand, statistical techniques are used to give meaning to the data gathered from the subjects. In this sense, you will be dealing with the general analysis of data according to your research design to the data gathering procedure. There are three different types of data analysis: univariate, bivariate, and multivariate. There are three general types of data analysis, you might be using qualitative or quantitative data analysis if you used mixed methods research designs. For qualitative data analysis, we have ethnographic data analysis, grounded theory data analysis, phenomenological data analysis, constant comparative method analysis, or language-based data analysis (content analysis, discourse analysis, narrative analysis). You may use other data analysis based on the nature of your research study: normative analysis (arithmetic mean and standard deviation), descriptive analysis, status analysis, classification of analysis, evaluate analysis, comparative analysis, and/or cost-effective analysis.

Quantitative Data Analysis

Quantitative data analysis, a prolific method of study, as it stems from positivism. It can be used for analysis with long- and short-term studies, as well as case studies, action research, correlational research, and experiments. Quantitative data analysis is based on numeric values while data collection generates numerical values on a scale. The study would use charts and

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statistics and could be facilitated by the identification of variables.

Scales of Data

In order to understand the range of data analysis one needs to be able to tell the difference between the different numbers. This brings us to the widely reported issue of scales or levels of data, and four are listed, each of which, in the order given below, subsumes its predecessor (Cohen, et al., 2007).

Nominal Scale. The nominal scale literally denotes divisions in such a way that there is a 1 for males and a 2 for females. The categories are statistically distinct and have little meaning. Consider numbers on a football shirt: they cannot be said to be double as anything as 2, or half as anything as 8; the number 4 merely defines a group, and, indeed nominal data are often called categorical data. The data classify but have no order. Data about the subject studied, including gender, age group, subject taught, type of education, socio-economic status. Nominal data denote discrete variables, categories that are distinct from each other, e.g. according to females they are category number 1 and for males, they are category number 2 (there cannot be a 1.25 or a 1.99 position).

Ordinal Scale. The ordinal scale not only orders the data but also classifies it. Scoring scales can have division scores like "strongly agree" versus "agree" or "very great deal" versus "very little". To determine the order, it is possible to position objects in a way, weakest to strongest, smallest to largest, lowest to greatest, least to most, and so on, but there is no metric – a calculation using equal intervals. Therefore, one cannot conclude that the distance between each point on a rating scale is equal: at certain points on the scale, the distance between each point is not the same. One does not say, for example, that, in a 5-point rating scale (1 = strongly disagree; 2 = disagree; 3 = neither agree nor disagree; 4 = agree; 5 = strongly agree) point 4 is in twice as much agreement as point 2, or that point 1 is in five times more disagreement than point 5. However, one could position them in order: 'not at all', 'very little', 'a little', 'quite a lot', 'a very great deal', or 'strongly agree', 'disagree', 'neither agree nor disagree', 'agree', 'strongly agree', i.e. it is possible to rate the data according to rules of 'lesser than' or 'greater than', concerning whatever the scale is used. Ordinal data is used in rating scales and surveys (opinions and attitudes) and contains elements such as ratings and rankings.

Interval Scale. The interval scale involves a metric—a standard and equivalent interval between each data point—as well as retaining the classification and order function of the prior scale. This lets us know at exactly what distances to locate the people, objects, or events under consideration (Cohen & Holliday, 1996). Due to the equivalent intervals between and data point, data calculated on equal-interval scales are often called interval level data (e.g. the distance between 3 degrees Celsius and 4 degrees Celsius is the same as the distance between 98 degrees Celsius and 99 degrees Celsius). However, in interval results, zero is not a true value. Let us analyze two cases. Because the freezing point of water is 32 degrees Fahrenheit, and the freezing point of water is not zero, it is not possible to conclude that 100 degrees Fahrenheit is twice as hot as 50 degrees Fahrenheit, since the calculation of Fahrenheit did not start at zero. In fact, at 68 degrees Fahrenheit, it is twice as hot as 50 degrees Fahrenheit. For example, many IQ tests start at the 70th point, which is the lowest possible score. We cannot assume that a person with an IQ of 150 has twice the measured intelligence as a person with an IQ of 110 since the starting point is 70; a person with an IQ of 150 has twice the measured intelligence as a person with an IQ of 70 since one has to deduct the original starting point of 70 ($\{110 - 70\} \div 2$). Unfortunately, in reality, the interval scale is rarely used, and figures measured on this scale are the same as those calculated on the ratio scale.

