

Dr. Sri Yuliani, M.Pd.
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EDUCATIONAL RESEARCH STATISTICS

Completed With SPSS Analysis



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To support the curriculum at the Faculty of Education and Teacher Training, this book, "Educational Research Statistics (Complete with SPSS Analysis)," has been compiled by us as the primary reference material for students in the expertise courses in the study program. This book is structured in such a way as to complement the references and reading resources for students taking the Educational Research Statistics course. The book is divided into eight sections, each of which explains statistics used in educational research for higher education. This book is generally structured using descriptive and inferential statistics commonly used in educational research.

The author hopes that this book, despite its limitations, will be beneficial to readers, especially education and teacher training students, and can serve as a reference source for other related courses. Finally, the author would like to express his gratitude to all those who have provided support, both directly and indirectly, in encouraging and completing this writing. Furthermore, he would like to express his special gratitude to his wife and children for their invaluable support in completing this book.

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FOREWORD

Assalamualaikum Wr. Wbr.

On this auspicious and happy occasion, I would like to express my infinite gratitude to Allah SWT for all His countless blessings and grace, enabling me to complete this book. I also extend my endless prayers and greetings to the Prophet Muhammad (peace be upon him).

To support the curriculum at the Faculty of Education and Teacher Training, this book, "**Educational Research Statistics (Complete with SPSS Analysis)**," has been compiled by us as the primary reference material for students in the expertise courses in the study program. This book is structured in such a way as to complement the references and reading resources for students taking the Educational Research Statistics course. The book is divided into eight sections, each of which explains statistics used in educational research for higher education. This book is generally structured using descriptive and inferential statistics commonly used in educational research.

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Thus concludes this foreword. May it receive the blessings of Allah SWT and prove useful. Regards.

Pekanbaru, January 2026

Author

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CHAPTER 01

INTRODUCTION

Basic Competence

Students are able to explain the meaning of statistics, its role in research, statistics in education and institutions related to statistics in Indonesia.

Indicators

- 1) Students are able to explain the institutions related to statistics.
- 2) Students are able to explain the meaning of statistics.
- 3) Students are able to explain the role of statistics in research.
- 4) Students are able to explain statistics and its relationship to education.

A. Introduction of Statistics

SPEAKING of statistics, every morning, mass media, both print and non-print, presents readers, listeners, and viewers with statistical information on a variety of topics, from economics and social issues to law and politics and education; from cinema to sports; from food and drink to medicine; from public opinion to social behavior; this information informs decisions in our personal lives and enables us to fulfill our responsibilities as citizens. In the

workplace, we may be confronted with quantitative information about budgets, inventories, manufacturing specifications, market demand, sales forecasts, or workloads. Teachers are confronted with educational statistics regarding student performance or their own accountability. Health scientists must understand the statistical results of experiments used to test the effectiveness and safety of drugs. Law enforcement professionals rely on statistics related to crime and delinquency. When considering job changes or moving to another field, our decisions can be informed by statistics on the cost of living, crime rates, and the quality of education, among other things.

The validity of the various data collected must be maintained. Collecting data requires a process closely related to statistical principles. Following statistical principles will produce quality data, namely data that is valid, accurate, and reliable. It's okay for data to differ. This will cause problems if the concept is unclear and the methodology is not explained. The data presented can be the result of surveys and data collection conducted by individuals, groups, or institutions, both government and private. One of the institutions producing national data in Indonesia is the Central Statistics Agency (BPS).

The Central Statistics Agency (BPS) itself is a non-ministerial government institution directly responsible to the President. Previously, BPS was the Central Bureau of Statistics, established under Law Number 6 of 1960 concerning the Census and Law Number 7 of 1960 concerning Statistics. Law Number 16 of 1997 concerning Statistics replaced these two laws. Based on this law, followed by subsequent regulations, the Central Bureau of Statistics was formally renamed the Central Statistics Agency. The duties, functions, and authorities of BPS are stipulated in Presidential Regulation Number 86 of 2007 concerning the Central Statistics Agency and Regulation of the Head of the Central Statistics Agency Number 7 of 2008 concerning the Organization and Work Procedures of the Central Statistics Agency.

The functions of BPS include: 1) Reviewing, formulating, and formulating statistical policies; 2) Coordinating national and regional statistical activities; 3) Establishing and administering basic statistics; 4) Establishing a national statistical system; 5) Guidance and facilitation of statistical activities by government agencies; and 6) Providing guidance and general administrative services in the areas of general planning, administration, organization and management, personnel, finance, archiving, public relations, legal affairs, equipment, and household affairs. BPS's authority includes: 1) Preparing macro-scale national plans within its field; 2) Formulating policies within its field to support macro-scale development; 3) Establishing information systems within its field; 4) Establishing and administering national statistics; 5) Formulating and implementing specific policies within the statistical activity field; and Preparing guidelines for conducting sectoral statistical surveys.

When discussing statistics, it is important to remember that statistics can be wrong, but they should not be used to deceive. While some data should be infallible, or have zero error, most statistical data contains errors. This error rate is inherent in statistical methods and must be managed. Common error rates are 1%, 5%, or 10%. However, if the data produced and presented is unsubstantiated or obtained using unclear methods, this can lead to deception, or the presentation of the data may be based on the request or interests of certain parties. Certain forms of deception in data collection, presentation, and publication should be avoided, as they constitute moral hazard. Therefore, statistical data collected and presented for various purposes should be fundamental and truthful.

B. Definition of Statistics

According to the Cambridge Dictionary, statistics (statistics) are numbers that provide information about a particular situation or event, such as crime statistics, employment or labor economics,

government statistics, labor markets, and others. Furthermore, statistics can also be defined as the science of collecting and studying numbers that provide information about a particular situation or event. Meanwhile, according to Shafer and Zhang (2012; 9), statistics is a collection of methods for collecting, displaying, analyzing, and drawing conclusions from data.

Overall, according to David M. Lane (2013), statistics are more than just facts and figures; they are more than that. Broadly speaking, "statistics" refers to a range of techniques and procedures for analyzing, interpreting, displaying, and making decisions based on data. Meanwhile, according to Sudjana (2004; 2-3), statistics is the knowledge related to the methods of collecting, processing, and making sound decisions based on the facts and analysis performed. Statistics is used to explain a collection of facts, generally in the form of numbers arranged in tables or diagrams that illustrate or depict a problem.

Simply put, statistics is the study of data. According to Statistics Law No. 16 of 1997, statistics are data obtained through collection, processing, presentation, and analysis, and are a system that regulates the interrelationships between elements in statistical administration. Data is information in the form of numbers about the characteristics (specific traits) of a population. Therefore, the series of data collection through to presentation and analysis is what constitutes statistics. There are various methods and levels of difficulty to choose from, ranging from simple to difficult. For basic data needs, we only discuss the data collection process. It's not too complicated and is quite straightforward in terms of methodology.

C. Role of Statistics in Research

Statistics plays a vital role in everyday life. We use statistics without realizing it. For example, calculating monthly expenses as a percentage (%), calculating harvest income from plantations involves statistics, and so on. Many students find statistics difficult

to learn. However, learning statistics is actually quite easy if we master basic statistical concepts.

Statistics has numerous uses in research. According to Sugiyono (2016), statistics plays a crucial role in research, including:

- 1) A tool for calculating the sample size taken from a population. This allows for a more reliable sample size.
- 2) A tool for testing the validity and reliability of instruments. Before instruments are used for research, their validity and reliability must first be tested.
- 3) Techniques for presenting data to make them more communicative. These data presentation techniques include tables, graphs, pie charts, and pictograms.
- 4) Tools for data analysis, such as testing proposed research hypotheses. In this case, the statistics used include: Correlation, regression, t-test, ANOVA, and others.

Meanwhile, according to Ridwan (2015), statistics serves as a tool for:

- 1) Communication: connecting several parties who produce statistical data or statistical analysis so that these parties can make decisions based on this information.
- 2) Description: presenting and illustrating data, for example, measuring production output, news coverage reports, consumer price indexes, financial reports, inflation rates, population, state income and expenditure, and so on.
- 3) Regression: predicting the influence of one data item on another and anticipating future trends.
- 4) Correlation: determining the strength or magnitude of the relationship between data in a study.
- 5) Comparison: comparing data between two or more groups.

Statistics has many functions. The following points briefly explain the functions of statistics:

- 1) Helping to collect and present data systematically.
- 2) Helping to understand complex and unstructured data by simplifying it.
- 3) Helping to classify data.
- 4) Provides a basis and techniques for making comparisons.
- 5) Helps us study relationships between various phenomena.
- 6) Helps us identify behavioral trends.
- 7) Helps us formulate and test hypotheses.
- 8) Helps us draw rational conclusions.

Measurement and evaluation are essential parts of the teaching and learning process. In this process, we obtain scores and then interpret these scores to make decisions. Statistics allow us to study these scores objectively, making the teaching and learning process more efficient.

Meanwhile, in education, statistical knowledge can assist teachers in the following ways:

- 1) It helps teachers provide the most accurate descriptions. For example, when a teacher wants to know about a student, they will conduct a test or observe the child. Then, based on the results, the teacher can explain the student's performance or characteristics. Statistics helps teachers provide accurate data descriptions.
- 2) It makes teachers precise and precise in their procedures and thinking. Sometimes, due to a lack of technical knowledge, teachers are unclear in describing student performance. However, statistics allows them to describe performance using precise language and symbols, which makes interpretations clear and precise.
- 3) It allows teachers to summarize results in a meaningful and precise form. Statistics order data, thus helping teachers make data precise and meaningful and express it in a way that is understandable and interpretable.

- 4) It allows teachers to draw general conclusions. Statistics helps us draw conclusions and draw conclusions. Statistical measures also help us determine how much faith should be placed in any conclusion and how far we can extend our generalizations.
- 5) It helps teachers predict future student performance. Statistics allows teachers to predict how things will happen under conditions we know and measure. For example, a teacher can predict a student's likely final exam score based on their entrance exam score. However, this prediction may be inaccurate due to various factors. Statistical methods tell us how much margin of error to allow for in making predictions.
- 6) Statistics allows teachers to analyze the multiple causal factors underlying complex and irregular events. It is a common fact that behavioral outcomes are the result of multiple causal factors. The reasons why certain students perform poorly in certain subjects are varied and numerous. Therefore, with appropriate statistical methods, we can hold these extraneous variables constant and observe the causes of student failure in certain subjects.

D. Role of SPSS in Research Statistics

SPSS stands for Statistical Package for the Social Sciences and is used by a wide variety of researchers for complex statistical data analysis. The SPSS software package was created for the management and statistical analysis of social science data. Originally launched in 1968 by SPSS Inc., it was later acquired by IBM in 2009. Officially known as IBM SPSS Statistics, most users still refer to it simply as SPSS. As the world standard for social science data analysis, SPSS is highly sought after for its straightforward, English-like command language and thorough user guides.

SPSS is used by market researchers, health researchers, survey companies, government entities, educational researchers,

marketing organizations, data miners, and many others to process and analyze survey data. Most of the world's leading research institutions use SPSS to analyze survey data and mine text data to maximize the results of their research projects.

The SPSS Statistics program provides a wide range of basic statistical functions, some of which include frequencies, cross-tabulations, and bivariate statistics. SPSS's Text Analytics for Surveys program helps survey administrators uncover powerful insights from responses to open-ended survey questions. SPSS's Visualization Designer program also allows researchers to use their data to easily create a variety of visuals, such as density graphs and radial boxplots.

In addition to the four programs mentioned above, SPSS also provides data management solutions, allowing researchers to perform case selection, create derived data, and reshape files. SPSS also offers data documentation solutions, allowing researchers to maintain a metadata dictionary. This metadata dictionary acts as a central repository of information related to data, such as its meaning, relationships to other data, origin, usage, and format.

Several statistical methods can be utilized in SPSS, including:

- 1) Descriptive statistics, including methodologies such as frequencies, cross-tabulations, and descriptive ratio statistics.
- 2) Bivariate statistics, including methodologies such as analysis of variance (ANOVA), means, correlations, and non-parametric tests.
- 3) Predictive numerical results, such as linear regression.
- 4) Predictions for identifying clusters, including methodologies such as cluster analysis and factor analysis.

In short, using SPSS allows researchers to perform numerous analyses quickly and accurately in a flexible and customizable manner to achieve appropriate results, even on complex data sets. This naturally gives researchers more time to perform their best in conducting analysis, identifying trends, developing predictive

models, and drawing appropriate conclusions based on the results obtained.

E. Exercises :

- 1) Explain statistics and statistical institutions in Indonesia.
- 2) Explain the meaning of statistics and its benefits in research.
- 3) Explain the relationship between statistics and educational research.
- 4) What are the benefits of SPSS in research statistics?

CHAPTER 02

BASIC CONCEPT OF STATISTICS

Main Competencies

Students are able to understand and explain the basic concepts of statistics in research.

Indicators

- 1) Students are able to explain the difference between descriptive and inferential statistics.
- 2) Students are able to differentiate between the types of statistical data used in research activities.
- 3) Students are able to explain statistics for educational research.
- 4) Students are able to understand data processing using SPSS in statistical analysis of research.

A. Differences Between Descriptive and Inferential Statistics

According to Sudijono (2011: 4-5), statistics can be divided into two parts based on the stages of statistical activities:

- 1) **Descriptive Statistics.** Also commonly called Deductive Statistics or Simple Statistics, statistics that involve collecting,

compiling or organizing, processing, presenting, and analyzing numerical data to provide an orderly, concise, and clear picture of a phenomenon, event, or situation. Meanwhile, according to Shater & Zhang (2012), Descriptive Statistics is a branch of statistics that includes organizing, displaying, and explaining data. Descriptive statistics include: Frequency Distribution, Central Tendency Analysis, and Standard Deviation.

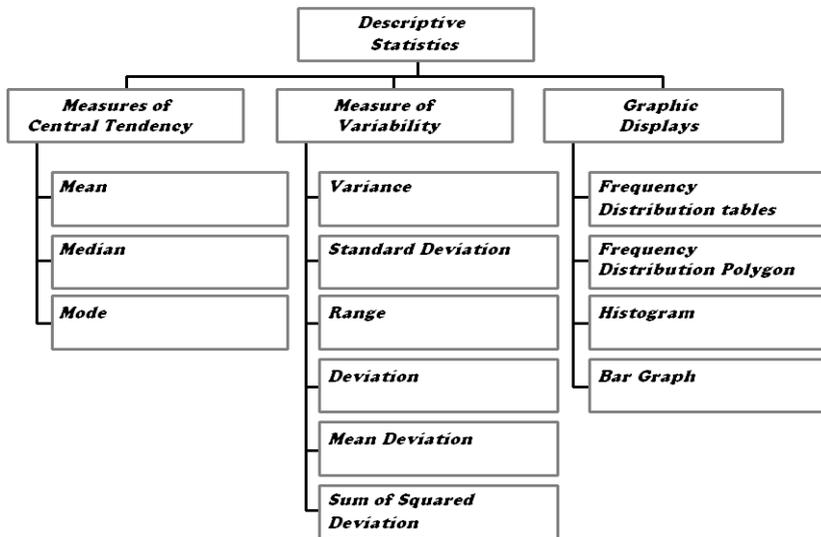


Figure 2. 1 Descriptive Statistics

2) **Inferential Statistics.** Also commonly called Inductive Statistics, Advanced Statistics, or In-depth Statistics, these statistics provide rules or methods that can be used as tools to draw general conclusions from a set of collected and processed data. Furthermore, Inferential Statistics also provides specific rules for drawing conclusions, formulating or making predictions, estimating, and so on. Thus, Inferential Statistics is more in-depth and a follow-up to Descriptive Statistics. Descriptive Statistics is the foundation of statistics as a whole, and therefore, to understand and deepen inferential statistics, one must first understand descriptive statistics. Shater &

Zhang (2012) added that inferential statistics is a branch of statistics that encompasses explaining various conclusions about a population based on samples taken from the population. Inferential statistics include: correlation tests, chi-square tests, linear regression, and comparative tests.

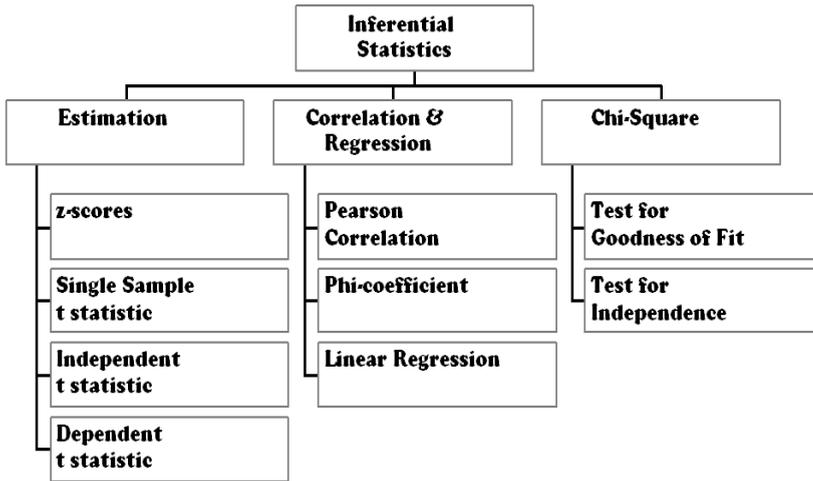


Figure 2. 2 Inferential Statistics

B. Data in Research Statistics

In studying research statistics, it is essential to first understand data and how it is obtained so that processing and analysis can be carried out appropriately. In general, data grouping and how it is obtained can be divided as follows:

- 1) Research data obtained from its source
- 2) Research data based on its source and nature
- 3) Research data based on the process and method of acquisition
- 4) Research data based on the type of measurement scale

The data types above are essential because statistical methods can only be used with certain types of data. Analyzing nominal data is different from analyzing interval data; otherwise, the analysis results will be erroneous. Therefore, determining the relevant data type will determine the selection of the appropriate

analysis method. An explanation of each type of data and how to obtain it is explained in more detail in the following discussion.

In research, data obtained based on its source can be divided into two types: primary data and secondary data.

- 1) **Primary data** is data obtained or collected by researchers directly from the data source. Primary data is also referred to as original data or new data that is up-to-date. To obtain primary data, researchers must collect it directly. Techniques that researchers can use to collect primary data include observation, interviews, focus group discussions (FGDs), and questionnaires.
- 2) **Secondary data** is data obtained or collected by researchers from various existing sources (the researcher acts secondhand). Secondary data can be obtained from various sources such as the Central Bureau of Statistics (BPS), books, reports, journals, and others.

Meanwhile, based on its form and nature, research data can be divided into two types: qualitative data (in the form of words/sentences) and quantitative data (in the form of numbers). Data can be grouped based on how it is obtained as follows:

- 1) **Qualitative Data:** data in the form of words, not numbers. Qualitative data is obtained through various data collection techniques, such as interviews, document analysis, focus group discussions, or observations recorded in field notes (transcripts). Another form of qualitative data is images obtained through photography or video recording.
- 2) **Quantitative Data:** data in the form of numbers. Depending on its form, quantitative data can be processed or analyzed using mathematical or statistical techniques.

Based on the process or method of obtaining it, quantitative data can be grouped into two forms, namely as follows:

- 1) **Discrete data** is data in the form of numbers (numbers) obtained by counting. Examples of discrete data include:
 - The number of State Elementary Schools in District XXX is 20.
 - The number of male students at SD YYY is 67 people.
 - The population of ZZZ Regency is 246,867 people.
 - Because it is obtained by counting, discrete data will be in the form of whole numbers (not fractional numbers).
- 2) **Continuum Data** is data in the form of numbers obtained based on measurement results. Continuum data can be in the form of whole numbers or fractions depending on the type of measurement scale used. Examples of continuum data include:
 - Budi's height is 150.5 centimeters.
 - Budi's IQ is 120.
 - The air temperature in the classroom is 24o Celsius.

Data grouped based on the type of measurement scale used can be divided into four types (levels) that have different characteristics, starting from the lowest to the highest data, namely:

- 1) **Nominal data** is often also called categorical data, namely data obtained through grouping objects shows qualitative differences. Although nominal data can be expressed in numerical form, these numbers have no order or mathematical meaning and therefore cannot be compared. The comparative logic ">" and "<" cannot be used to analyze nominal data. Mathematical operations such as addition (+), subtraction (-), multiplication (x), or division (:) also cannot be applied in nominal data analysis.