Ratio Scale. The ratio scale embraces the main features of the previous three scales – classification, order, and an equal interval metric – but adds a fourth, powerful feature: a true zero. This enables the researcher to determine proportions easily – 'twice as many as', 'half as many as', 'three times the amount of', and so on. Because there is an absolute zero, all of the arithmetical processes of addition, subtraction, multiplication, and division are possible. Measures of distance, money in the bank, population, time spent on homework, years teaching, income, Celsius temperature, marks on a test, and so on are all ratio measures as they are capable of having a 'true' zero quantity. If I have one thousand pesos in the bank then it is twice as much as if I had five hundred pesos in the bank; if I score 90 percent in an examination then it is twice as many as if I had scored 45 percent. The opportunity to use ratios and all four arithmetical processes renders this the most powerful level of data. Interval and ratio data are continuous variables that can take on any value within a particular, given range. Interval and ratio data typically use more powerful statistics than nominal and ordinal data.

Designing Tables and Charts (Diagrams)

In order to get an understanding of the method of data collection and data analysis, table design is an excellent way to imagine and familiarize oneself with collected or gathered data. In designing tables, follow the instructions as

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detailed: (a) requires a simple, descriptive title, (b) needs clearly defined units of measurement, (c) clearly stated source(s) of data, (d) notes to clarify abbreviations and uncommon terms, (e) states the size of the sample on which the values in the table are based, (f) specific column and row headings, and (g) columns and rows logically sequenced.

For charts, the same guidelines are applied in designing tables with the following additional directions: (a) needs clear axis labels, (b) bars logically sequenced, (c) judicious use of color and shading, and (d) legend used where appropriate. Observe and analyze the sample table below, Face and Content Validity of the Philippine Music Achievement Test by the Validators (Tabuena, 2020c):

Table 1. *Sample Table for Designing Tables and Charts*

Indicators	Weighted Mean	Interpretation
Format and Design	4.47	Very Acceptable
Objective	4.40	Very Acceptable
Content	4.50	Very Acceptable
Language	4.47	Very Acceptable
General Weighted Mean	4.46	Very Acceptable

General Types of Data Analysis

There are three different general types of data analysis: (a) univariate analysis - is a test of a single variable to determine whether the sample is similar to the population from which it has been drawn; (b) bivariate analysis - is a test of two variables on how they differ with each other (statistical tools i.e., correlation coefficient, z-test, and t-test); and (c) multivariate analysis - is a test of three or more independent variables at a time on the degree of relationship with the dependent variable. Below is a sample presentation, analysis, and interpretation for univariate analysis:

Table 2. *Sample Presentation, Analysis, and Interpretation for Univariate Analysis*

Levels of Colleges	Weighted Mean	Descriptive Interpretation
1	3.6	Very Adequate
2	3.4	Adequate
3	2.9	Adequate
4	2.8	Adequate

Table 2 shows a sample presentation of data on the adequacy of instructional materials at the level of colleges. In this case, the following is an illustrative analysis and interpretation of the aforementioned table:

"The table shows the adequacy of instructional materials at the level of colleges. Level 1 college obtained a weighted mean of 3.6 interpreted as very adequate; level 2, obtained a weighted mean of 3.4 interpreted as adequate); level 3 obtained a weighted mean of 2.9 interpreted as adequate; and level 4 obtained a weighted mean of 2.8 interpreted as adequate. Based on the foregoing results as shown in the table, the instructional materials of the different levels of colleges in certain regions as perceived by the Mathematics professors ranged from adequate to very adequate; thus the null hypothesis is rejected."