Examples of nominal data include:

- Gender, which consists of two categories: (1) Male; (2) Female. The number (1) for male and (2) for female are merely symbols used to distinguish the two gender categories. These numbers have no quantitative meaning; meaning the number (2) in the data above does not

necessarily mean greater than the number (1), because male does not have a greater meaning than female.

- Marital status, which consists of three categories: (1) Unmarried, (2) Married, (3) Widow/Widower. These data have the same characteristics as data on gender.

2) **Ordinal data** is data originating from an object or category that has been arranged hierarchically according to size. Each ordinal data has a specific level that can be ordered from lowest to highest or vice versa. However, the distance or range between levels does not have to be the same. Compared to nominal data, ordinal data has different properties in terms of order. Comparisons with ordinal data apply using the difference functions ">" and "<". Although ordinal data can be arranged in a sequence, mathematical operations (+, -, x, :) cannot be performed on it.

Examples of ordinal data types include:

- Education levels arranged in the following order: Kindergarten (TK) Elementary School (SD) Junior High School (SMP) Senior High School (SMA) Diploma Bachelor's Degree Analysis of the data sequence above shows that elementary school has a higher level than kindergarten and a lower level than junior high school. However, the data cannot be added together, for example, elementary school (2) + junior high school (3) \neq (5) Diploma. In this case, mathematical operations (+, -, x, :) do not apply to ordinal data.
- The ranking of students in a class shows the order of highest to lowest learning achievement. Students ranked (1) have higher learning achievement than students ranked (2).

3) **Interval data** is measurement data that can be sorted based on certain criteria and exhibits all the properties of ordinal data. The advantage of interval data over ordinal data is that it has equal distance (equality interval), or the same range between the sorted data. Because of this equal distance, interval data

can be performed on mathematical operations such as addition and subtraction (+, -). However, interval data still lacks one property: the absence of absolute zero.

Several examples of interval data are explained below, including:

- Temperature measurements using a thermometer are expressed in degrees. The temperature range between 0°C and 10°C is the same as 10°C and 20°C. Therefore, the mathematical operation (+, -) applies, for example, 150°C + 150°C = 300°C. However, it cannot be stated that an object at 150°C has half the heat capacity of an object at 300°C. Likewise, it cannot be said that an object with a temperature of 0°C has no temperature at all. 0°C is relative (not absolute). This means that when measured using a Fahrenheit thermometer, 0°C = 32°F.
 - Intellectual intelligence is expressed in IQ. The IQ range of 100 to 110 is the same as that of 110 to 120. However, it cannot be said that someone with an IQ of 150 has 1.5 times the intelligence of someone with an IQ of 100. Based on strong assumptions, achievement test scores (e.g., student GPA and student exam results) can be considered interval data.
 - In many research activities, score data obtained through questionnaires (for example, attitude scales or behavioral intensity) are often expressed as interval data after the answer alternatives are given a score equivalent to the interval scale, for example: Score (5) for the answer "Strongly Agree" Score (4) for the answer "Agree" Score (3) for the answer "No Opinion" Score (2) for the answer "Disagree" Score (1) for the answer "Strongly Disagree" In processing, questionnaire answer scores are assumed to have the same properties as interval data.
- 4) **Ratio Data** is data that combines all the properties of nominal, ordinal, and interval data. Ratio data is data in the form of numbers in the true sense because it is equipped with an

absolute zero point (absolute), so that all forms of mathematical operations (+, -, \times , :) can be applied. The properties that distinguish ratio data from other types of data (nominal, ordinal, and interval) can be seen in the following example:

- The length of an object expressed in meters is ratio data. An object that is 1 meter long is significantly different from an object that is 2 meters long, so it can be categorized into objects that are 1 meter and 2 meters long (nominal data properties). The length of objects can be ordered from longest to shortest (ordinal data properties). The difference between an object that is 1 meter long and 2 meters long is the same distance as the difference between an object that is 2 meters long and 3 meters long (interval data properties). The advantages of ratio data are shown by two things, namely: (1) The number 0 meters indicates an absolute value, meaning there is no object being measured; and (2) An object that is 2 meters long is twice as long as an object that is 1 meter long, indicating the validity of all mathematical operations. These two things do not apply to nominal data, ordinal data, or interval data.
- Data from measuring the weight of an object expressed in grams has all the properties of interval data. An object that weighs 1 kg is significantly different from an object that weighs 2 kg. The weight of objects can be ordered from heaviest to lightest. The difference between objects that weigh 1 kg. A 2 kg weight range is the same as the difference between an object weighing 2 kg and 3 kg. A 0 kg value indicates no object (weight) being measured. An object weighing 2 kg is twice as heavy as an object weighing 1 kg.

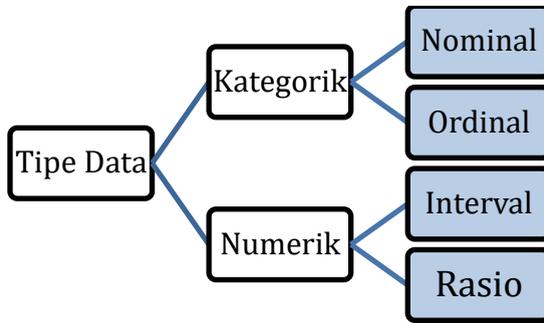


Figure 2. 3 Data Based On Measurement Scale Type

A researcher's understanding of the types of research data mentioned above is useful for determining the data analysis techniques to be used. There are several data analysis techniques that researchers must choose based on the type of data. Qualitative data analysis techniques will differ from quantitative data analysis techniques. Because of their distinct nature, nominal data analysis techniques will differ from ordinal, interval, and ratio data analysis techniques. The use of data types based on measurement scales can be summarized as in the following table:

Table 2. 1 Use Of Data Types

Provides:	Nominal	Ordinal	Interval	Ratio
The "order" of values is known		✓	✓	✓
"Counts," aka "Frequency of Distribution"	✓	✓	✓	✓
Mode	✓	✓	✓	✓
Median		✓	✓	✓
Mean			✓	✓
Can quantify the difference between each value			✓	✓
Can add or subtract values			✓	✓
Can multiple and divide values				✓
Has "true zero"				✓

C. Exercise:

- 1) Name the divisions of statistics and explain each.
- 2) Name and explain the data in research statistics based on their sources.
- 3) Name and explain the data in research statistics based on the process and method of obtaining them.
- 4) Name and explain the following examples of data grouping based on the type of measurement scale.

CHAPTER 03

DESCRIPTIVE STATISTICS *(FREQUENCY DISTRIBUTION)*

Main Competencies

Students are able to explain and analyze frequency distributions in research and use SPSS for frequency distribution.

Indicators

- 1) Students are able to understand and explain frequency distributions, including interval classes, interval class boundaries, and interval midpoints.
- 2) Students are able to create frequency distribution tables.
- 3) Students are able to create frequency distribution graphs.
- 4) Students are able to analyze frequency distributions using SPSS.

A. Definition of Frequency Distribution

FREQUENCY distribution is an arrangement of data, from the smallest to the largest, that divides a large amount of data into several classes. Soedijono (2011; 37) adds that in statistics, frequency distribution refers to a situation that describes how the

frequency distribution of a phenomenon or variable, represented by numbers, is distributed, divided, or dispersed.

In grouping data, data that was initially distributed irregularly is grouped based on a numerical range that is easy to understand and read by those who need it.

Example:

The following is a group of data obtained from the results of a student economics exam at a school:

75	80	81	65	86	66	88	87	68	66
78	77	80	55	56	67	76	77	72	82
76	82	81	85	82	89	82	86	78	68
82	78	68	55	77	87	75	75	73	79
86	81	71	80	81	76	62	87	75	67

The student exam score data above shows that the scores are arranged haphazardly, making them difficult to understand and summarize. The data is then grouped in the following table:

Table 3. 1 Tally Data Of Statistics Exam Score

Class Range	Middle Score	Tally Data	Frequencies
55-59	57	///	3
60-64	62	/	1
65-69	67	/// ///	8
70-74	72	///	3
75-79	77	/// /// ////	14
80-84	82	/// /// //	12
85-89	87	/// ////	9
Total			50

To better understand frequency distribution, data management should be structured through the following steps:

1. Determining the Class Range

The data range is the difference between the smallest and largest data values. From the data above, the difference or class range is:

$$R = 89 - 55 = 34$$

The class range is 34.

2. Determining the Number of Classes

The number of classes is determined by calculating the number of classes used and is calculated based on the amount of data processed and a constant of 3.322. To determine the number of classes, the Sturges Criterion (Kurges; 1926) can be used with the following formula:

$$K = 1 + 3.322 \text{ Log } n$$

Where:

K = Number of Classes

n = Number of Observation Values (If n = 50), then the number of classes is as follows::

$$K = 1 + 3.322 \text{ Log } 50$$

$$K = 1 + 3.322 (1.69897)$$

$$K = 1 + 5.6 \text{ (Rounded to 6)}$$

$$K = 1 + 6 = 7$$

Therefore, the number of classes is 7.

3. Determining Class Intervals

Class intervals are the difference between the largest and smallest data points divided by the number of classes. The results obtained using the following formula are:

$$P = \frac{R}{K}$$

Where

P = Class Interval

R = Class Range

K = Number of Classes

From the previously determined data, the Class Interval value is as follows:

$$P = R = 34 = 4.85 \text{ (Rounded to 5)} \quad K = 7$$

The results above show that the Interval or Class Length value is 5.

4. Determining the Class Midpoint:

To determine the Class Midpoint, which is the value in the middle of the class, use the following formula:

$$\text{Midpoint} = \frac{\text{Lower Class Limit} + \text{Upper Class Limit}}{2}$$

Using the formula above, the Class Midpoint is:

$$\text{First Class} = \frac{55 + 59}{2} = 57$$

$$\text{Second Class} = \frac{60 + 64}{2} = 62$$

$$\text{Third Class} = \frac{65 + 69}{2} = 67$$

$$\text{Fourth Class} = \frac{70 + 74}{2} = 72$$

$$\text{Fifth Class} = \frac{75 + 79}{2} = 77$$

$$\text{Sixth Class} = \frac{80 + 84}{2} = 82$$

$$\text{Seventh Class} = \frac{85 + 89}{2} = 87$$

Table 3. 2 Frequency Distribution Of Student Economics Exam Scores

Class Range	Frequency
55-59	3
60-64	1
65-69	8
70-74	3
75-79	14
80-84	12
85-89	9
Total	50

5. Frequency Distribution Tables

Frequency distribution table is a statistical data presentation tool in the form of columns and rows containing numbers that can describe or illustrate the distribution or frequency distribution of the variables being researched (Sudijono; 2011; 38). Briefly, a frequency distribution table is defined as a data grouping based on the existing frequency distribution.

Several types of frequency distribution tables are known in research statistics and are commonly used in descriptive statistical data analysis, namely:

6. Single Data Frequency Distribution Table

A Single Data Frequency Distribution Table is a type of table commonly used for single data, not for groups of data.

Table 3. 3 Frequency Distribution Of Student Uniform Sizes

Size	Frequency
S	3
L	8
XL	7
XXL	2
Total	20

The table above shows the frequency distribution of single-item data for student uniform sizes, with 3 students wearing the smallest size S and 2 students wearing the largest size XXL, for a total of 20 uniforms.

7. Grouped Data Frequency Distribution Table

A Grouped Data Frequency Distribution Table is a type of table used for grouped data, with each group containing a frequency distribution of numbers.

Table 3. 4 Frequency Distribution Of Students' Economic Values

Students' Score	Frequency
1-2	0
3-4	5
4-5	4
5-6	2
6-7	6
7-8	2
9-10	1
Total	20

The table above shows the frequency distribution of data for student grade groups taking the economics exam, with the lowest grade group being 1-2 (0) and the highest grade group being 6-7 (6).

8. Cumulative Frequency Distribution Table

A Cumulative Frequency Distribution Table is a type of table in which data is added or summed to the next section or group.

Table 3. 5 Frequency Distribution Of Age Students' Parents

Age Group (Year)	Frequency	Accumulative Frequency (%)
<35 Tahun	0	0
35-39	1	1
40-44	3	4

Age Group (Year)	Frequency	Accumulative Frequency (%)
45-49	11	15
50-54	5	20
55-59	4	24
>60 Tahun	1	25
Total	25	

9. Relative Frequency Distribution Table (Percentage).

A Relative Frequency Distribution Table is a type of table that presents relative data, generally in the form of percentages (%).

Table 3. 6 Relative Frequency Distribution Of Age Of Parents Of High School Students

Age Group (Year)	Frequency	Accumulative Frequency (%)
<35 Year	0	0%
35-39	1	4%
40-44	3	12%
45-49	11	44%
50-54	5	20%
55-59	4	16%
>60 Year	1	4%
Total	25	100%

10. Cumulative Percentage Table.

A Cumulative Percentage Table or Relative Frequency Distribution Table (RRD) is a table that displays non-real (relative) data in the form of percentages added to the next section or group.

Table 3. 7 Relative Cumulative Frequency Distribution Of Students' Parents' Ages

Age Group (Year)	Frequency	Accumulative Frequency (%)
<35 Tahun	0	0%
35-39	1	4%
40-44	3	16%
45-49	11	60%
50-54	5	80%
55-59	4	96%
>60 Tahun	1	100%
Total	25	

11. Graphs in Frequency Distribution

After understanding the steps in collecting and grouping data into tables for easy understanding and reading, the next step is to create a graph. Graphs in statistics are used to further clarify the visual display of data based on tabulated data.

In statistics, there are several types of graphs commonly used in data analysis, as follows:

a. Line Graph

Presenting statistical data using a straight line diagram is called a straight line diagram or line chart. Line charts are typically used to present statistical data obtained based on sequential observations over time. The X-axis shows the observation times, while the Y-axis shows the observation data values for a specific time period. The collection of times and observations forms points on the XY plane. The columns of each two adjacent points are then connected with a straight line to create a line diagram or line chart. Here is an example problem:

Table 3. 8 Student Parents' Income Data

Income (Rp)	Frekuensi
<1 millions	6
1-2 millions	4
2-3 millions	3
4-5 millions	2
>5 millions	5
Total	20

From the frequency distribution table presented above, a line chart can be drawn as shown in the following graph or diagram:

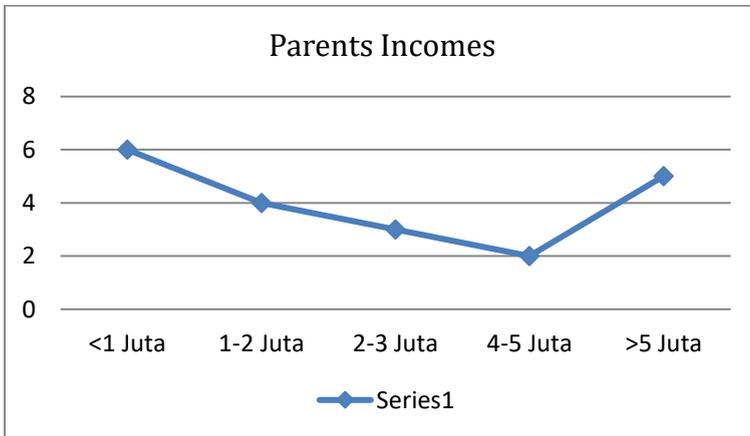


Figure 3. 1 Parental Income Graph

Line graphs, or line charts, are used to represent periodic data. Line graphs can be either single-line or multiple-line graphs.

b. Pie Chart

A pie chart is a presentation of statistical data using a circular image. The sections of the circle represent parts or percentages of the whole. To create a pie chart, first determine the percentage of each item in the total data and the central angle of the circular sector. Pie charts are more suitable for presenting cross-sectional data, where the data can be expressed as a percentage.

An example of a line chart is shown below:

Figure 3. 2 Comparison Of Male And Female Students

Gender	Frequency
Male	12
Female	8
Total	20

From the frequency distribution table of student gender in one of the MAN classes presented above, a pie chart can be drawn as shown in the following graph or diagram:

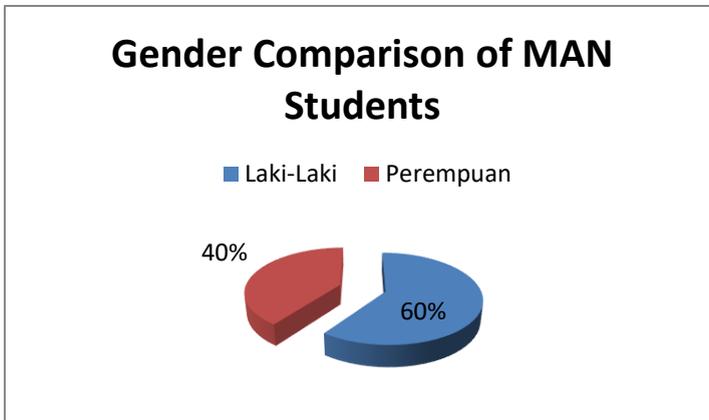


Figure 3. 3 Gender Comparison Graph

c. Bar Chart

Bar charts are generally used to depict the development of a research object's value over a specific period of time. Bar charts display information using vertical or horizontal bars of equal width and separate bars. Bar charts essentially serve the same function as line charts, namely, to depict periodic data. Bar charts also come in the form of single bar charts and double bar charts. These charts use images or symbols to indicate the number of objects represented.

Table 3. 9 2010 Inflation Rate In Indonesia

Months	Inflation Rate (%)
January	3,72
Pebruary	3,81
March	3,43
April	3,91
May	4,16
June	5,05
July	6,22
August	6,44
September	5,80
October	5,67
November	6,33
December	6,96

From the frequency distribution table presented above, a bar chart can be drawn as shown in the following graph or diagram:

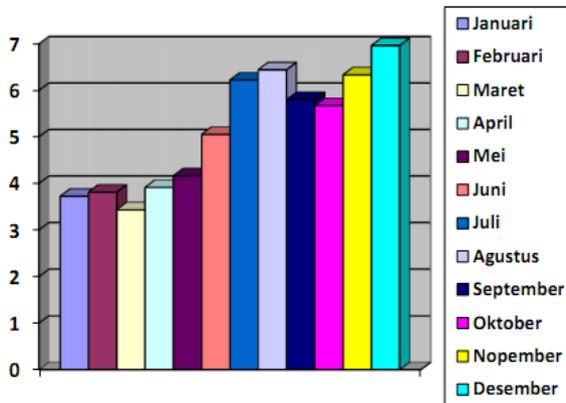


Figure 3. 4 Graphic Of 2010 Inflation Rate

d. Radar Chart

A radar chart is a graphical method of displaying multivariate data in the form of a two-dimensional graph of three or more quantitative variables represented by axes starting from the same point. A radar chart is a graph and/or plot consisting of

spokes that describe the values of a single variable. The length of the spokes is equal to the magnitude of the variable value. Lines are then drawn connecting the data values, forming a radar- or star-shaped plot.

Table 3. 10 Frequency Data On Student Achievement Values

Students' Achievement	Frequency
1-2	1
3-4	2
5-6	8
7-8	6
9-10	3
Total	20

From the frequency distribution table presented above, a Radar Graph can be depicted as in the following graph or diagram:

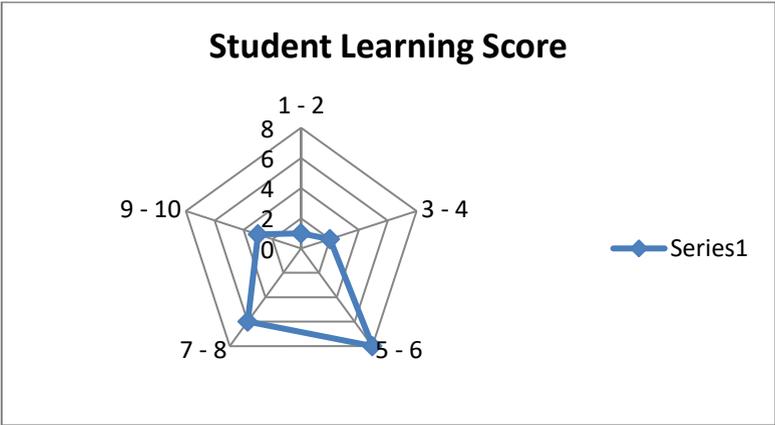


Figure 3. 5 Student Learning Score Graph

e. Area Chart

This chart, better known as an area chart or diagram, is used to depict data series as a cumulative line, displaying overlapping lines. There are two types of area chart models: 2-dimensional and 3-dimensional, each with three additional options.

Example of using an Area Chart:

**Table 3. 11 Us Dollar Exchange Rate Against Rupiah In 2010
In Indonesia**

Bulan	Nilai Tukar US\$ - Rupiah
January	9365
February	9335
March	9115
April	9012
May	9180
June	9083
July	8952
August	9041
September	8924
October	8928
November	9013
December	8991

From the table of the US Dollar exchange rate against the Rupiah during 2010 presented above, an Area Chart can be drawn as shown in the following graph or diagram:

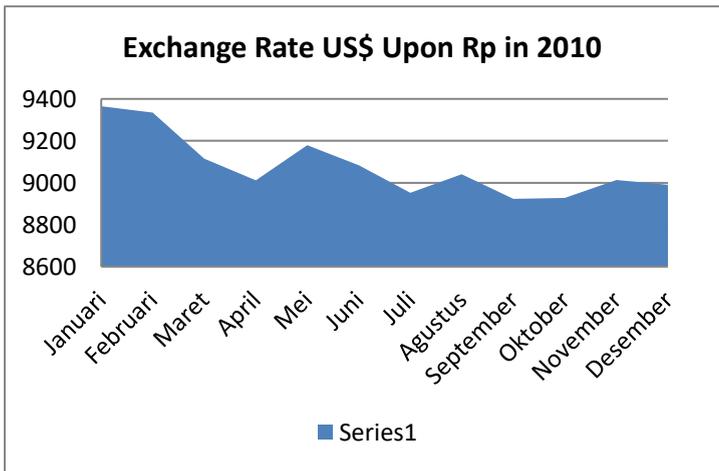


Figure 3. 6 Graph Of US\$ Exchange Rate Against The Rupiah

f. Histogram

The data obtained can be arranged in a frequency distribution table and presented in a diagram called a histogram. While the bars in a bar chart are separate, in a histogram the bars overlap. Histograms can be presented as either a single frequency distribution or a grouped frequency distribution.

Table 3. 12 Frequency Data On Students' Economics Exam Score

Class Range	Middle Score	Frequency
55-59	57	3
60-64	62	1
65-69	67	8
70-74	72	3
75-79	77	14
80-84	82	12
85-89	87	9
Total		50

From the frequency distribution table presented above, a histogram can be drawn as shown in the following graph or diagram:

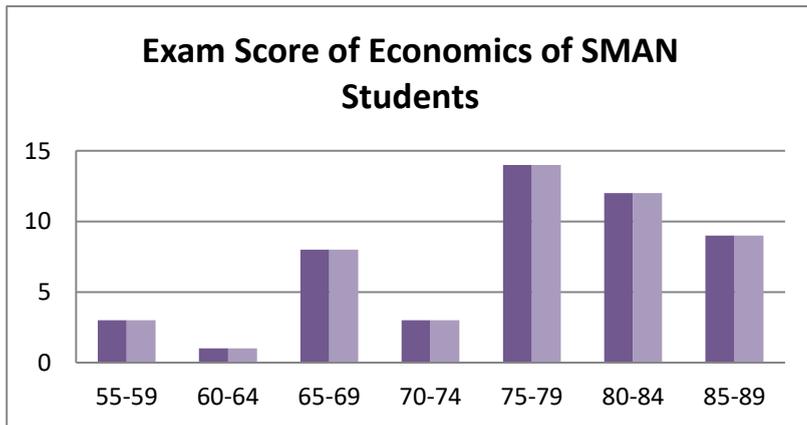


Figure 3. 7 Student Economics Exam Scores Graph

g. Frequency Polygon

A frequency polygon is a line graph that connects the midpoints of each adjacent upper edge to the midpoints of their respective absolute frequency ranges. The difference between a histogram and a frequency polygon is that a histogram uses class boundaries, while a polygon uses midpoints. A histogram is rectangular or resembles a bar chart, while a polygon is a line or curve that is connected to each other. If the midpoints of a histogram are connected with lines and the bars are removed, a frequency polygon is obtained.

Table 3. 13 Frequency Data Of Students' Economics Exam Score

Class Range	Middle Score	Frequency
55-59	57	3
60-64	62	1
65-69	67	8
70-74	72	3
75-79	77	14
80-84	82	12
85-89	87	9
Total		50

From the frequency distribution table presented above, a frequency polygon can be drawn as shown in the graph or diagram as follows :

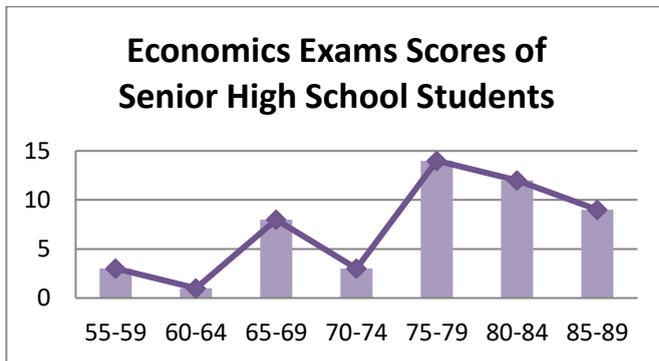


Figure 3. 8 Graph Of Students' Economics Exam Scores

h. Ogive Graph

An ogive is a graph drawn based on data organized in a cumulative frequency distribution table. For data organized in a cumulative frequency distribution table of less than, the graph is a positive ogive, while for data organized in a cumulative frequency distribution table of more than, the graph is a negative ogive.

The cumulative frequency of less than for a class is the sum of the frequencies of all classes before that class and the frequency of that class. The cumulative frequency of more than for a class is the sum of the frequencies of all classes after that class and the frequency of that class. Example data:

Table 3. 14 Frequency Distribution By Group Age Of Students' Parents

Age Group (Years)	Frequency	Cumulative Frequency Less Than	Cumulative Frequency More Than
<35 Years	0	0	25
35-39	1	1	24
40-44	3	4	21
45-49	11	15	10
50-54	5	20	5
55-59	4	24	1
>60 Years	1	25	0
Total	25		

From the cumulative frequency distribution table presented above, an Ogive can be depicted as shown in the following graph or diagram:

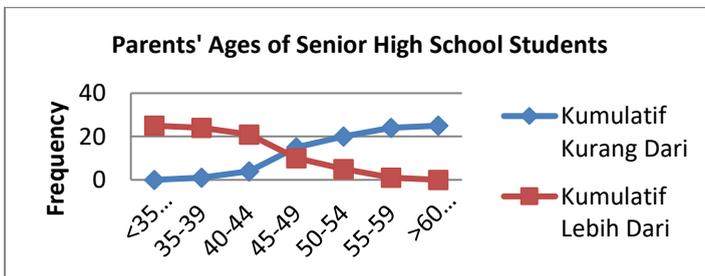


Figure 3. 9 Graphic Of Students' Parents' Ages

B. Using SPSS for Frequency Distribution

SPSS can be used to process frequency distribution data in addition to Word and Excel. SPSS's assistance in processing frequency distribution data is intended to facilitate the analysis and interpretation of research data obtained.

The steps for creating frequency distribution tables and graphs using SPSS can be seen in the following example data:

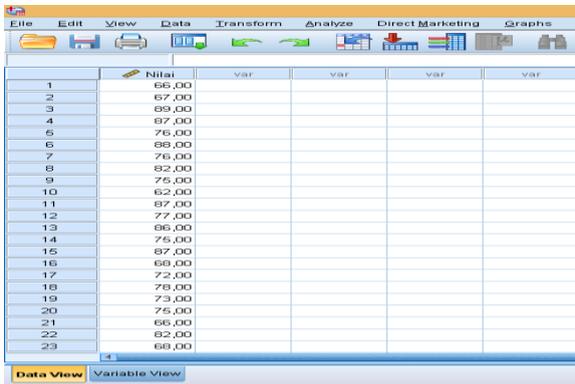
- 1) Organizing Data
- 2) Entering Data
- 3) Creating a Frequency Distribution Table
- 4) Creating a Histogram
- 5) Reading the Frequency Distribution Table and Histogram

Examples of SPSS data and applications for frequency distribution can be seen in the following data and analysis:

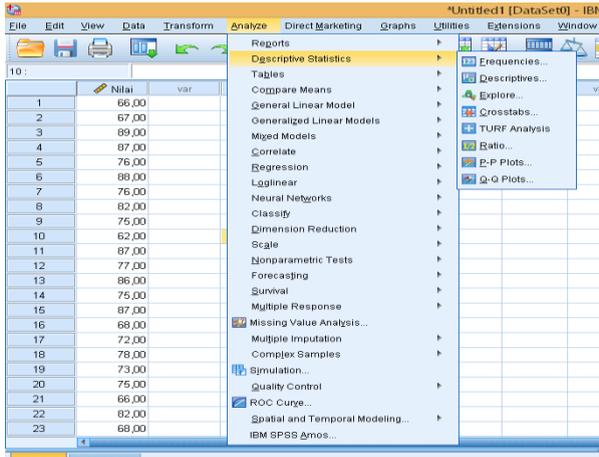
Table 3. 15 Semester Exam Results Of Students In Social Studies

67	74	83	68	82
75	77	78	55	56
70	82	82	85	82
81	76	68	55	77
86	81	73	85	83
66	82	84	69	76

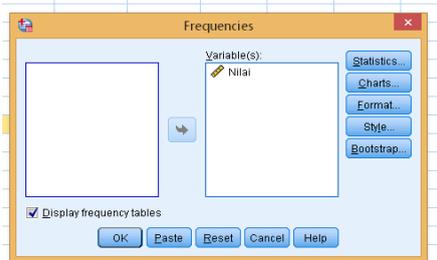
- 1) Open the SPSS Program
- 2) Input the above data into SPSS Data View



- 3) Choose and Click *Analyze*
- 4) Click *Descriptive Statistics*
- 5) Choose *Frequencies*



- 6) Enter the value into the top right column and press OK



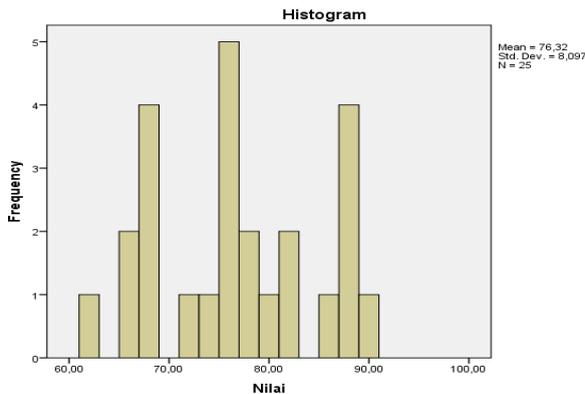
- 7) The results of the SPSS analysis can be seen as follows:

Statistics					
Scores					
N		Valid	25		
		Missing	0		
Scores					
	Frequency	Percent	Valid Percent	Cumulative Percent	
Valid	62,00	1	4,0	4,0	4,0
	66,00	2	8,0	8,0	12,0
	67,00	2	8,0	8,0	20,0
	68,00	2	8,0	8,0	28,0

72,00	1	4,0	4,0	32,0
73,00	1	4,0	4,0	36,0
75,00	3	12,0	12,0	48,0
76,00	2	8,0	8,0	56,0
77,00	1	4,0	4,0	60,0
78,00	1	4,0	4,0	64,0
79,00	1	4,0	4,0	68,0
82,00	2	8,0	8,0	76,0
86,00	1	4,0	4,0	80,0
87,00	3	12,0	12,0	92,0
88,00	1	4,0	4,0	96,0
89,00	1	4,0	4,0	100,0
Total	25	100,0	100,0	

8) The frequency distribution data above shows that the lowest value is 62 and the highest is 89, with a total of 25 data points. The relative frequency in percentage form for each value and the cumulative relative frequency are also generated from the SPSS analysis above.

9) Histogram Results using SPSS



C. Exercise:

- 1) State the definition of Frequency Distribution and explain it.
- 2) Create a Frequency Distribution Table using the following data on Student Intelligence Levels (IQ) at a school in Pekanbaru.

82	89	92	109	101	81
107	101	88	87	94	90
102	89	86	93	95	87
91	92	105	98	102	103
96	100	86	97	92	98

- 3) Create 5 graphs using the frequency distribution data from the student IQ scores above.
- 4) Using SPSS, perform a frequency distribution analysis on the data presented above, including the frequency distribution table, graph, and histogram.

CHAPTER 04

DESCRIPTIVE STATISTICS *(CENTRAL TENDENCY ANALYSIS)*

Main Competencies

Students are able to explain and conduct central tendency analysis in research and use SPSS in analyzing central tendency.

Indicators

- 1) Students are able to understand and explain central tendency.
- 2) Students are able to explain and analyze the mean, median, and mode.
- 3) Students are able to explain and analyze quartiles and percentiles.
- 4) Students are able to analyze central tendency using SPSS.

A. Definition of Central Tendency

CENTRAL Tendency is the central value of observed data (central tendency). Any arithmetic measurement intended to describe a value that represents the central value or central value of a data set (observation set) is known as a measure of central tendency. Measures of central tendency, or measures of location, are several

measures that indicate where the data distribution is centered (Howell, 1982).

One use of measures of central tendency is to compare two (populations) or samples, as it is very difficult to compare individual members of each population or individual members of the sample data. The values of these measures of central tendency are designed to adequately represent all values in the data. The most commonly used measures of central tendency are the median, mean, and mode. Each of these measures of central tendency has its drawbacks. The mean is highly influenced by outliers. The median is too variable to be used as a population parameter. The mode, on the other hand, can only be applied to large data sets.

B. Calculating the Mean, Median, and Mode for Single and Grouped Data

1. Mean (Arithmetic Average)

The mean, or arithmetic mean, is a frequently used measure of central tendency. The advantage of this average is that it can be used as a representative or overview of the data. It is sensitive to the presence of extreme data or outliers. There are several types of averages:

a. Arithmetic Average (Arithmetic Average) for Single Data

If there are n data sets consisting of

$$X_1, X_2, X_3, \dots, X_n,$$

The arithmetic mean of the data can be defined as follows

$$\bar{x} = \frac{X_1 + X_2 + X_3 + \dots + X_n}{n}$$

or

$$\bar{x} = \frac{\sum_{i=1}^n X_i}{n} \quad \text{or} \quad \bar{x} = \frac{\Sigma X_i}{n}$$

Description:

n = number of data points

$\sum X_i$ = number of data points (number of data points from 1st to nth)

Example Question:

The Economics test scores of 5 students in the 11th grade Marketing program were 6, 8, 8, 5, 7, 10, and 5. Calculate the average of these students' scores.

Answer:

n (no of data) = 7

$\sum X_i$ (no of data) = 6 + 4 + 8 + 5 + 7 + 10 + 5
= 49

$$\bar{x} = \frac{\sum X_i}{n} \quad \bar{X} = \frac{49}{7} \\ = 7$$

b. Grouped Data Mean

When grouped data is combined into a frequency distribution, it will be mixed with other data according to its class. Therefore, to avoid the possibility of data in each interval having a value greater or less than the midpoint, the group mean is calculated using the following formula: :

$$\bar{x} = \frac{\sum f_i \cdot X_i}{\sum f_i} \quad \text{or} \quad \bar{x} = x_0 + \frac{\sum f_i \cdot C_i}{n} .l$$

Description :

\bar{x} = Mean

C_i = Code of Middle Point

X_0 = Midpoint at highest frequency

x_i = Midpoint

f_i = Frequency

(t_i, f_i) = Total Frequency

Example Question:

What is the average value of book sales at Kramat Jati Market based on the following data?:

No	Book Sales (in tens of thousands)	f_i
1	1 - 5	6
2	6 - 10	20
3	11 - 15	10
4	16 - 20	9
5	21 - 25	5
	Total	50

Answer:

Create the following table by calculating the columns according to the formula

No	Interval Range	Midpoint (t_i)	Frequency (f_i)	Number ($t_i \cdot f_i$)
1	1 - 5	3	6	18
2	6 - 10	8	20	160
3	11 - 15	13	10	130
4	16 - 20	18	9	162
5	21 - 25	23	5	115
	Total		$\Sigma f_i = 50$	$\Sigma (t_i \cdot f_i) = 585$

Calculate the Mean (Average) Value of the Group:

$$\bar{x} = \frac{\sum f_i \cdot x_i}{\sum f_i}$$

$$\bar{x} = \frac{585}{50} = 11,7 \times 10.000 = 11.700,-$$

The average book sales at Kramat Jati Market is 117,000,-

c. Weighted Mean

If the values of n data items are $x_1, x_2, x_3, \dots, x_n$, and their respective frequencies are $f_1, f_2, f_3, \dots, f_n$, the arithmetic mean of the data set is defined as follows.

$$\bar{x} = \frac{f_1 \cdot X_1 + f_2 \cdot X_2 + f_3 \cdot X_3 + \dots + f_n \cdot X_n}{n}$$

or
$$\bar{x} = \frac{\sum_{i=1}^n f_i \cdot X_i}{n}$$
 or
$$\bar{x} = \frac{\sum f_i \cdot X_i}{\sum f_i}$$

Description :

$\sum f_i \cdot X_i$ = The sum of the results of multiplying each data and its frequency

f_i = Frequency of data to-i

x_i = Data to-i

$\sum f_i$ = total of data (n)

Example Question:

Determine the average price of food sold by students based on the sales data in the table below.

<i>Food Price (Rp)</i>	Number of Items Sold
4000	5
5000	10
6000	5
8000	10
9000	5
Total	45

Answer:

Food Price (X_i)	Number of Items Sold (f_i)	X_if_i
4000	5	20.000
5000	10	50.000
6000	5	30.000
8000	10	80.000
9000	5	45.000
Total	45	225.000

$$\bar{x} = \frac{\sum f_i \cdot x_i}{\sum f_i}$$

$$= \frac{225.000}{45} = 5.000$$

2. Median

The median, or middle value, is a measure of central tendency that occupies the middle position after the data is sorted. The median is commonly used in non-parametric statistics and is used for scored data. The median is not affected by the presence of extreme points or outliers, and is therefore used in robust statistics.

a. Calculating the Median of Single Data

The median of single data is found by sorting the data obtained from smallest to largest, or vice versa, by sorting from largest to smallest. In finding the median, the data can be an odd or even number. Therefore, if the number of data is odd, the middle number is taken after sorting. If the number of data is even, the two middle numbers are taken and divided by the average after sorting. To find the median, the following formula can be used:

If the number of data is odd, the following formula is used :

$$k = \frac{n - 1}{2} \quad \text{where } n \text{ is the number of data}$$

The Median value is the result of the value $k + 1$

Example:

The following is the student exam results data : 50, 65, 45, 60, 85, 80, 75, 90, 88

What is the median value for the data above?

Answer:

Arrange the data from smallest to largest.

45, 50, 60, 65, 75, 80, 85, 88, 90

$$\text{Median} = \frac{9-1}{2} = 4$$

So Median score $k = n + 1 = X_5 = 75$

If the amount of data is even, then the following formula is used :

$$k = \frac{n}{2} \quad \text{where } n \text{ is total of data}$$

$$\text{Median Score (Md)} = \frac{1}{2} (X_k + X_{k+1})$$

Example:

The following is the exam result data for 10 students: 50, 65, 45, 60, 85, 80, 75, 90, 88, 89

What is the Median value of the data above?