Qualitative Data Analysis

In comparison with quantitative data analysis, which is focused on quantifiable meanings expressed through words, qualitative data analysis is based on meaning expressed through language (conceptualization). Qualitative data analysis includes arranging, accounting for, and describing data; in short, making sense of data in terms of participants' meanings of the case, noting trends and themes (patterns), categories, and regularities. Having a database (a compilation of information such that it can be conveniently accessed, maintained, and updated) is not sufficient to perform a qualitative analysis. In order to achieve results that will turn raw data into new information, a qualitative researcher must effectively participate in all stages of the research process. The understanding of these processes is an important part of reading, understanding, and interpreting qualitative research.

Qualitative data is obtained in a number of ways. In most qualitative studies, a database consists of a series of interview transcripts generated through the process of open-ended, oriented, and exploratory interviews. However, there is no limit of what could constitute a qualitative archive, and increasingly we are making more inventive use of such sources as documented findings (both video and participatory), focus groups [discussion], texts and papers, multi-media or public domain sources, policy manuals, photos, and lay autobiographical accounts.

Transcribing Interviews

Researchers may have to discover some data and turn it into a collection of data findings, often called themes, grouped according to the research problem and purpose. In certain cases, the study does not require systematic trials, but it can

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prove helpful in organizing and presenting the findings. One strategy for qualitative analysis is to keep notes of the data (to transcribe the interviews). The following are the best methods for conducting interviews. (a) ensure transcription encourages preferred research process, (b) use precise interviewer/interviewee identifiers, (c) include interview questions in the transcript, (d) save each interview as a separate file, (e) ensure privacy (anonymity) and confidentiality concerns are preserved, (f) ensure the transcript is correct, and (g) ensure a backup copy is produced.

Quantifying Qualitative Research

Qualitative research produces useful data that offers insights into the broader subject field; it is important because it generates data that can provide in-depth insight into a question or topic. However, to draw conclusions from qualitative data, it is essential to quantify the data. Quantitative analysis of qualitative data involves turning the data from words or images into numbers. This can be done by coding ethnographic or other data and looking for emerging patterns (Green, 2001). If qualitative data is in the form of responses to standardized questionnaire surveys (structured surveys), this data may also be quantified. Simple statistical measurements such as frequencies and relationships between variables can be calculated either manually, or by using qualitative software or tools. For example, a researcher studying smoking habits utilized a frequency table to describe the smoking that occurred in specific contexts or a time-lapse video in which participants smoked cigarettes in the sense of specific activities. The definitions of these "contexts" were derived from interview data generated from in-depth interviews with youth. There are three main steps to conducting a quantitative analysis of qualitative data: (a) organizing the data, (b) reading and coding it, and (c) presenting and interpreting it.

*Organize Data.*First, the data should be organized. The data may be grouped into logical classes since they pertain to various areas of interest. For example, a study on tobacco farmers might contain information on the history of tobacco farming, the effect of other crops, the role of women on tobacco farming, the reasons for tobacco farming, and its environmental consequences.

*Reading and Coding.*The next step is to carefully read all of the data and create a category structure that will allow all of the data to be classified in a logical order. All in a category must be related in some way, and the distinctions between categories must be straightforward and clear. When a large volume of data does not fit into the category structure, it typically implies a defect that necessitates the system's reorganization. All data in good qualitative research should be classified, and every effort should be made to ensure that each section fits into just one category. Finally, the classification system should be useful and pertinent to the analysis. Once a framework for organizing the data has been developed, each category should be given a number, and transcriptions of interviews or survey results should be coded.

*Data Presentation and Interpretation.*Data should be presented and ordered after it has been coded so that it can be understood. Simple matrices or charts are commonly used to compile interview data in order to identify trends or patterns among respondents. In addition to causal network diagrams and flow charts, causal network diagrams and flow charts are commonly used to determine the cause and effect of relationships that appear in data. In qualitative research, data coding and interpretation vary from study to study and are based on the research design as well as the researcher's ability and experience. It is always appropriate to record how the data was coded and interpreted, as well as to measure it in order to draw conclusions, regardless of the analysis.

Methodological Tools for Analyzing Qualitative Data

For analyzing qualitative data, there are several procedural tools available. Analytic induction, constant comparison, typological analysis, and enumeration, according to LeCompte and Preissle (1993), are useful methods for qualitative researchers to use in data analysis.