Answer:

Sort the data from smallest to largest

45, 50, 60, 65, 75, 80, 85, 88, 89, 90

$$k = \frac{10}{2} = 5$$

$$\begin{aligned} \text{So Median score} &= \frac{1}{2} (X_k + X_{k+1}) = \frac{1}{2} (X_5 + X_{5+1}) \\ &= \frac{1}{2} (75 + 80) \\ &= 77,5 \end{aligned}$$

b. Calculating the Median of Grouped Data

To calculate the median of grouped data, first construct a frequency distribution by ordering the data from lowest to highest, or vice versa, from highest to lowest. Next, calculate the R (Range), Number of Classes (K), and Class Length (P). The following formula applies :

$$M_d = L_{me} + \left(\frac{\left(\frac{1}{2}n - \Sigma f \right)}{f_m} \right) i$$

Description:

Md = Median of group data

- Lme = Lower limit of median class
- n = Total frequency
- Σf = Cumulative frequency before median class
- Fm = Frequency of median class
- i = Median class interval

Example :

Determine the median of the following data set::

Interval Class	Frequency
20 - 29	4
30 - 39	7
40 - 49	8
50 - 59	12
60 - 69	9
70 - 79	8
80 - 89	2
Total	50

Answer:

Create a table that explains the cumulative frequency of the data as follows::

Class of Interval	Frequency	Cummulative Frequency
20 - 29	4	4
30 - 39	7	11
40 - 49	8	19
50 - 59	12	31
60 - 69	9	40
70 - 79	8	48
80 - 89	2	50
Total	50	

Median position = $\frac{1}{2} N = \frac{1}{2} \times 50 = 25$

So median in Class IV (50 - 59)

Lme = 49,5; $\Sigma f = 19$; fm = 12

$$i = 10$$

$$M_d = 49,5 + \left(\frac{\left(\frac{1}{2}50 - 19 \right)}{12} \right) 10$$

$$M_d = 49,5 + \left(\frac{(25-19)}{12} \right) 10$$

$$M_d = \mathbf{54,5}$$

3. Mode

The mode is the value that occurs most frequently in a series of data. The mode cannot be used as a description of the data. (Howell, 1982). In another sense, the mode is the data value that appears frequently (the one with the greatest frequency). The mode is useful for determining the frequency with which an event occurs. A data series may have two modes (Bimodal), have three modes (trimodal), or more than two (Multimodal).

a. Single Data Mode

Example:

Set the Mode of the following number data series:

- 1) 5, 7, 5, 8, 6, 9, 7, 7, 6, 5, 5, 10
- 2) 17, 18, 16, 19, 17, 16, 16, 15, 17

Answers :

- 1) 5 = 4 times 6 = 1 times 7 = 3 times 8 = 1 kali
9 = 1 time 10 = 1 times

The value that often appears is 5

So Mode = 5

- 2) 15 = 1 time 16 = 3 times 17 = 3 times 18 = 1 time
19 = 1 time

The values that often appear are 16 and 17

So the Mode = 16 and 17

b. Grouped Data Mode

To find the mode of grouped data, you can use the following formula: :

$$M_o = L_{mo} + \left(\frac{d_1}{d_1 + d_2} \right) i$$

Description:

M_o = Mode

L_{mo} = Lower edge of the mode class

d_1 = Difference between the frequency of the mode class and the frequency of the previous class

d_2 = Difference between the frequency of the mode class and the frequency of the next class

i = Class interval

Example:

Set the mode for the grouped data as follows:

Classes of Interval	Frequency
20 - 29	4
30 - 39	7
40 - 49	8
50 - 59	12
60 - 69	9
70 - 79	8
80 - 89	2
Total	50

Answer :

Classes of Interval	Frequency
20 - 29	4
30 - 39	7
40 - 49	8
50 - 59	12
60 - 69	9
70 - 79	8
80 - 89	2
Total	50

The Mode Class is the class with the highest frequency, so it is concluded that the Mode of the data above is Class IV (50-59), and so on :

$$\begin{aligned} L_{mo} &= 49,5 \\ d_1 &= 12 - 8 = 4 \\ d_2 &= 12 - 9 = 3 \\ i &= 10 \end{aligned}$$

$$M_o = L_{mo} + \left(\frac{d_1}{d_1 + d_2} \right) i$$

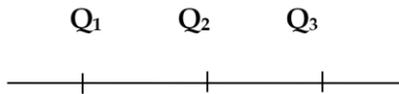
$$M_o = 49,5 + \left(\frac{4}{4 + 3} \right) 10$$

$$\text{So } M_o = 55,21$$

4. Calculating Quartiles and Percentiles

a. Quartiles

Quartiles are values that divide a data set into four equal parts after the numbers have been sorted. The location of the quartiles can be shown on a number line as follows::



Quartiles of Single Data

Calculating quartiles can be done in the following way::

$$\frac{i(n+1)}{4}$$

- Q_i = Data to
- i = 1, 2, 3
- n = amount of data

Example:

The results of the age data collection for 12 toddlers (in years) are as follows: 4, 3, 4, 4, 2, 1, 1, 2, 1, 3, 3, 4. Determine:

- 1) Lower quartile (Q_1)
- 2) Middle quartile (Q_2)
- 3) Upper quartile (Q_3)

Answers :

Data is sorted : 1,1,1,2,2,3,3,3,4,4,4,4

$$\begin{aligned} \text{a) Position } Q_1 &= \text{data ke } - \frac{1(12+1)}{4} \\ &= \text{data to } - 3 \frac{3}{4} \end{aligned}$$

$$\begin{aligned} \text{Score } Q_1 &= \text{data to } -3 + \frac{1}{4} (\text{data to } 4 - \text{data to } 3) \\ &= 1 + \frac{1}{4} (2 - 1) = 1 \frac{1}{4} \end{aligned}$$

$$\begin{aligned} \text{b) Position } Q_2 &= \text{data to } \frac{2(12+1)}{4} \\ &= \text{data to } 6 \frac{1}{2} \end{aligned}$$

$$\begin{aligned} \text{Score } Q_2 &= \text{data to } 6 + \frac{1}{2} (\text{data to } 7 - \text{data to } 6) \\ &= 3 + \frac{1}{2} (3 - 3) = 3 \end{aligned}$$

$$\begin{aligned} \text{c) Position } Q_3 &= \text{data to } \frac{3(12+1)}{4} \\ &= \text{data to } 9 \frac{3}{4} \end{aligned}$$

$$\begin{aligned} \text{d) Score } Q_3 &= \text{data to } 9 + \frac{3}{4} (\text{data to } 10 - \text{data to } 9) \\ &= 4 + \frac{3}{4} (4 - 4) = 4 \end{aligned}$$

b. Percentile

The **percentile** of a set of numbers is the value that divides the group of numbers into 100 equal parts after the numbers have been arranged from smallest to largest.

Single Data Percentile

$$\text{Position } P_i = \text{data to } \frac{i(n+1)}{100}$$

$$i = 1, 2, \dots, 99$$

Example:

If the data is as follows: 9,3,8,4,5,6,8,7,5,7

Then try to determine P20 and P70.

Answer:

First, sort the data.: 3, 4, 5, 5, 6, 7, 7, 8, 8, 9

$$\text{Position } P_{20} = \text{data to } \frac{20}{10} = \text{data to } 2$$

$$\begin{aligned} \text{Score } P_{20} &= \text{data to } 2 + \frac{1}{5} (\text{data to } 3 - \text{data to } 2) \\ &= 4 + \frac{1}{5} (5 - 4) \\ &= 4 \frac{1}{5} \end{aligned}$$

$$\begin{aligned} \text{Position } P_{70} &= \text{data to } \frac{70(10+1)}{100} \\ &= \text{data to } 7 \frac{7}{10} \end{aligned}$$

$$\begin{aligned} \text{Score } P_{70} &= \text{data to } 7 + \frac{7}{10} (\text{data ke } 8 - \text{data to } 7) \\ &= 7 + \frac{7}{10} (8 - 7) \\ &= 7 \frac{7}{10} \end{aligned}$$

Percentile of Group Data

To find the percentile value for group data, the following formula can be used.

$$\left[\frac{\frac{in - F}{100}}{f} \right]$$

$$\text{Score } P_i = b + p ,$$

Where $i = 1, 2, \dots, 99$

Example :

Determine the percentile of group data from the following data :

Range of Score	Frequency
50 - 59	7
60 - 69	10
70 - 79	15
80 - 89	12
90 - 99	6

Range of Score	Frequency
Total	50

Answers :

To determine P₁₀, it is required = $10/100 \times 50$ data = 5 data. This means that P₁₀ is located in the first interval class with

$$b = 49,5; \quad p = 10; \quad F = 0; \quad f = 7$$

$$\begin{aligned} \text{Score} \quad P_{10} &= 49,5 + 10 \left[\frac{10 \cdot 50 - 0}{100} \right] \\ &= 49,5 + 7,14 \\ &= 56,64 \end{aligned}$$

To determine P₉₀ required = $90/100 \times 50$ data = 45 data, This means that P₉₀ is located in the 5th interval class, with b = 89.5; F = 44; f = 6.

$$\left[\frac{90 \cdot 50 - 44}{100} \right]$$

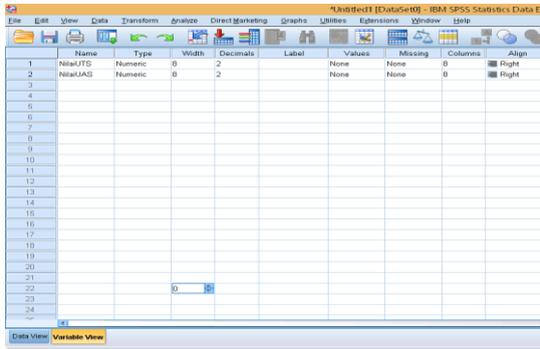
$$\begin{aligned} \text{Score of } P_{90} &= 89,5 + 10 \\ &= 89,5 + 1,67 = \mathbf{91,17} \end{aligned}$$

$$\begin{aligned} \text{Percentile Range} &= P_{90} - P_{10} \\ &= 91,17 - 56,64 \\ &= \mathbf{34,53} \end{aligned}$$

5. Data Centralization Analysis with SPSS

To perform data analysis, in addition to the calculations described above, you can also use SPSS to obtain the mean, median, and mode values. The mean is the average value, the median is the middle value, and the mode is the most frequently occurring value. SPSS is an application program used to assist with statistical calculations. Statistics is part of...

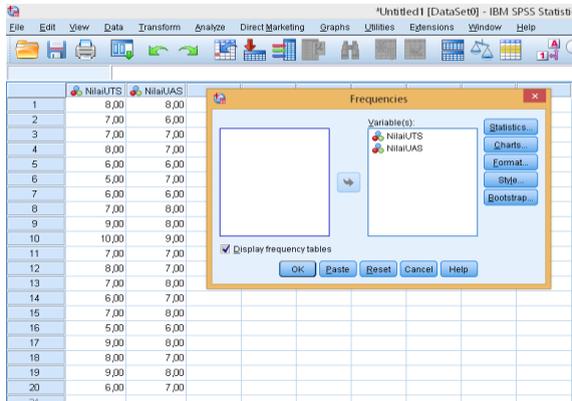
- 1) First, open SPSS.
- 2) Open variable view, then set it as shown in the image below.



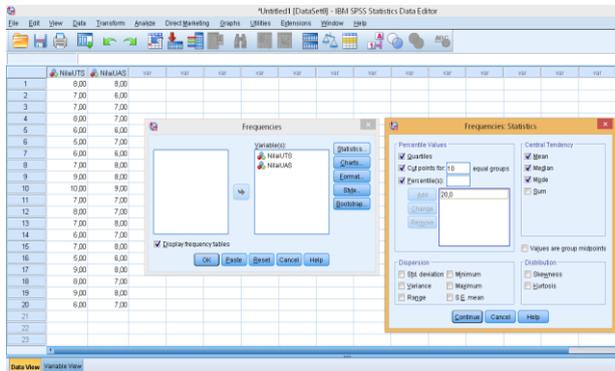
- 3) Click the dot on the values in the fruit column. Enter the value 1 for the mid-term exam score and 2 for the final exam score.
- 4) Then, press OK.
- 5) Return to Data View and enter the following data.

	NilaiUTS	NilaiUAS	var	var	var
1	8,00	8,00			
2	7,00	6,00			
3	7,00	7,00			
4	8,00	7,00			
5	6,00	6,00			
6	5,00	7,00			
7	6,00	6,00			
8	7,00	8,00			
9	9,00	8,00			
10	10,00	9,00			
11	7,00	7,00			
12	8,00	7,00			
13	7,00	8,00			
14	6,00	7,00			
15	7,00	8,00			
16	5,00	6,00			
17	9,00	8,00			
18	8,00	7,00			
19	9,00	8,00			
20	6,00	7,00			
21					

- 6) The next step is to process the data.
- 7) Click the Analyze menu and select Frequencies.



8) Then a window like this will appear. Move the data to be processed..



9) Then continue, and ready to use.

➔ **Frequencies**

Statistics			
		NilaiUTS	NilaiUAS
N	Valid	20	20
	Missing	0	0
Mean		7,2500	7,2500
Median		7,0000	7,0000
Mode		7,00	7,00
Sum		145,00	145,00
Percentiles	10	5,1000	6,0000
	20	6,0000	6,2000
	25	6,0000	7,0000
	30	6,3000	7,0000
	40	7,0000	7,0000
	50	7,0000	7,0000
	60	7,6000	7,6000
	70	8,0000	8,0000
	75	8,0000	8,0000
	80	8,8000	8,8000
90	9,0000	8,0000	

10) The SPSS data results can be seen as follows :

Statistics			
		NilaiUTS	NilaiUAS
N	Valid	20	20
	Missing	0	0
Mean		7,2500	7,2500
Median		7,2000 ^a	7,2667 ^a
Mode		7,00	7,00
Sum		145,00	145,00
Percentiles	10	5,3333 ^b	6,0000 ^b
	20	6,0000	6,3333
	25	6,2000	6,5000
	30	6,4000	6,6667
	40	6,8000	7,0000
	50	7,2000	7,2667
	60	7,6000	7,5333
	70	8,0000	7,8000
	75	8,2857	7,9333
	80	8,5714	8,1250
90	9,2500	8,6250	

a. Calculated from grouped data.

b. Percentiles are calculated from grouped data.

Mid Semester Test				
	Frequency	Percent	Valid Percent	Cumulative Percent
Valid	5,00	2	10,0	10,0
	6,00	4	20,0	30,0
	7,00	6	30,0	30,0
	8,00	4	20,0	20,0
	9,00	3	15,0	15,0
	10,00	1	5,0	5,0
	Total	20	100,0	100,0

C. Exercises

- 1) Determine the average height of the flag-raising team members from the following eight female students: 164, 165, 163, 160, 167, 165, 160, and 160 cm.
- 2) The average score for 15 students on a math test is 6.8. If five students take a make-up exam, the average score will be 7.0. What is the average score for the five students who took the make-up exam?
- 3) Calculate the average distance traveled by students from home to school for the group using the data in the following table::

Distance	Frequency
1 - 10	40
11 - 20	25
21 - 30	20
31 - 40	15

- 4) Explain the meaning of Median and solve the following questions?

Food Price (Rp)	Total Sold
5500	10
7500	8
8500	12
9000	8
9500	7
Number	45

- 5) Explain the meaning of Mode and solve the following problem.
 - a) Determine the Mode of the following numerical data:
2, 3, 2, 4, 5, 7, 4, 3, 5, 6, 7, 3, 8, 6, 9, 3, 10, 8
 - b) Determine the Mode of the following numerical data:
2, 3, 2, 4, 5, 7, 4, 3, 5, 6, 2, 7, 3, 8, 6, 9, 3, 10, 2, 8
 - c) Determine the Mode for the following age group data::

Class of Interval (Age)	Frequency
20 - 29	3
30 - 39	7

Class of Interval (Age)	Frequency
40 - 49	8
50 - 59	6
60 - 69	12
70 - 79	7
80 - 89	5
Total	48

6) Process the following central tendency data using SPSS for the following data:

a) Data: 7, 8, 6, 5, 6, 9, 10, 6, 7, 5, 8, 9, 6, 7, 6, 7

b) Data: 45, 44, 42, 29, 25, 35, 46, 56, 54, 27

CHAPTER 05

DESCRIPTIVE STATISTICS (VARIABILITIES)

Main Competencies

Students are able to explain and analyze measures of data dispersion or variability in research and use SPSS to measure dispersion/variability.

Indicators

- 1) Students are able to understand and explain measures of data dispersion.
- 2) Students are able to analyze the Range Value.
- 3) Students are able to analyze the Mean Deviation.
- 4) Students are able to analyze the Standard Deviation.
- 5) Students are able to analyze the Skewness Measure.
- 6) Students are able to analyze Kurtosis.
- 7) Students are able to analyze Deviation using SPSS.

A. Definition of Data Variability (Measures of Dispersion)

MEASURES of Spread or Variability are measures that indicate how much data values differ or vary from a central value, or how

large the deviation is. Data variation can be smaller or larger, positive or negative. However, if all or all of the data in a group are the same and there are no differences, the data is said to be homogeneous. If all or all of the data in a group are not the same and there are many differences, the data can be said to be heterogeneous. Understanding the homogeneity and heterogeneity of data within a group is crucial not only for identifying the characteristics of the group but also for understanding the differences between two or more groups.

Some forms of variability or measures of data dispersion include:

- 1) Distance Value
- 2) Mean Deviation
- 3) Standard Deviation
- 4) Skewness Measure
- 5) Kurtosis

Calculating Distance Value

Distance value is the difference between the highest or furthest value and the lowest or shortest value. Distance value is one of the easiest and simplest measures of data dispersion.

The following formula is used to calculate distance value :

$$NJ \text{ (Distance Value)} = X2 - X1$$

Where:

NJ = Distance Value

X2 = Highest Value

X1 = Lowest Value

Example:

City X is known to be 10 km from Pekanbaru City and City Y is 120 kilometers from Pekanbaru City. Calculate the distance between City X and City Y.

Answer:

$$NJ \text{ (Distance Value)} = X_2 - X_1$$

$$NJ \text{ (Distance Value)} = 120 - 10$$

$$= 110 \text{ km}$$

Therefore, the distance from City X to City Y is 110 km.

B. Calculating the Mean Deviation

The mean deviation of a set of numbers is the average of the absolute values of its deviations.

1. Mean Deviation for Single Data

To calculate the mean deviation for single data, use the following formula :

$$SR = \frac{\sum |x - \bar{x}|}{n}$$

SR = Mean Deviation

x = i -th data point (weighted data)

\bar{x} = Midpoint of i -th class interval (group data)

Example:

The math test scores of 6 students are: 7, 5, 6, 3, 8, and 7.

Determine the mean deviation

Answers:

$$\bar{x} = \frac{7 + 5 + 6 + 3 + 8 + 7}{6}$$

$$\bar{x} = 6$$

$$SR = \frac{(7-6) + (5-6) + (6-6) + (3-6) + (8-6) + (7-6)}{6}$$

$$SR = \frac{8}{6} = 1,33$$

2. Mean Deviation of Group Data

To calculate the Mean Deviation of Group Data, the following formula is used :

$$SR = \frac{\sum f|x - \bar{x}|}{\sum f}$$

Descriptions :

SR = Mean Deviation

x = i-th data point (weighted data)

\bar{x} = Midpoint of i-th class interval (group data)

f = Frequency

Example:

Determine the Mean Deviation for the Following Data

SR = Mean Deviation

x = i-th Data (weighted data)

\bar{x} = Midpoint of i-th class interval (group data)

f = Frequency

Determine the Mean Deviation for the Following Data:

Data	Frequency	X
3 - 5	2	4
6 - 8	4	7
9 - 11	8	10
12 - 14	6	13
Total	20	

Answer:

Create a tabulation like the one below:

Data	Frequency	x	f.x	$ x - \bar{x} $	f $ x - \bar{x} $
3 - 5	2	4	8	5,7	11,4
6 - 8	4	7	28	2,7	10,8
9 - 11	8	10	80	0,3	2,4
12 - 14	6	13	78	3,3	19,8
Total	20		194		44,4

$$\begin{aligned}\bar{x} &= \frac{\sum f \cdot x}{\sum f} \\ &= \frac{194}{20} = 9,7\end{aligned}$$

$$SR = \frac{\sum f |x - \bar{x}|}{\sum f}$$

$$SR = \frac{44,4}{20} = 2,22$$

C. Calculating Standard Deviation

Standard Deviation is the standard deviation (S) of a set of numbers. It is the square root of the sum of the squared deviations of those numbers divided by the number of numbers, or the square root of the mean square deviation, or the square root of the variance. It indicates the standard deviation of the data from its mean.

Analysis of calculating Standard Deviation can also be grouped into two types: Standard Deviation for Single Data and Grouped Data, as below:

Standard Deviation for Single Data

$$S = \sqrt{\frac{\sum (x_i - \bar{x})^2}{n}} \quad \text{atau} \quad S = \sqrt{\frac{\sum x^2}{n} - \left[\frac{\sum x}{n} \right]^2}$$

S = Standar Deviation

Example :

Determine the standard deviation of the data : 2,3,5,8,7.

$$\begin{aligned}\text{Answer :} \\ S &= \sqrt{\frac{\sum (x_i - \bar{x})^2}{n}} \\ &= 5\end{aligned}$$

x	$(x - \bar{x})$	$(x - \bar{x})^2$
2	-3	9
3	-2	4
5	0	0
8	3	9
7	2	4
		26

$$\begin{aligned}
 S &= \sqrt{\frac{\sum (x - \bar{x})^2}{n}} \\
 S &= \sqrt{\frac{26}{5}} \\
 S &= \sqrt{5,2}
 \end{aligned}$$

D. Standard Deviation of Group Data

The Standard Deviation of Group Data is found using the following formula and analysis:

$$S = \sqrt{\frac{\sum f(x - \bar{x})^2}{\sum f}} \quad \text{atau} \quad S = \sqrt{\frac{\sum fx^2 - \left[\frac{\sum fx}{\sum f} \right]^2}{\sum f}}$$

Example:

Calculate the standard deviation of the following group data.

Data	f	x	fx	x ²	Fx ²
3 - 5	2	9	8	16	32
6 - 8	4	4	28	49	195
9 - 11	8	0	80	100	800
12 - 14	6	9	78	169	1014
Total			194		2042

Answer :

$$\begin{aligned} S &= \sqrt{\frac{\sum fx^2}{\sum f} - \left[\frac{\sum fx}{\sum f} \right]^2} \\ S &= \sqrt{\frac{2042}{20} - \left[\frac{194}{20} \right]^2} \\ S &= \sqrt{8,01} = 2,83 \end{aligned}$$

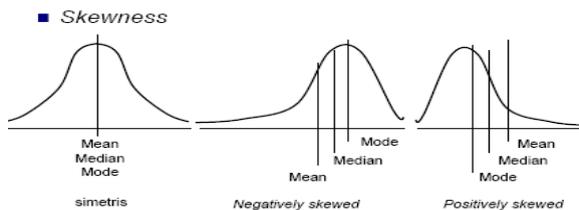
E. Calculating the Slope of a Curve (Skewness)

The measure of the slope of a data distribution curve (skewness) is given by Pearson, and is therefore called the Pearson skewness coefficient. Skewness defines a value that indicates how far the distribution deviates from symmetry:

- 1) The mean tends to shift towards
- 2) Values that are too large or too small.
- 3) The more skewed the distribution, the greater the distance between the mean and the mode; this distance is used as a measure of the distribution's skewness.

The formula used to calculate the slope of the curve is as follows :

$$J = \frac{3(\bar{x} - M_e)}{s}$$



Description:

J = skewness coefficient

\bar{x} = mean

Me = Median

s = standard deviation

The formula above is used for both ungrouped and grouped data.

- 1) If $\alpha = 0$ or close to zero, the data distribution is said to be symmetric.
- 2) If α is negative, the data distribution is said to be skewed to the left.
- 3) If α is positive, the data distribution is said to be skewed to the right.

The larger α , the more skewed or asymmetric the data distribution.

Example:

Determine the skewness value and test the direction of the skewness, and draw a graph of the data in the following table!

Test Score	Frequency
31 - 40	4
41 - 50	3
51 - 60	5
61 - 70	8
71 - 80	11
81 - 90	7
91 - 100	2
Total	40

Answer :

$$\bar{X} = 67,5$$

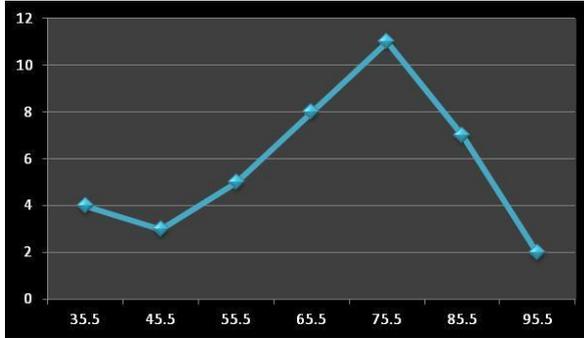
$$M_0 = 74,94$$

$$M_e = 70,5$$

$$s = 16,3$$

$$sk = \frac{\bar{X} - M_0}{s} = \frac{67,5 - 74,94}{16,2} = -0,46$$

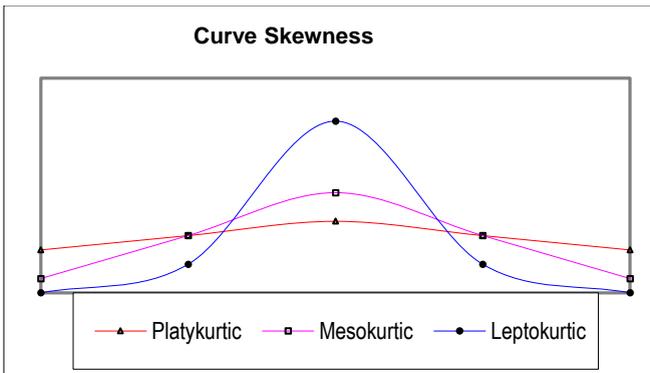
Because the skewness value is negative, the curve is skewed to the left (negatively skewed).



F. Calculating Kurtosis

Kurtosis (curve steepness) is the degree of steepness of a distribution compared to a normal distribution. To calculate the curve steepness, or kurtosis, use the following formula: :

$$KK = \frac{Q_3 - Q_1}{2(P_{90} - P_{10})}$$



Description:

KK > 3 : Leptokurtic curve (very sharp peak)

KK < 3 : Platykurtic curve (slightly flat peak)

KK = 0 : Mesokurtic curve (not very sharp peak or normal distribution)

Example:

From a set of data arranged in a frequency distribution table, the values of $Q1 = 55.24$; $Q3 = 73.64$; $P10 = 44.5$; $P90 = 82.5$ are known. Determine the kurtosis coefficient for the data curve.

Answer:

$$\begin{aligned} KK &= \frac{73,64 - 55,24}{2(82,5 - 44,5)} \\ KK &= \frac{18,4}{2(38)} = \mathbf{0,242} \end{aligned}$$

Because the KK value is <3 , the distribution curve is platykurtic.

G. Data Variability Analysis with SPSS

To obtain data variability values using SPSS, follow these steps:

- 1) Open SPSS.
- 2) Enter the data to be analyzed into Data View.

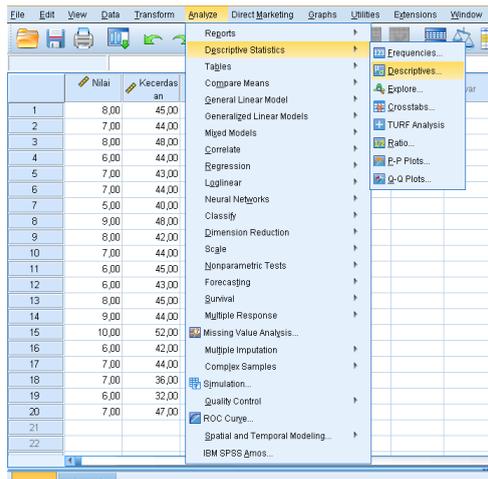
8,00	45,00
7,00	44,00
8,00	48,00
6,00	44,00
7,00	43,00
7,00	44,00
5,00	40,00
9,00	48,00
8,00	42,00
7,00	44,00
6,00	45,00
6,00	43,00
8,00	45,00
9,00	44,00
10,00	52,00
6,00	42,00
7,00	44,00

7,00 36,00
 6,00 32,00
 7,00 47,00

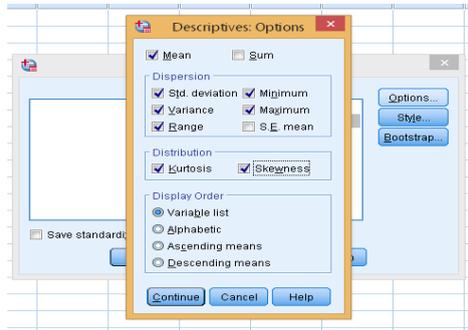
- 3) Then type Data Type: Values and Intelligence
- 4) Then press ok.
- 5) Return to Data View, fill in the data you want to analyze.

	Nilai	Kecerdasan	var	var	var	var	var
1	8,00	45,00					
2	7,00	44,00					
3	8,00	48,00					
4	6,00	44,00					
5	7,00	43,00					
6	7,00	44,00					
7	5,00	40,00					
8	9,00	48,00					
9	8,00	42,00					
10	7,00	44,00					
11	6,00	45,00					
12	6,00	43,00					
13	8,00	45,00					
14	9,00	44,00					
15	10,00	52,00					
16	6,00	42,00					
17	7,00	44,00					
18	7,00	36,00					
19	6,00	32,00					
20	7,00	47,00					

- 6) Click Analyze and then select Descriptives



- 7) Next, enter the two groups of numbers in the data view into the small box and click on the option and check the box to select the type of data to be analyzed for Variability Data as follows:



8) Then press continue and click ok, and the results will be as below

Descriptive Statistics

	N	Range	Minimum	Maximum	Mean		Std. Deviation	Variance	Skewness		Kurtosis	
	Statistic	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic	Statistic	Statistic	Std. Error	Statistic	Std. Error
Nilai	20	5,00	5,00	10,00	7,2000	,27720	1,23989	1,537	,501	,512	,067	,992
Kecerdasan	20	20,00	32,00	52,00	43,6000	,94423	4,22275	17,832	-,966	,512	2,708	,992
Valid N (listwise)	20											

The image above shows the statistical range, standard deviation, variance, skewness, and kurtosis values of the analyzed data.

H. Exercise:

- 1) Explain the meaning of variability and state its types.
- 2) If Village A is 15 km from Village B and Village C is 145 km from Village B, calculate the distance from Village B to Village C.
- 3) If the economics test scores of 8 students are: 6, 7, 7, 5, 6, 3, 8, and 7, calculate the mean deviation.
- 4) Determine the mean deviation.
- 5) Determine the mean deviation of the following data set

Data	Frequency (f)	X
3 - 5	3	4
6 - 8	4	7

Data	Frequency (f)	X
9 - 11	8	10
12 - 14	6	13
15 - 17	4	15
Total	25	

- 6) Determine the Standard Deviation of the following data: 4,6,5,8,7,9,6,7.
- 7) Determine the Standard Deviation of the following data group:

Data	Frequency (f)	X
3 - 5	3	4
6 - 8	4	7
9 - 11	8	10
12 - 14	6	13
15 - 17	4	15
Total	25	

- 8) Determine the Skewness value and test the direction of the slope and draw a graph of the data in the following table!

Test Score	Frequency
31 - 40	7
41 - 50	4
51 - 60	5
61 - 70	9
Total	25

- 9) A group of data arranged in a frequency distribution table has the following values: $Q_1 = 45.24$; $Q_3 = 64.64$; $P_{10} = 41.5$; $P_{80} = 87.5$. Determine the kurtosis coefficient for the data curve.
- 10) Analyze the variability of the data presented below. :

IQ Test	Score
80	7
70	7
90	9
88	8
78	8
79	7

IQ Test	Score
91	9
77	8
94	9
98	9

CHAPTER 06

INFERENTIAL STATISTICS (HYPHOTESIS TESTING)

Main Competencies

Students are able to explain and conduct inferential statistical analysis (hypothesis testing) in research and use SPSS in hypothesis testing.

Indicators

- 1) Students are able to understand and explain Inferential Statistics
- 2) Students are able to understand and explain Hypotheses
- 3) Students are able to explain Significance and Confidence Level
- 4) Students are able to explain Degrees of Freedom (Df)
- 5) Students are able to analyze Hypothesis Tests
- 6) Students are able to analyze Hypothesis Tests using SPSS

A. Definition of Inferential Statistics

INFERENTIAL statistics can be defined as statistics used to generalize sample data to a population. Inferential statistics is a continuation of descriptive statistics, as explained in the previous section. Inferential statistics are used to perform calculations or

statistical tests to draw general conclusions or make predictions or forecasts; therefore, these statistics are also known as inductive statistics.

Inferential statistics can generally be divided into two categories:

- 1) **Parametric statistics** is the science of statistics that considers the type of data distribution, namely whether the data is normally distributed or not. In general, if the data is not normally distributed, then the data must be processed using non-parametric statistical methods, or at least transformed to ensure the data follows a normal distribution, allowing it to be processed with parametric statistics. Examples of parametric statistical methods include the z-test (1 or 2 samples), t-test (1 or 2 samples), Pearson correlation, Experimental Design (1 or 2-way parametric ANOVA), etc. In parametric statistical analysis, the data used are normally distributed and have an interval or ratio scale.
- 2) **Non-parametric statistics** are distribution-free statistics (they do not require the distribution of population parameters to be normal or not). Non-parametric statistics are typically used to analyze nominal or ordinal data. Nominal and ordinal data are not normally distributed. Examples of non-parametric statistical methods: Binomial test, Chi-square test, Median test, Friedman test, etc. Non-parametric statistics, also known as distribution-free statistics, can be used on data that has a normal distribution or not and has a nominal or ordinal scale.

In short, the difference is that if the data has a normal distribution, parametric statistics are used. If the data does not have a normal distribution, nonparametric statistics are used.

In inferential statistics, hypothesis testing is one of the objectives that must be carried out to rationally answer research problems. The purpose of hypothesis testing is to determine whether the theoretical answer contained in the hypothesis statement is supported by the facts collected during the research

process. Hypothesis testing (which describes population characteristics) using sample data (which describes sample characteristics) is essentially a decision-making process through an inference process that requires researcher accuracy in making estimates.

B. Hypothesis

A hypothesis is a statement whose validity is still weak and needs to be proven, or a tentative assumption. This hypothesis needs to be tested before being accepted or rejected.

In other words, a hypothesis is an assumption or supposition that may be true or false about something, and is made to explain something and therefore requires further verification.

- 3) Assumptions or suppositions are often used as the basis for decisions or determinations in planning or other areas, whether in economics, business, education, or other fields.
- 4) The requirements for a hypothesis are as follows:
 - Stated as a declarative sentence
 - Involves at least two research variables
 - Contains a prediction
 - Must be testable
- 5) Rejecting a hypothesis does not mean concluding that the hypothesis is false, as evidence inconsistent with the hypothesis is lacking. Accepting a hypothesis simply results from insufficient evidence to reject it and does not imply that the hypothesis is necessarily true. In general, hypotheses can be divided into two types:
 - Correlative Hypothesis, which states whether or not there is a relationship between two or more variables.
 - Comparative Hypothesis, which states whether or not there is a difference between two or more groups.
 - Furthermore, the formulation of a hypothesis can be done as follows:
 - Stated as a declarative sentence.

- Involves at least two research variables.
- Contains a prediction.
- Must be testable.

The formulation of a hypothesis can be divided into two types:

- 1) Null Hypothesis (H_0): a statement to be tested; the hypothesis has no difference or zero difference from the true hypothesis.
- 2) Alternative Hypothesis (H_a): any hypothesis that differs from the null hypothesis. The choice of this hypothesis depends on the nature of the problem at hand.
- 3) Significance Level and Confidence Level

The significance level is the tolerance limit for accepting errors in the hypothesis results relative to the population parameter value. The significance level depends on the decision maker's willingness to tolerate the magnitude of the error.

This magnitude of error is referred to as the critical region of the test/rejection region. The significance level is denoted by α (alpha), and is also called the risk level because it describes the risk of rejecting the null hypothesis when it is actually true.

There is no single significance level that applies to all research involving sampling. We must decide whether to use a significance level of 0.05 (called the 5 percent level), a level of 0.01, or some other level between 0 and 1.

Generally, a significance level of 0.05 is used in research activities, while 0.01 is chosen for quality control, and 0.10 is used for collecting social science opinion polls.

C. Degrees of Freedom (DF)

The term "degrees of freedom" is defined as the total number of observations in the sample ($= N$) minus the number of independent (linear) controls or restrictions placed on those observations. In other words, the number of degrees of freedom is the number of independent observations out of a total of N

observations. Therefore, the general formula for determining degrees of freedom (df) is the total number of observations (N) minus the number of estimated parameters, or $df = N - \text{number of estimated parameters } (k)$. (Gujarati, 1978).

Based on this understanding, it can be understood that the degrees of freedom formula will differ from one observation case to another, depending on the number of parameters being estimated. Therefore, the degrees of freedom formula can be $df = N - 2$ or $df = N - 3$, depending on the number of parameters (variables) being estimated. For example, if we want to study two variables, the degrees of freedom are $df = N - 2$. Why $N - 2$? Because there are two variables.

Another important thing to understand in the study of degrees of freedom is its relationship to sampling research. The basic idea is that each time we estimate a parameter (population characteristic), we lose one degree of freedom. Therefore, the degrees of freedom, as proposed by Gujarati (1978), will always be $N - k$, not N . To understand this, consider the following explanation: Suppose there is a population with a mean of 10. We are then allowed to sample 10 people from that population. The question is, how many people can we freely sample?

For example, if we take the first person at random, they have a score of 14. The second person is still at random, they have a score of 8. Then, successively, the third person through the ninth are taken at random, with scores of 15, 6, 11, 14, 8, 6, and 5. What about the tenth person? Is it taken at random? The answer is, of course, no. The tenth person cannot be taken at random. Once there are 9 numbers, the tenth number can no longer be determined freely to obtain the same estimate (i.e., mean = 10). For example, the sum of the scores of the nine people is 87. To obtain the same estimate, i.e., mean = 10, the tenth person must be determined at 13. Thus, we can say we have lost one degree of freedom. This degree of freedom is then used to look at certain table values, for example, the t-table.

In our calculation, we only estimated one parameter. Therefore, we only lost one degree of freedom, so our degrees of freedom are $N - 1$, i.e., $10 - 1 = 9$.

D. Hypothesis Testing in Research

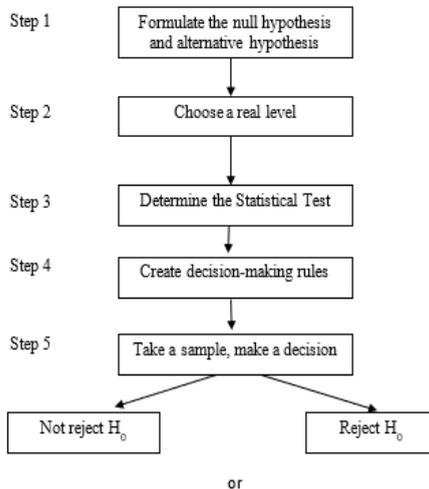
Hypothesis testing is a procedure that will result in a decision, namely the decision to accept or reject a hypothesis.

In conducting a hypothesis test, there are many determining factors, such as whether a large or small sample size is taken, whether the population standard deviation is known, whether the population variance is known, what parametric method is used, etc.

In general, the hypothesis testing procedure is carried out through the following stages:

- 1) Determining the hypothesis formulation
- 2) Determining the significance level
- 3) Determining the test criteria
- 4) Determining the test statistic value
- 5) Drawing conclusions

The stages or steps in conducting a hypothesis test can be seen briefly in the following chart.:



To explain the image above, the steps involved in hypothesis testing are as follows:

Step 1: Formulate the null and alternative hypotheses

- 1) The first step is to formulate the hypothesis to be tested. This hypothesis is called the null hypothesis (H_0) (pronounced H zero).
- 2) The alternative hypothesis describes what you would conclude if you reject the null hypothesis. The alternative hypothesis is written as H_1 (pronounced H one).

Step 2: Determine the Significance Level/Level of Realism

- 1) In the next step, we must determine the significance level to be used or make a decision whether to use a level of 0.05 (called a 5 percent significance level), a level of 0.01 (called a 1 percent significance level), or another level between 0 and 1.

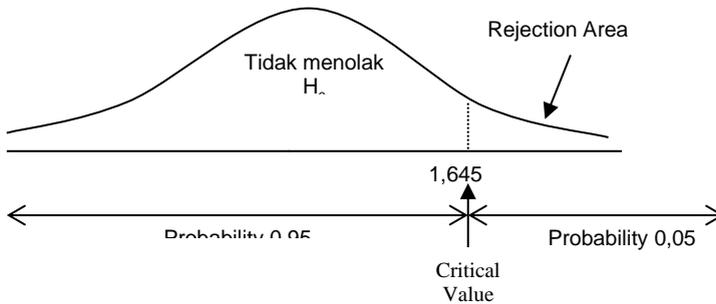
Step 3: Submit the Statistical Test

- 1) This is a value determined based on information from the sample and will be used to determine whether to accept or reject the hypothesis.
- 2) There are various statistical tests; here we will use statistical tests such as the z-test, student t-test, F-test, and Chi^2 (chi-square).