Analytic Induction. Data is scanned to produce categories of phenomena, relationships between these categories are searched, and working typologies and summaries based on the data examined are written. Negative and discrepant cases are intentionally tried to alter, enlarge, or limit the initial interpretation or hypothesis, which is then refined by subsequent cases and studies.

*Constant Comparison.*The researcher will compare newly acquired data with existing data, categorize data, and hypotheses and establish a perfect match between these and existing data. As a consequence, negative cases or data that contradict current categories or hypotheses cause them to be changed before they can completely handle all of the data.

Constant comparison is made when taking notes from the data obtained, which is the core of the Grounded Theory process (Dick, 2005; Bugday, 2012). Theory emerges from this comparative study. The researcher(s) equate the initial data to the theory, and the comparison results are written in the margins of the notes as

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codes. Certain theoretical propositions will arise as you code. Coding is one of the phases in Grounded Theory as divided into three stages: (a) open coding to reduce the data to a small collection of themes that explain the phenomenon under investigation; (b) axial coding to relate the codes to each other, through the combination of inductive and deductive thinking; and (c) selective coding to select a single category and relate all other categories to that category.

In the constant comparison process of qualitative analysis, a constant comparison is made as the compilation and coding of data occurs. This analytical approach consists of four stages (Glaser & Strauss, 1967, Glaser, 1978): (a) Stage 1: Comparing incidents related to each category – coding each incident with as many possible categories as possible as categories emerge or as data emerge that match existing categories; (b) Stage 2: Incorporate categories and their properties, as this process starts in a small way, memos and potential conferences are short; but as coding progresses, the constant comparison units shift from comparison of incidents with an incident to comparison of an incident with properties of the category that results from initial comparisons of incidents; (c) Stage 3: Delimiting the theory, as the theory evolves, the different delimiting features of the constant comparative approach begin to regulate what might otherwise become a daunting challenge; and (d) Stage 4: Analysis/anecdote writing (e.g. theory writing) in which the researcher owns the coded data, memos, and a theory.

*Typological Analysis.*It is a system in which data are grouped into subsections, groups, or subsets based on some specific criterion (e.g. acts, meanings, nature of participation, relationships, activities). Typologies are a way to describe a number of phenomena under a broader definition or category (Loflfland 1970). In categorizing participants, the researcher must deliberately gather all the data about their responses.

*Enumeration.*The method of finding the number of different combinations of codes, units of study, concepts, sentences, or ideas. It enables customers to record their transactions, and conduct statistical studies of how frequent the purchases are. This is the framework used for content analysis by traditional methods.

Conclusion

There are a number of approaches that can be used for analysis. Data analysis requires thorough preparation based merely on whether the findings are to be qualitative or quantitative. Statistical methods are used in order to assign meaningful significance to the data obtained from the study subjects. One may be contemplating the analysis of data, depending on the study design and data collection process. There are three fundamentally different types of quantitative data analysis: univariate, bivariate, and multivariate analysis. For qualitative data analysis, we have ethnographic data analysis, grounded theory data analysis, phenomenological data analysis, constant comparative method analysis, or language-based data analysis (content analysis, discourse analysis, narrative analysis). On the other hand, there are several procedural tools such as analytic induction, constant comparison, typological analysis, and enumeration as valuable techniques to use in analyzing data.

The importance of research in developing recommendations to direct social and economic policies is becoming more commonly known these days; these guidelines can differ in style or material, but they all require a rigorous review of any approach to a problem using the scientific method in order to assess the best evidence-based solution for action at the time (Mason et al., 1999; Tabuena, 2021a; Tabuena, 2021b). Involvement in research activities enhances students' links to the school they are enrolled in; thus, academic institutions must enhance such activities for retention purposes (Baker, 2008; Correa et al., 2015). In this situation, society expects universities and institutions to be at the forefront of both teaching and science, contributing to a slew of policy recommendations and programs to encourage research and innovation (Oriokot et al., 2011); as these preliminary research data analysis methods might help students in planning data analysis procedures among senior high school courses in the research writing process.

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