Step 4: Decision Statement

- 1) The decision statement is a statement of the conditions under which the null hypothesis is rejected and the conditions under which the null hypothesis is not rejected.
- 2) The following figure illustrates the rejection region for a significance level test. :

Sampling Distribution for Statistics z



Note in the figure above that:

- 1) The region where the null hypothesis is not rejected includes the region to the left of 1.645.
- 2) The rejection region is to the right of 1.645.
- 3) A one-tailed test is applied.
- 4) A significance level of 0.05 is chosen.
- 5) The value of 1.645 separates the regions where the null hypothesis is rejected from those where it is not.
- 6) The value of 1.645 is called the critical value.

Step 5: Making a Decision

- 1) The final step in the statistical test is making a decision whether or not to reject the null hypothesis.
- 2) The decision to reject the null hypothesis is made because the test statistic value lies in the rejection region.
- 3) It should also be noted that the decision to reject or not is made by the researcher conducting the study.
- 4) These results are recommendations based on sample evidence that the researcher can provide to top managers as decision-makers, but the final decision is usually still made by the top managers.

Example:

A student registration procedure at a particular university takes an average of 50 minutes. This time is considered quite long, so a new procedure has been developed. The goal is to determine whether the new procedure being tested is effective and time-

efficient. A sample of 12 students was taken during registration, and the average time was 42 minutes with a standard deviation (s) of 11.9 minutes. The hypothesis was tested using a significance level of $\alpha = 0.05$ (using a one-tailed test).

Answer :

Ho : U = 50 minutes

H1 : u < 50 minutes

A = 0.05

Critical Value: T < -1.796, where

$$t = \frac{\bar{x} - u_0}{s / \sqrt{n}}$$

dengan derajat bebas $v = 12 - 1 = 11$

Calculation: $\bar{x} = 42$ minutes, $s = 11,9$ minutes and $n = 12$

So,

$$t = \frac{\bar{x} - u_0}{s / \sqrt{n}} = \frac{42 - 50}{11.9 / \sqrt{12}} = -2.33$$

Keputusan: Tolak Ho pd taraf nyata 0.05, karena:

$t = -2.33$ berada dalam daerah kritis. Dengan demikian dapat dibuat kesimpulan bahwa prosedur registrasi yang baru lebih efisien dalam hal waktu

Juika menggunakan 2 arah, maka yang membedakan hanya daerah kritis

$$- Z_{\alpha/2; (n-1)} \text{ dan } Z_{\alpha/2; (n-1)}$$

So :

1) Ho : u = 50 minutes

2) H1 : u \neq 50 minutes

3) A = 0.05

4) Critical area: $Z < -2.201$ dan $Z > 2.201$ where

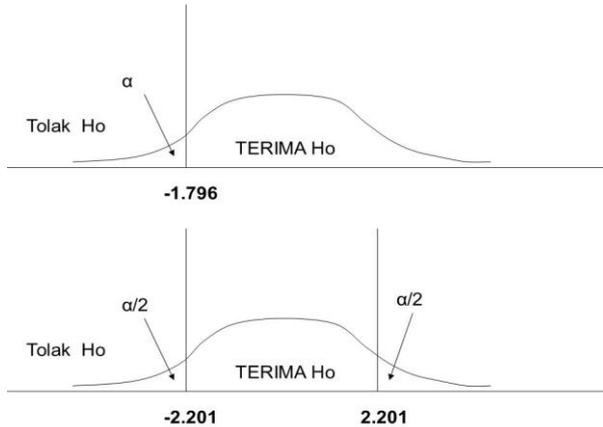
$$Z = \frac{\bar{x} - u_0}{s / \sqrt{n}} \text{ with degrees of freedom } v = 12 - 1 = 11$$

5) Calculation : $\bar{x} = 42$ minutes, $s = 11.9$ minutes dan $n=12$

$$\text{so: } Z = \frac{42 - 50}{11.9 / \sqrt{12}} = -2.33$$

- 6) The decision to reject H_0 because of $t_{\text{count}} = -2.33$ is in the critical area for two-way testing.

The conclusion is that the new registration procedure takes an average time not equal to 50 minutes, and in reality is less than 50 minutes.



E. Hypothesis Testing Analysis with SPSS

Calculations or analysis using SPSS are performed after first identifying the data and variables. The following is an example of a hypothesis testing analysis using SPSS.

Example:

A sales agent receives a shipment of canned fruit from a supplier. According to the information received from the supplier, the average weight of the cans is 16 grams. The agent is skeptical and tests 10 random samples of canned fruit before accepting the shipment in his delivery van. The following data is the result of observations of 12 samples on one delivery day.

Number	Fruit Weight (Kg)
1	14,42
2	17,23
3	15,84
4	14,46

Number	Fruit Weight (Kg)
5	16,78
6	16,02
7	16,44
8	15,69
9	15,88
10	17,26
11	15,42
12	16,34

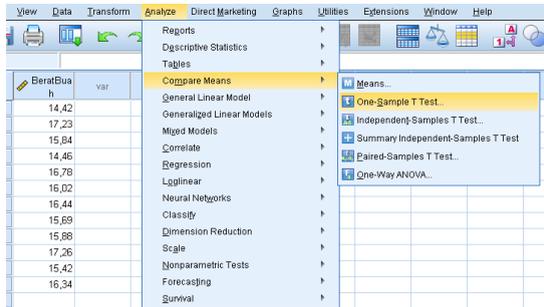
Conduct an analysis to test whether the results of the fruit can weight test conducted by the sales agent match the supplier's information.

The next step is to compare the calculated t-value with the t-table.

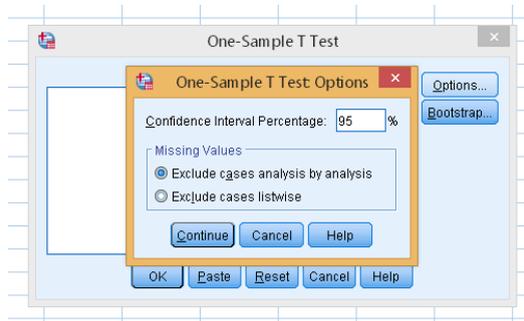
- 1) If the calculated t-value $>$ t-table, then H_0 is rejected, meaning the expected mean value differs from the mean value of the sample measurements.
- 2) However, if the calculated t-value $<$ t-table, then H_0 is accepted, meaning the compared means are the same.

The next steps to conduct a hypothesis test using SPSS are as follows:

- 1) Create a Fruit Weight variable in variable view.
- 2) In data view, type the observed values, with values ranging from 14.42, 17.23, to 16.34, as shown in the image below.
- 3) In the Analyze menu, select Compare Means $>$ One Sample T-Test, as shown below. :



- 4) After the process is complete, the following display will appear:
- 5) Move the variable to the right and in the test value, fill it with a value of 16, then click the option button and fill in the Confident Level with 95.



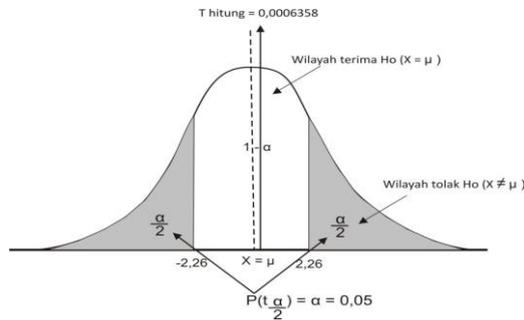
- 6) Click the Continue button and click OK, then the SPSS report will appear as follows :

One-Sample Statistics						
	N	Mean	Std. Deviation	Std. Error Mean		
BeratBuah	12	15,9817	,92220	,26622		
One-Sample Test						
Test Value = 0						
					95% Confidence Interval of the Difference	
	t	df	Sig. (2-tailed)	Mean Difference	Lower	Upper
Berat Buah	60,033	11	,000	15,98167	15,3957	16,5676

- 7) The results of the SPSS calculations are the same as the manual calculations, where the mean value indicates the sample average $X = 15,981$ dengan standard error $S_x = 0,26622$.
- 8) T-value = 0,006 value $p(t) = 0,995$ and CI Difference is $0,1539 \leq D \leq 0,1656$.
- 9) Decision making

Because the CID crosses zero, the compared means are insignificant, or H_0 is accepted.

In addition to using the calculated t-test with the t-table and CID, we can also use the sig of (two-tailed t-test), which is actually the area under the curve bounded by $-t$ and t . As shown in the image below.



- 10) From the figure above, it is clear that the sig value of (two-tailed t) is the probability value under the normal curve, limited by the calculated t value $p(t)$. If the sig value $> \alpha$, then H_0 is accepted and H_a is rejected. Conversely, if the sig value $\leq \alpha$, then H_0 is rejected and H_a is accepted.
- 11) Because the $p(t)$ value is greater than α (0.05), this value falls within the acceptance range for H_0 . Therefore, H_0 is accepted and H_a is rejected. It can be concluded that, at a 95% confidence level, the observed can weight values made by the wholesaler match the information provided by the supplier.

F. Exercise:

- 1) Explain the meaning of inferential statistics and what analyses can be performed using inferential statistics.
- 2) Explain the meaning of hypothesis and hypothesis testing, and provide examples.
- 3) Explain significance and degrees of freedom.
- 4) Conduct a hypothesis test with the following data:
 - H1: There is an influence of learning motivation on student learning achievement
 - H0: There is no influence of learning motivation on student learning achievement

Learning Motivation	Learning Achievement
45	7
44	6
53	8
65	9
53	8
48	7
57	7
62	8
51	7
58	8

- Use SPSS to conduct a hypothesis test on the data above.!

CHAPTER 07

INFERENTIAL STATISTICS (REGRESSION AND CORRELATION TEST)

Main Competencies

Students are able to explain and conduct inferential statistical analysis (correlation tests) in research and use SPSS for correlational tests.

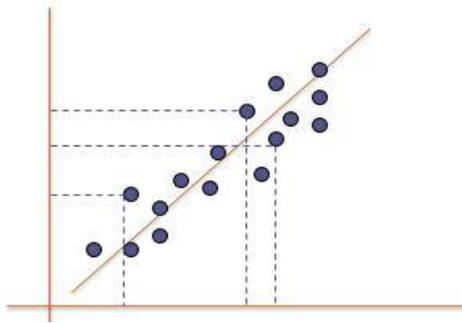
Indicators

- 1) Students are able to understand and explain correlation tests.
- 2) Students are able to explain the types of correlation tests.
- 3) Students are able to analyze correlation tests.
- 4) Students are able to analyze correlation tests using SPSS.

A. Definition of Correlation Test

IN inferential statistics, the correlation test is a type of test frequently used in research data analysis. A correlation test is an analytical tool used to determine the relationship between independent variables and dependent variables. Correlation analysis is conducted to analyze the relationship between two or more quantitative variables.

Variables are said to be correlated if changes in one variable are followed by changes in the other variable. To see a graph showing a correlation, see the following figure. :



Several things to know about correlation tests:

- 1) Correlation values range from -1 to 1.
- 2) If X and Y are independent, the correlation will be 0.
- 3) Although correlation measures the degree of relationship, it is not a causal test.
- 4) Correlation in a population is usually symbolized by ρ (rho), while in a sample it is symbolized by r .
- 5) The measure of the degree of relationship is called the Correlation Coefficient.
- 6) The relationship between two variables can be due to mere chance or a causal relationship.
- 7) Two variables are correlated if they change regularly, in the same direction or in opposite directions.
- 8) In correlation analysis, in addition to measuring the fit of the regression line to the sample data (called the Coefficient of Determination), it also measures the closeness of the relationship between the variables (called the Correlation Coefficient).

B. Types of Correlation Tests in Research

In correlation tests, the relationship between variables can be in the form of a simple correlation or paradigm, or multiple paradigms. For relationships with simple paradigms, the analysis

is conducted using partial correlation. This correlation occurs when one independent variable is related to one dependent variable. However, when multiple independent variables are related to one dependent variable, this is called multiple correlation..

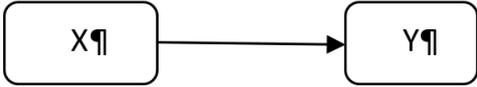


Figure 7. 1 Simple Correlation (Partial)

The image above shows the relationship between variable X and variable Y and because it only connects 2 variables, it is called a simple correlation.

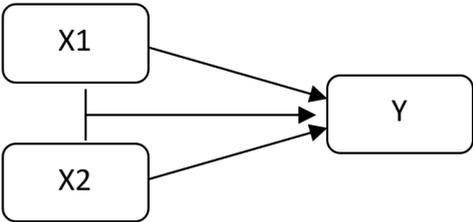


Figure 7. 2 Multiple Correlation

Meanwhile, the image above shows the relationship between variables X1 and X2 with variable Y. Because it only connects more than two variables, it is called a multiple correlation.

To determine the level of relationship between variables, the Guilford Criterion is used, described as follows :

- <0,2 = Correlation very weak
- 0,2-<0,4 = Correlation week
- 0,4-<0,7 = Correlation strong enough
- 0,7-<0,9 = Correlation strong
- 0,9-<1,0 = Correlation very strong
- 1,0 = Hubungan sempurna

C. Analysis in Correlation Tests

Some correlation tests commonly used in statistical analysis are as follows:

1. Product Moment Correlation (Pearson)

For a data set (X_i, Y_i) of size n , the correlation coefficient can be calculated using the formula:

$$r = \frac{n \sum X_i Y_i - (\sum X_i)(\sum Y_i)}{\sqrt{\{n(\sum X_i^2) - (\sum X_i)^2\} \{n(\sum Y_i^2) - (\sum Y_i)^2\}}}$$

Example:

The data on the number of credits and GPA of students at a university are as follows :

Number of Credits (X)	GPA (Y)
10	3
10	2,5
15	2
10	1,5
5	1

Determine the product moment correlation analysis value for the data above?

Answer:

Create a table as follows :

No	X_i	Y_i	$X_i Y_i$	X_i^2	Y_i^2
1	10	3,00	30	100	9,00
2	10	2,50	25	100	6,25
3	15	2,00	30	225	4,00
4	10	1,50	15	100	2,25
5	5	1,00	5	25	1,00
n=5	$\sum X_i = 50$	$\sum Y_i = 10$	$\sum X_i Y_i = 105$	$\sum X_i^2 = 550$	$\sum Y_i^2 = 22,5$

$$r = \frac{5(105) - (50)(10)}{\sqrt{\{5(550) - (50)^2\}\{5(22,5) - (10)^2\}}}$$

$$= \frac{25}{\sqrt{(250)(12,5)}} = 0,447$$

These results reveal a positive correlation between the number of credits (X) and the GPA obtained (Y).

2. Spearman Rank Correlation

This correlation coefficient measures the closeness of the relationship between two ordinal variables. This correlation coefficient is called the rank correlation coefficient or Spearman correlation coefficient, symbolized by r.

We arrange the observed data pairs (X_i, Y_i) according to the order of their magnitude in each variable. Then, we form the difference or rank difference between the X_i and Y_i ranks of the original paired data. This difference is symbolized by b_i , and the rank correlation coefficient r is calculated using the formula

$$r = 1 - \frac{6 \sum b_i^2}{n(n^2 - 1)}$$

The following data is the assessment of 2 judges of 8 competition participants.

Participant	Judge I	Judge II
A	70	80
B	85	75
C	65	55
D	50	60
E	90	85
F	80	70
G	75	90
H	60	65

Determine the Spearman Rank Correlation Coefficient!

Answer:

Create a table as follows :

Participant	Judge I	Judge II	Difference (b _i)	b _i ²
A	5	3	2	4
B	2	4	-2	4
C	6	8	2	4
D	8	7	1	1
E	1	2	-1	1
F	3	5	-2	4
G	4	1	3	9
H	7	6	1	1
Number	-	-	-	28

$$r = 1 - \frac{6 \sum b_i^2}{n(n^2 - 1)} = 1 - \frac{6(28)}{8(64 - 1)} = 0,667$$

The Spearman Rank Coefficient value is 0,667

3. Multiple Correlation

This correlation coefficient regulates the relationship between two independent variables (X₁ and X₂), so r is calculated using the formula:

$$r_{y \ x_1 \ x_2} = \sqrt{\frac{r_{y \ x_1}^2 + r_{y \ x_2}^2 - 2 r_{y \ x_1} r_{y \ x_2} r_{x_1 \ x_2}}{1 - r_{x_1 \ x_2}^2}}$$

Descriptions :

$r_{y \ x_1 \ x_2}$ = Multiple correlation coefficient between variables X₁ dan X₂ together with variables Y

$r_{y \ x_1}$ = Correlation coefficient between X₁ and Y

$r_{y \ x_2}$ = Correlation coefficient between X₂ and Y

$r_{x_1 \ x_2}$ = Correlation coefficient between X₁ and X₂

Example:

Suppose we conduct observations on 10 families regarding :

X_1 = income in thousands of rupiah

X_2 = number of families per person

Y = expenditure to purchase item A in hundreds of rupiah

X_1	10	2	4	6	8	7	4	6	7	6
X_2	7	3	2	4	6	5	3	3	4	3
Y	23	7	15	17	23	22	10	14	20	19

It will be proven that there is a positive and significant linear relationship between variables X_1 and X_2 together with variable Y .

No	X_1	X_2	Y	X_1Y	X_2Y	X_1X_2	X_1^2	X_2^2	Y^2
1	10	7	23	230	161	70	100	49	529
2	2	3	7	14	21	6	4	9	49
3	4	2	15	60	30	8	16	4	225
4	6	4	17	102	68	24	36	16	289
5	8	6	23	184	138	48	64	36	529
6	7	5	22	152	110	35	49	25	484
7	4	3	10	40	30	12	16	9	100
8	6	3	14	84	42	18	36	9	196
9	7	4	20	140	80	28	49	16	400
10	6	3	19	114	57	18	36	9	361
Total	60	40	170	1121	737	267	406	182	3162

From table it's found that:

$n = 10$, $\sum X_1 = 60$, $\sum X_2 = 40$, $\sum Y = 170$, $\sum X_1Y = 1122$, $\sum X_2Y = 737$,
 $\sum X_1 X_2 = 267$, $\sum X_1^2 = 406$, $\sum X_2^2 = 182$, $\sum Y^2 = 3162$

$$r_{y x_1} = \frac{n \sum X_1 Y - (\sum X_1) (\sum Y)}{\sqrt{\{n (\sum X_1^2) - (\sum X_1)^2\} \{n (\sum Y^2) - (\sum Y)^2\}}} =$$

$$r_{y x_1} = \frac{10(1122) - (60)(170)}{\sqrt{\{10(406) - (60)^2\}\{10(3162) - (170)^2\}}}$$

$$r_{y x_1} = \frac{1020}{\sqrt{460 \times 2720}} = \frac{1020}{1118,57}$$

$$r_{y x_1} = \mathbf{0,912}$$

$$r_{y x_2} = \frac{n \sum X_2 Y - (\sum X_2)(\sum Y)}{\sqrt{\{n(\sum X_2^2) - (\sum X_2)^2\}\{n(\sum Y^2) - (\sum Y)^2\}}} =$$

$$r_{y x_2} = \frac{10(737) - (40)(170)}{\sqrt{\{10(182) - (40)^2\}\{10(3162) - (170)^2\}}}$$

$$r_{y x_2} = \frac{570}{\sqrt{220 \times 2720}} = \frac{570}{773,56}$$

$$r_{y x_2} = \mathbf{0,74}$$

4. Linear Regression Analysis

Linear regression is a tool that can be used to predict future demand based on past data or to determine the effect of one independent variable on a dependent variable.

Linear regression is divided into two categories: simple linear regression and multiple linear regression.

5. Simple Linear Regression

Simple Linear Regression is used for only one independent variable and one dependent variable.

Simple Linear Regression Formula

$$\mathbf{Y = a + b.X}$$

Where:

Y = dependent variable

X = independent variable

a and b = constant

6. Multiple Linear Regression

Multiple Linear Regression is used for one dependent variable and two independent variables. Multiple linear regression is a tool that can be used to predict future demand based on past data or to determine the effect of one or more independent variables on the dependent variable.

Multiple Linear Regression Formula:

$$Y = a + b_1X_1 + b_2X_2 + b_3X_3..... + b_nX_n$$

Keterangan:

Y = Dependent Variable ,

X1 = First independent variable,

X2 = Second independent variable

a and b1 as well as b2 = Constant

The purpose of applying these two methods is to forecast or predict the value of the dependent variable that is influenced by the independent variable.

The purpose of conducting a partial significance test of two independent variables on the dependent variable is to separately measure the contribution of each independent variable (x1 and x2) to the dependent variable (Y).

The significance test for the influence between variables is carried out as follows:

1) Formulate a hypothesis in a descriptive sentence.

Ho = There is no partial significant influence between variable x1 or x2 on variable y.

Ha = There is a partial significant influence between variable x1 or x2 on variable y.

- 2) Determine the significance level (α).
- 3) Test rules:
 - If $r_{\text{table}} \leq r_{\text{calculated}} \leq r_{\text{table}}$, then H_0 is accepted.
 - If $r_{\text{calculated}} > r_{\text{table}}$, then H_0 is rejected.

Example:

A student conducted a survey to investigate whether there is a correlation between weekly income and the amount of weekly savings at a company. To answer this question, a sample of 10 heads of families was taken.

Saving	2	4	6	6	8	8	9	8	9	10
Income	10	20	50	55	60	65	75	70	81	85

Answer :

H_0 : There is no positive correlation between savings and income

H_a : There is a positive correlation between savings and income

H_0 accepted If

$$r_{\text{count}} \leq r_{\text{table}}(\alpha, n-2) \text{ OR}$$

$$t_{\text{count}} \leq t_{\text{table}}(\alpha, n-2)$$

H_a accepted If

$$r_{\text{count}} > r_{\text{table}}(\alpha, n-2) \text{ OR}$$

$$t_{\text{count}} > t_{\text{table}}(\alpha, n-2)$$

Create the following table first :

N	X_i	Y_i	X_i^2	Y_i^2	XY
1	2	10	4	100	20
2	4	20	16	400	80
3	6	50	36	2500	300
4	6	55	36	3025	330
5	8	60	64	3600	480
6	8	65	64	4225	520
7	9	75	81	5625	675
8	8	70	64	4900	560
9	9	81	81	6561	729

10	10	85	100	7225	850
Total	70	571	546	38161	4544

$$r_{xy} = \frac{10(4544) - (70)(571)}{\sqrt{\{10(546) - (70)^2\}} \sqrt{\{10(38161) - (571)^2\}}} = 0,981$$

D. Hypothesis Testing:

From the calculation results above, the hypothesis test using the calculated r criteria is as follows::

$$r_{\text{count}} (0,981) > r_{\text{table}} (0,707)$$

Since $r_{\text{count}} > r_{\text{table}}$, H_1 is accepted and H_0 is rejected.

With the t count criterion:

$$t = \frac{r_{xy} \sqrt{n-2}}{\sqrt{(1-r^2)}}$$

$$t = \frac{0,981 \sqrt{10-2}}{\sqrt{(1-0,962)}} = 14,233$$

Since $t_{\text{count}} (14,233) > t_{\text{table}} (1,86)$, so H_1 is accepted and H_0 is rejected.

The significance test for the simultaneous influence between variables is carried out as follows:

- 1) Formulate a hypothesis in a descriptive sentence.
 H_0 = There is no significant simultaneous (joint) influence between variables x_1 and x_2 on variable y .
 H_a = There is a significant simultaneous (joint) influence between variables x_1 and x_2 on variable y .
- 2) Determine the significance level (α).
- 3) Testing rules:
 If the calculated $F \leq F_{\text{table}}$, then H_0 is accepted.
 If the calculated $F > F_{\text{table}}$, then H_0 is rejected.

E. Correlation Test with SPSS

The correlation test with SPSS is carried out with the following steps:

- 1) Data on learning interest and learning motivation, and their influence on student achievement are shown in the following table:

No	Communication in Learning (X_1)	Learning Motivation (X_2)	Learning Achievement (Y)
1	76	77	70
2	75	76	75
3	65	60	65
4	82	80	85
5	85	78	82
6	78	75	76
7	68	70	75
8	90	88	85
9	84	80	80
10	76	75	75

- 2) Open the SPSS program and click on Variable View, and in Variable type X1 for Communication in Learning, X2 for Learning Motivation and Y for Learning Achievement, and change Measure from unknown to Scale as follows:

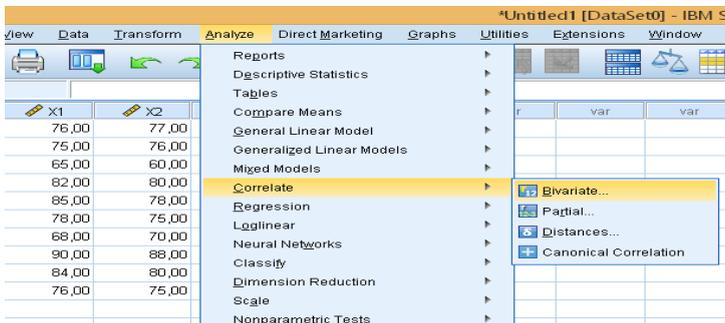
The screenshot shows the SPSS Variable View window. The variables X1, X2, and Y are defined with the following properties:

Variable	Name	Type	Width	Decimals	Label	Values	Missing	Columns	Align	Measure	Role
1	X1	Numeric	8	2		None	None	8	Right	Scale	Input
2	X2	Numeric	8	2		None	None	8	Right	Scale	Input
3	Y	Numeric	8	2		None	None	8	Right	Scale	Input
4											
5											
6											
7											

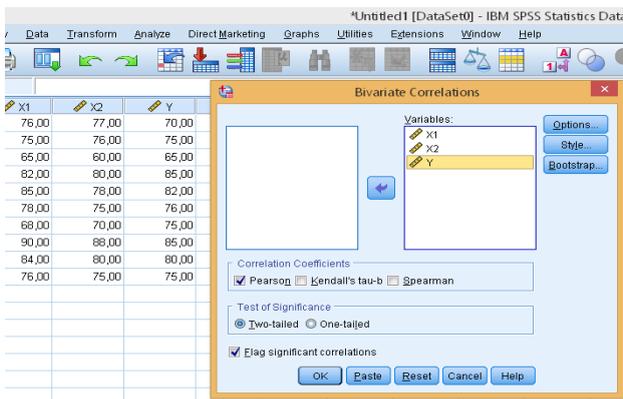
- 3) After that, type Data View and enter data for each view variable as follows. :

	X1	X2	Y	var
1	76,00	77,00	70,00	
2	75,00	76,00	75,00	
3	65,00	60,00	65,00	
4	82,00	80,00	85,00	
5	85,00	78,00	82,00	
6	78,00	75,00	76,00	
7	68,00	70,00	75,00	
8	90,00	88,00	85,00	
9	84,00	80,00	80,00	
10	76,00	75,00	75,00	
11				

- 4) Next, from the SPSS Main Menu, click Analyze, then click Correlate and select the following Bivariate :



- 5) Then in the Dialog Box, enter the variables X1, X2 and X3 into the bivariate correlations box and click *Pearson*, Click Two Tailed and Click Flag significant correlations as follows :



- 6) The results of the correlation between the two independent variables and one dependent variable can be seen as follows.:

Correlations				
		X1	X2	Y
X1	Pearson Correlation	1	,928**	,862**
	Sig. (2-tailed)		,000	,001
	N	10	10	10
X2	Pearson Correlation	,928**	1	,837**
	Sig. (2-tailed)	,000		,003
	N	10	10	10
Y	Pearson Correlation	,862**	,837**	1
	Sig. (2-tailed)	,001	,003	
	N	10	10	10

** . Correlation is significant at the 0.01 level (2-tailed).

The conclusions from the correlation test above are as follows:

- 1) Based on the Pearson Correlations, the calculated r value for the relationship between X1 and Y is 0.862 > r table of 0.526, indicating a relationship between communication in learning and learning achievement. The calculated r value for the relationship between X2 and Y is 0.837, and the r table of 0.526 indicates a relationship between learning motivation and student learning achievement.
- 2) Based on the significance value (2-tailed) between X1 and Y, the sig. value (2-tailed) is 0.001 < 0.05, indicating a significant correlation between Communication in Learning and Learning Achievement. The sig. value (2-tailed) for X2 and Y is 0.003 < 0.05, indicating a significant correlation between Learning Motivation and Learning Achievement.

F. Exercise:

- 1) Explain correlation testing and what you need to know to conduct a hypothesis test.
- 2) Name two types of correlation tests and explain them.
- 3) What are the divisions of linear regression and explain them?

- 4) The table below shows the weight, height, and age of a random sample of 12 boys. Weight is measured in pounds, height is measured in inches, and age is measured in years..

Weights (X₁)	Height (X₂)	Age (Y)
64	57	8
71	59	10
53	49	6
67	62	11
55	51	8
58	50	7
77	55	10
57	48	9
56	52	10
51	42	6
76	61	12
68	57	9

Calculate the correlation coefficient between variables X₁ and X₂ together with variable Y.

- 5) Perform the correlation test calculation for question no. 4 using SPSS analysis and provide an interpretation of the results of the correlation test above?

CHAPTER 08

INFERENCEAL STATISTICS (*COMPARATIVE TEST*)

Main Competencies

Students are able to explain and conduct inferential statistical analysis (comparative tests) in research and use SPSS in comparative tests.

Indicators

- 1) Students are able to understand and explain comparative tests.
- 2) Students are able to explain various types of comparative tests.
- 3) Students are able to analyze comparative tests.
- 4) Students are able to analyze comparative tests using SPSS.

A. Definition of Comparative Tests

THE selection of the type of statistical test used must also be adjusted to the form of the hypothesis. If the form of the hypothesis is a difference test or a test that measures the presence or absence of differences between two or more groups, whether independent or paired, then a comparative test must be used. If the data scale is ordinal or nominal, in other words, not in interval or ratio form, then it is called a non-parametric comparative test.

Examples of hypotheses in comparative testing:

- 1) There is a difference in the ability to understand mathematical concepts between graduates of Islamic boarding school X and graduates of high school X.
- 2) There is a significant difference between the two regions regarding the election of the mayoral candidate in Pekanbaru.
- 3) There is a difference in the cognitive abilities of students in the control class and students in the experimental class.

B. Types of Comparative Tests in Research

Before conducting analysis in a comparative test, the following must first be understood:

- 1) The data measurement scale is categorical or numerical.
- 2) The type of hypothesis is comparative or correlative.
- 3) Paired or unpaired data.
- 4) The number of pairs consists of two or more pairs.

This information must be understood beforehand to determine the type of analysis to be used in the comparative test. Otherwise, the comparative test conducted will not be in accordance with the analytical tools that should be used in comparative research. Comparative tests in statistics can be grouped as follows:

1. Paired Two-Group Comparative Test

- McNemar (Categorical)
- Sign Test (Ordinal)
- Wilcoxon (Ordinal)
- Related T-Test (Numeric)

2. Unpaired Two-Group Comparative Test

- Two-Sample X² (Categorical)
- Median Test (Ordinal)
- Mann-Whitney (Ordinal)

- Kolmogorov-Smirnov (Ordinal)
- Independent T-Test (Numeric)

3. Paired More-Group Comparative Test

- Cochran Q (Categorical)
- Friedman (Ordinal)
- Two-Way ANOVA (Ordinal)
- One-Way ANOVA (Numeric)

4. Unpaired More-Group Comparative Test

- X² k samples (Categorical)
- Median Extension (Ordinal)
- Kruskwales (Ordinal)
- One-way ANOVA (Ordinal)
- Two-way ANOVA (Numeric)

A summary of the comparative test can be seen in the table below:

MACAM DATA	DESKRIPTIF	KOMPARATIF				ASOSIATIF (KORELATIF)
		DUA KELOMPOK		> 2 KELOMPOK		
		berpasangan	Tidak berpasangan	berpasangan	Tidak berpasangan	
Kategorik (Nominal, ordinal)	<ul style="list-style-type: none"> ➢ Binomial ➢ χ^2 satu sampel 	Mc Nemar	<ul style="list-style-type: none"> ➢ Fisher exact probability ➢ χ^2 dua sampel 	Cochran Q	<ul style="list-style-type: none"> χ^2 k sampel 	<ul style="list-style-type: none"> ➢ Koefisien kontingensi ➢ Lambda ➢ Eta Square
Kategorik (ordinal)	Run test	<ul style="list-style-type: none"> ➢ Sign test ➢ Wilcoxon 	<ul style="list-style-type: none"> ➢ Median test ➢ Mann-whiteneý ➢ Kolmogorov smirnov ➢ Uji wald 	<ul style="list-style-type: none"> ➢ Friedman ➢ Two-way anova 	<ul style="list-style-type: none"> ➢ Median extension ➢ Kruskalwalis ➢ One way annova 	<ul style="list-style-type: none"> ➢ Spearman ➢ Kendall's tau
Numerik (Interval &rasio)	T-test	Related T-Test	Independent T- test	<ul style="list-style-type: none"> ➢ One-way annova ➢ Two- way annova 	<ul style="list-style-type: none"> ➢ One-way annova ➢ Two- way annova 	<ul style="list-style-type: none"> ➢ Korelasi product moment ➢ Pearson ➢ Korelasi parsial ➢ Korelasi ganda ➢ Regresi sederhana & ganda

Figure 8. 1 Analysis Of Comparative Tests

C. Analysis of Comparative Tests

Once the analytical tool used in the comparative test is known, the data to be analyzed is processed using the following comparative tests:

1. Paired Two-Group Comparative Test

a. McNemar Test

The McNemar Test was introduced by psychologist Quinn McNemar in 1947. This test is used for research comparing before and after an event/treatment, where each subject serves as its own control. The McNemar Test uses frequencies from paired samples of nominal data consisting of two categories to test the null hypothesis for a 2x2 frequency table.

To conduct this test, several requirements must be met, namely:

- 1) The sample data must be random
- 2) The sample data are frequencies from paired samples
- 3) The sample data have a nominal measurement scale, and each observation consists of two frequency categories such that $b + c \geq 10$

To conduct a test using the McNemar Test, the first step is to determine the hypothesis.

Steps in the McNemar Test :

$H_0 : p(A) = p(D) = 1/2$ {proportion before treatment = proportion after treatment}

$H_1 \quad \neq$ (2 way) or $<$ or $>$ (1 way)

$\alpha \quad =$ Significat Level

The McNemar statistical test formula is as follows:

$$\chi^2 = \frac{(|A - D| - 1)^2}{(A + D)}$$

Where :

χ^2 = The chi-square value of the calculation results

A = Objects that show changes from positive to negative

D = Objects that show changes from negative to positive

Test criteria:

- 1) For one-way test: reject H_0 if $\chi^2 \geq \chi^2_{2\alpha}$, accept in other cases.
- 2) For a 2-tailed test: reject H_0 if $\chi^2 \geq \chi^2_{\alpha}$, accept in other cases.

Note: If $1/2 (A + D) < 5$, use the binomial test. In the binomial test, $n = A + D$, with $x =$ the smaller frequency between A and D .

Example: Based on a survey of seasoning use among cadres, the data observed between before and after owning a TV is shown in the table below. Investigate with $\alpha = 5\%$ whether there is a difference in food seasoning use.?

No	Before TV is available	After TV is available
1	+	-
2	+	-
3	-	+
4	-	+
5	-	-
6	+	+
7	+	+
8	-	-
9	-	+
10	-	-
11	+	+
12	+	+
13	-	+
14	+	+
15	+	-
16	-	+
17	-	+
18	-	+
19	-	+
20	+	-
21	-	+

Answer :

H0 : p (after) = p (before) = 1/2

{There is no difference in the food served daily between before and after entering TV media}

H1 : p (after) ≠ p (before) ≠ 1/2

{There are differences in the food served daily between before and after entering TV media} α: 5%

After Treatment

	+	-
+	(A) 4	(B) 5
-	(C) 3	(D) 9

After Treatment

Test Statistics :

$$\chi^2 = (|4-9| -1)^2/4+9$$

$$\chi^2 = 1,23$$

McNemar test criteria:

For a one-tailed test: reject H0 if $\chi^2 \geq \chi^2_{2\alpha}$, accept otherwise.

For a two-tailed test: reject H0 if $\chi^2 \geq \chi^2_{\alpha}$, accept otherwise.

$$\alpha = 5\%$$

$$v = \text{degrees of freedom} = 1,$$

$$\chi^2_{\alpha} = 3,841$$

$$\text{Because } \chi^2 = 1,23 < \chi^2_{\alpha} = 3,841$$

then H0 is accepted, meaning there is no difference in the food served daily between before and after entering the TV media.

b. Wilcoxon Match Pairs Test

This test is used to test the comparative hypothesis of two correlated samples when the data is ordinal. If the data is less than 25, a table can be used. Test criteria: if the number of small levels is greater than the t-value of the table, then H0 is accepted.

Example: A study was conducted to determine the difference between air-conditioned rooms and work productivity. Data on employee work productivity was collected before and after the AC was installed. The data on employee work productivity before the AC was installed is X_a , and after the installation is X_b .

Research Hypothesis

H_0 : Air conditioning does not affect employee work productivity

H_a : Air conditioning makes a difference to employee work productivity

Employee work productivity data before and after the AC was installed

No	Before	After
1	100	105
2	98	94
3	76	78
4	90	98
5	87	90
6	89	85
7	77	86
8	92	87
9	78	80
10	82	83

For testing, the data needs to be arranged in the following table:

No Employee	X_a	X_b	Difference	Grade mark		
			$X_b - X_a$	Grade	+	-
1	100	105	+ 5	7,5	7,5	0,0
2	98	94	- 4	5,5	0,0	5,5
3	76	78	+ 2	2,5	2,5	0,0
4	90	98	+ 8	9,0	9,0	0,0
5	87	90	+ 3	4,0	4,0	0,0
6	89	85	- 4	5,5	0,0	5,5
7	77	86	+ 9	10,0	10,0	0,0

No Employee	Xa	Xb	Difference	Grade mark		
			Xb - Xa	Grade	+	-
8	92	87	- 5	7,5	0,0	7,5
9	78	80	+ 2	2,5	2,5	0,0
10	82	83	+ 1	1,0	1,0	0,0
Total					T =	18,5
					36,5	

Based on the table for $n = 10$, with a 5% margin of error (two-tailed test), the t-table value is 8. Due to the small number of levels, the value is 18.5, and the t-table value is 8. This means that $18.5 > 8$. Therefore, H_0 is accepted.

Therefore, it can be concluded that there is no difference in the effect of air-conditioned workspaces on employee performance.

c. t-Test

The parametric statistic used to test the comparative hypothesis of two sample means when the data is in interval or ratio form is the t-test.

$$t = \frac{(\bar{x}_1 - \bar{x}_2) - (\mu_1 - \mu_2)}{\sqrt{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}}}$$

X1: sample mean 1

X2: sample mean 2

S1: sample standard deviation 1

S2: sample standard deviation 2

S1: sample variance 1

S2: sample variance 2

r: correlation between 2 samples

Example:

A study was conducted to determine whether there was a difference in work productivity between PT Meregehese

employees before and after receiving official vehicles. Based on a randomly selected sample of 25 employees, it was found that employee productivity before and after receiving official vehicles was as shown in the following table:

H₀: There is no difference in employee work productivity before and after receiving official vehicles.

H_a: There is a difference in employee work productivity before and after receiving official vehicles.

No of Respondent	Productivity	
	Before (X1)	After (X2)
1	75	85
2	80	90
3	65	75
4	70	75
5	75	75
6	80	90
7	65	70
8	80	85
9	90	95
10	75	70
11	60	65
12	70	75
13	75	85
14	70	65
15	80	95
16	65	65
17	75	80
18	70	80
19	80	90
20	65	60
21	75	75
22	80	85
23	70	80
24	90	95
25	70	75
Average	74,00	79,20
Standard deviation	7,50	10,17

No of Respondent	Productivity	
	Before (X1)	After (X2)
Variance	56,25	103,50

From the table, we obtain:

$$t_{\text{count}} = -4.952$$

$$df = n_1 + n_2 - 2 = 50 - 2 = 48$$

If the error rate is 5%, then

$$t_{\text{table}} = 2.013 \text{ or } t_{\text{table}} = -2.013$$

Because the t_{count} is to the left of the t_{table} , or in the rejection zone of H_0 , H_0 is rejected or H_a is accepted.

Conclusion:

There is a difference in employee work productivity between before and after receiving official vehicles.

2. Unpaired Two-Group Comparative Test

a. Two-Sample X_2

The Two-Sample X_2 Test (Chi-square) is used to test a two-sample comparative hypothesis when the data is nominal and the sample is large.

Table 8. 1 Contingency

Sample	Frequency On		No of Sample
	Object I	Object II	
Sample A	A	B	a + b
Sample B	C	D	c + d
Total	a + c	b + d	n = no of sample

Formula:

$$X^2 = \frac{n(ad - bc - \frac{1}{2}n)}{(a + b)(a + c)(b + d)(c + d)}$$

Example:

A study was conducted to determine the chances of two individuals becoming regent in a particular district. The candidates were Abbas and Bakri. After conducting a survey, 60 people agreed with Abbas and 20 disagreed. Meanwhile, 50 people agreed with Bakri and 25 disagreed. This data was then compiled into the following frequency table for Abbas and Bakri elections :

Group	Approval		No of Sample
	Agree	Disagree	
Abas	60	20	60
Bakri	50	25	75
Jumlah	110	45	155

Hypothesis

Ho: Abbas and Bakri have equal chances of becoming regent, or there is no difference of opinion among the public regarding the two regent candidates.

Ha: Abbas and Bakri have unequal chances of becoming regent, or there is a difference of opinion among the public regarding the two regent candidates.

Based on the values in the table, the chi-square value is

$$X^2 = \frac{n(ad - bc) - \frac{1}{2}n}{(a+b)(a+c)(b+d)(c+d)}$$

$$X^2 = \frac{n(60 \times 25 - 20 \times 50) - \frac{1}{2} \times 155)^2}{(60 + 20)(60 + 50)(20 + 25)(50 + 25)} = 0,93$$

With a 5% error rate and $df = 1$, the X^2 table value is 3.841, and the 1% value is 6.635. The calculated X^2 value is smaller than the X^2 table value for both the 5% and 1% error rates. Thus, Ho is accepted and Ha is rejected.

The results showed that there is no difference in public opinion regarding the two regent candidates. This means that both candidates have an equal chance of being approved by the public, or that the two regent candidates have the same tenure.

b. Median Test

The Median Test is used to test the significance of the comparative hypothesis of two independent samples when the data is nominal or ordinal. The test is based on the median of a randomly drawn sample. Therefore, the Ho to be tested reads: There is no difference between the two population groups based on their medians.

If the Fisher's Test is used for small samples, and the Chi-Square Test (χ^2) is used for large samples, then the median test is used to compare Fisher's and Chi-Square's. The following is a guide.

If $n_1 + n_2 > 40$, the Chi-square test with Yates's correlation continuity can be used.

If $n_1 + n_2$ is between 20 and 40, and no cell has the expected frequency of 5, the Chi-square test with correlation continuity can be used. If $f < 5$, use the Fisher's exact test.

If $n_1 + n_2 < 20$, use the Fisher's exact test.

To use the median test, first calculate the combined median for both groups (the median for all groups). Then, divide by two and enter it in a table like the following:

Group	Group I	Group I	Number
Above the combined median	A	B	A + B
Below the combined median	C	D	C + D
Total	A + C = n_1	B + D = n_2	N = $n_1 + n_2$

Dimana :

A = banyak kasus dalam kelompok I di atas median gabung
 $\frac{1}{2} n_1$

B = banyak kasus dalam kelompok II diatas median gabung
 $\frac{1}{2} n_2$

C = banyak kasus dalam kelompok I di bawah median
gabung = $\frac{1}{2} n_1$

D = banyak kasus dalam kelompok II di bawah median
gabung = $\frac{1}{2} n_1$

$$X^2 = \frac{N[(AD - BC) - \frac{N}{2}]^2}{(A + B)(C + D)(A + C)(B + D)}$$

Degree of Freedom (dk)= 1

Example:

Research was conducted to determine whether fishermen's income differs from that of farmers based on their income. Based on interviews with 10 farmers and 9 fishermen, the data shown in the table below is obtained :

No	Farmer	Fisherman
1	50	45
2	60	50
3	70	55
4	70	60
5	75	65
6	80	65
7	90	70
8	95	80
9	95	100
10	100	

Hypothesis

Ho: There is no significant difference between the incomes of farmers and fishermen.

Ha: There is a significant difference between the incomes of farmers and fishermen.

Hypothesis Testing Criteria

Ho: Accepted if the calculated chi-square is < the table.

Ho: Rejected if the calculated chi-square is ≥ the table.

Data Presentation

Ordered from smallest to largest.

45 50 50 55 60 60 65 65 70 70 70 75 80 80 90 95 95 100 100

Median = 70

The table above then A = 6, C = 4, B = 2, D = 7

Next, enter it in the following table.

Number of Score	Farmer	Fisherman	Total
Above Combined Median	A = 6	B = 2	A + B = 8
Below Combined Median	C = 4	D = 7	C + D = 11
Total	10	9	N = 19

Calculation :

$$\chi^2 = \frac{19 \left[(6.7 - 2.4) - \frac{19}{2} \right]^2}{(6+8)(4+7)(6+4)(2+7)} = \frac{4.75}{13860} = 0,00034$$

With the chi square table price df = 1 and α = 5% is 3,841

Then $\chi^2_{hitung} = 0,00034 < 3,841 = \chi^2_{tabel}$

It was further concluded that there was no significant difference between the income of farmers and fishermen, based on the median.

3. Comparative Test of More than Two Paired Groups

a. Friedman (Ordinal)

Also known as the Friedman Test, two-sided ANOVA can be used to test comparative hypotheses for k paired samples (related) when the data is ordinal (ranked).

Interval or ratio data must be converted to ordinal form. For example, in a measurement, the following values are obtained: 4, 7, 9, and 6. This data is interval data. The data is converted to ordinal form, so it becomes: 1, 3, 4, and 2.

The formula used is :

$$\chi^2 = \frac{12}{Nk(k+1)} \sum_{j=1}^k R_j^2 - 3N(k+1)$$

Description:

N = number of groups, k = number of categories, and R_j = number of ranks in each j category.

If the price χ^2 -count $\geq \chi^2$ -table (Table A.5), then H_0 is rejected and H_1 is accepted.

The study was designed to determine the level of consumer preference for three types of products (products A, B, and C). This preference level was measured using an instrument consisting of 20 criteria. Each criterion used was given a score of 1, 2, 3, or 4, meaning dislike very much, dislike very much, like very much, and like very much very much. Therefore, each criterion had the potential to receive a maximum score of $4 \times 20 = 80$, and a minimum score of $1 \times 20 = 20$. For this purpose, 15 randomly selected panelists were used. The results of the panelists' assessment of the three types of products are presented in the following table.

Panelist/Group	Types of Product		
	A	B	C
1	76	70	75
2	71	65	77
3	56	57	74
4	67	60	59
5	70	56	76
6	77	71	73
7	45	47	78
8	60	67	62
9	63	60	75
10	60	59	74
11	61	57	60
12	56	60	75
13	59	54	70
14	74	72	71
15	66	63	65
Total	961	918	1064

Ho: Consumers have the same level of preference for the three types of products.

H1: Consumers have different levels of preference for the three types of products.

$\alpha = 0,05$

Critical Area: $\chi^2 \geq 5,991$, is from Table A.5 with $df = k - 1 = 3 - 1 = 2$ and $\alpha = 0,05$

Calculation: For analysis purposes, the interval scores for the three product types were converted to ordinal data. For example, for panelist/group 1, scores of 76, 70, and 75 were converted to 3, 1, and 2, respectively. The conversion results are presented in the following table.

Panelist/Group	Types of Product		
	A	B	C
1	3	1	2
2	2	1	3
3	1	2	3

Panelist/Group	Types of Product		
	A	B	C
4	3	2	1
5	2	1	3
6	3	1	2
7	1	2	3
8	1	3	2
9	2	1	3
10	2	1	3
11	3	1	2
12	1	2	3
13	2	1	3
14	3	2	1
15	3	1	2
Total	32	22	36

$$\chi^2 = \frac{12}{(15)(3)(3 + 1)} [32^2 + 22^2 + 36^2] - 3(15)(3 + 1) = 6,93$$

Score χ^2 - count greater than χ^2 -tabel (χ^2 -count located in the critical area), then reject Ho and conclude that the three types of products have different levels of preference.

4. Comparative Test of More Than Two Unpaired Groups

a. χ^2 k sample (Categorical)

The test is used to test comparative hypotheses of more than two samples, when the data is discrete or nominal. The basic formula for the test is the same as for comparing two independent samples, namely:

$$\chi^2 = \sum \frac{(f_o - f_e)^2}{f_e}$$

To test the significance χ^2_{count} , need to be compared with the critical values for Chi-square. The test conditions are if $\chi^2_{count} > \chi^2_{\alpha}$ then H_0 is rejected.

Example : The following is a relationship between occupation and geographic region. Two groups of people were randomly selected,

one from the east coast and one from the west coast of the United States. The observed frequencies are presented as follows.:

	Fisherman	Farmers	Traders	Total
Coastal Area	182	215	203	600
Plateau	154	136	110	400
Total	336	351	313	1000

With a significance level of 5%, is there no relationship between religion and geographic region?

Answer:

H0: $p_1 = p_2 = \dots = p_k$ (there is no relationship between occupation and geographic region)

H1: $p_1 \neq p_2 \neq \dots \neq p_k$ (between the work undertaken and the geographical area concerned)

To get the expected value of each cell is:

$$P(\text{Fishermen in Coastal Areas}) = (336)(600)/1000 = 202$$

$$P(\text{Fishermen in the Highlands}) = (336)(400)/1000 = 134$$

$$P(\text{Farmers in Coastal Areas}) = (351)(600)/1000 = 211$$

$$P(\text{Farmers in the Highlands}) = (351)(400)/1000 = 140$$

$$P(\text{Pedagang di Daerah Pantai}) = (313)(600)/1000 = 187$$

$$P(\text{Traders in the Highlands}) = (313)(400)/1000 = 126$$

Next obtained :

	Fishermen	Farmers	Traders	Total
Coastal Areas	182 (202)	215 (211)	203 (187)	600
Highlands	154 (134)	136 (140)	110 (126)	400
Total	336	351	313	1000

$$\chi^2 = (182-202)^2/202 + \dots + (110-126)^2/126 = 8,556$$

From the table above, the value is obtained $\chi^2_{0,05,2} = 5,99$. Because $\chi^2_{\text{count}} > \chi^2_{\alpha}$ ($8,556 > 5,99$) then we decide to reject H0 which means that there is a relationship between the work undertaken and the geographical area.

b. Median Extension (Ordinal)

This test is used to test the comparative hypothesis of median k independent samples with ordinal data, in this test the number of samples does not have to be the same.

Example :

Is there a relationship between employee groups (goals I, II, III and IV) and the number of leaves/permits not to come to work taken in 1 year?

H₀: There is no relationship between class and the amount of leave taken by employees in one year?

H_a: Is there a relationship between class and the amount of leave taken by employees in one year?

	Employee Grades			
	Grade 1	Grade 2	Grade 3	Grade 4
No of Leave > Median	1	2	4	5
<= Median	6	6	4	6

	No of Leave
N	34
Median	4,0000
Chi-Square	2,979 ^a
df	3
Asymp Sig.	,395

- 1) 5 cells (,0%)
5 The minimum expected cell frequency is 2,5
- 2) Grouping Variable : Grades of Employee

Based on the calculations above, it can be concluded that with a degree of error in drawing conclusions of 0.05, there is no significant relationship. This conclusion is drawn by looking at the calculated Chi-square (2.979) which is smaller than the Chi-square Table of 9.488, in addition to the Asymp Sig (0.395) which is greater than 0.05.

c. Kruskwales (Ordinal)

This test is used to test comparative hypotheses for more than two samples when the data is ordinal. For two-sample cases, this test is equivalent to the Mann-Whitney test. It also uses more complete information than the median test, making it more *powerful*.

Sample 1	Sample 2	...	Sample k
X _{1,1}	X _{2,1}	.	X _{k,1}
X _{1,2}	X _{2,2}	.	X _{k,2}
X _{1,3}	X _{2,3}	.	X _{k,3}
.	.	.	.
X _{1,n1}	X _{2,n1}	.	X _{k,nk}

From all observations, sort and rank them from smallest to largest, then add up the ranks for each sample. For identical values, the average rank is taken.

To test H₀, that k independent samples come from the same population, use the formula:

$$H = \frac{12 \left(\sum_{i=1}^k \frac{R_i^2}{n_i} - 3(n+1) \right)}{n(n+1)}$$

To test the significance of H, it is necessary to compare it with the critical values for Chi-square. The test condition is that if the value $H > \chi^2_{\alpha,an}$ then H₀ is rejected.

Raw measures			Ranked Measures			Combination A, B, C
A	B	C	A	B	C	
6.4	2.5	1.3	11	2	1	
6.8	3.7	4.1	12	3	4	
7.2	4.9	4.9	13	5.5	5.5	
8.3	5.4	5.2	17	8	7	
8.4	5.9	5.5	18	10	9	
9.1	8.1	8.2	19	14	15.5	

9.4	8.2		20	15.5		
9.7			21			
Sum of ranks			131	58	42	231
Average of ranks			16.4	8.3	7.0	11

	A	B	C	D
Counts	8	7	6	21
Sums	131	58	42	231
Means	16.4	8.3	7.0	11.0

A: $8 (16.4 - 11.0)^2 = 233.3$

B: $7 (8.3 - 11.0)^2 = 51.0$

C: $6 (7.0 - 11.0)^2 = 96.0$

SSB = 380.3

Example:

In an experiment to determine which of three missile systems is superior, the fuel burn rate is measured. The data are as follows:

System Missile 1	System Missile 2	System Missile 3
24,0	23,2	18,4
16,7	19,8	19,1
22,8	18,1	17,3
19,8	17,6	17,3
18,9	20,2	19,7
	17,8	18,9
		18,8
		19,3

With a significance level of 5%, is the fuel burn rate the same for all missile systems?

Answer:

H0: $p_1 = p_2 = \dots = p_k$ (the fuel burn rate is the same for all missile systems)

H1: $p_1 \neq p_2 \neq \dots \neq p_k$ (the fuel burn rate is not the same for all missile systems)

System Missile 1	Ranking	System Missile 2	Ranking	System Missile 3	Ranking
24,0	19	23,2	18	18,4	7
16,7	1	19,8	14,5	19,1	11
22,8	17	18,1	6	17,3	2,5
19,8	14,5	17,6	4	17,3	2,5
18,9	9,5	20,2	16	19,7	13
		17,8	5	18,9	9,5
				18,8	8
				19,3	12
		$R_1 = 61$		$R_1 = 63,5$	$R_1 = 65,5$

$$H = 12 [61^2/5 + 63,5^2/6 + 65,5^2/8] - 3(20)] / 19(20) = 1,6586$$

From the table we get the value of $\chi^2_{0,05;2} = 5,99$. Since $H < \chi^2_{\alpha}$ ($1,6586 < 5,99$) then we decide to accept H_0 which means that the fuel burn rate is the same for all missile systems.

D. Comparative Test Analysis with SPSS

Comparative tests for two unpaired groups were conducted using the Independent t-Test. To conduct a comparative test analysis with SPSS, the following steps must be followed:

Example:

The following data shows the academic achievement scores of male and female students in economics at a school:

No	Male	Female
1	78	80
2	75	77

No	Male	Female
3	80	78
4	82	88
5	90	92
6	75	80
7	82	84
8	76	75
9	82	85
10	68	

Answer:

- 1) Create a Hypothesis

Ho: There is no significant difference in learning outcomes between males and females at SMAN 1 Dumai

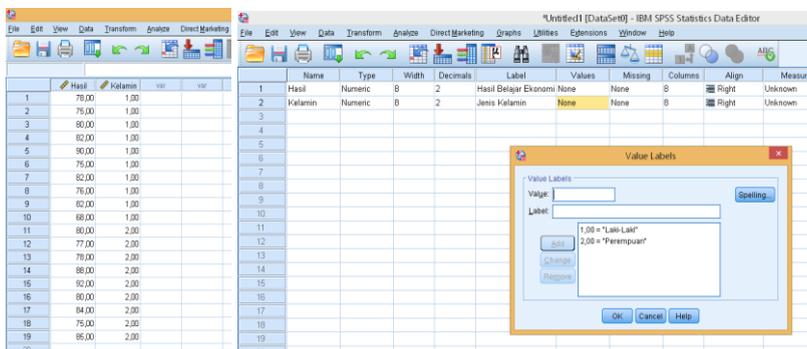
Ha: There is a significant difference in learning outcomes between males and females at SMAN 1 Dumai

- 2) To determine whether there is a difference in learning achievement scores between male and female students for decision-making purposes, the following guidelines can be used:

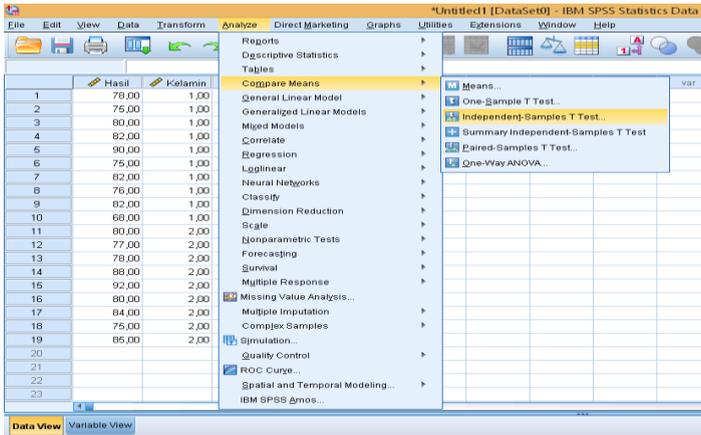
Exact sign < significance level $\alpha \rightarrow$ reject Ho

Exact sign > significance level $\alpha \rightarrow$ accept Ho

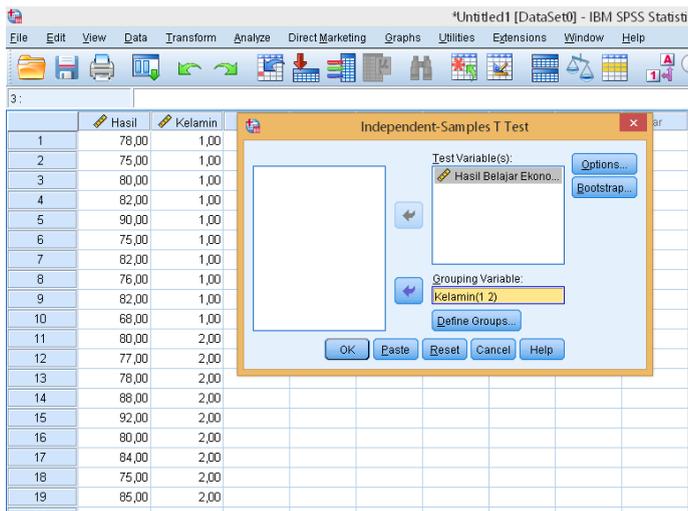
- 3) Input data from Word or Excel into SPSS
- 4) Open a new worksheet or sheet in SPSS
- 5) Enter data in the SPSS editor as shown below.
- 6) Click Analyze, select Compare Means, and click Independent Samples T-Test



- 7) Click Analyze, select Compare Means, click Independent Samples T-Test.



- 8) Move the Student Learning Outcomes variable to the Test Variable List by pressing the right arrow button.
- 9) Move the Grouping Variable by pressing the right arrow button. Click the Define Group... button, then enter a value of 1 in Group 1 and a value of 2 in Group 2, then click Continue.



- 10) Click Option... select 95% confidence level or 5% significance level and click OK.

T-Test

[DataSet0]

	Jenis Kelamin	N	Mean	Std. Deviation	Std. Error Mean
Hasil Belajar Ekonomi	Laki-Laki	10	78,8000	5,88407	1,86070
	Perempuan	9	82,1111	5,55528	1,85176

The results above showed the difference in the mean (*average*) of learning achievement scores of male and female students, where in the male group with a sample size of 10 and an average of 78.8 with a standard deviation of 5.88, while in the female group with a sample size of 9 students with an average of 82.11 and a standard deviation of 5.55.

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Hasil Belajar Ekonomi	Equal variances assumed	,013	,911	-1,257	17	,226	-3,31111	2,63353	-8,86737	2,24515
	Equal variances not assumed			-1,261	16,950	,224	-3,31111	2,62612	-8,86506	2,23863

The F test results for the SPSS results above conclude that the F hit is 0.013 with a probability value of 0.911, which means the probability value of $0.911 > 0.05$ which means H_0 is accepted and H_1 is rejected, which means there is no difference in the learning achievement values of boys and girls. With a t-count value of 1.257 compared to the t-table for 19 data known to have a value of 2.09, it is concluded that the t-count value ($1.257 < t\text{-table } (2.09)$), which means there is no difference in the learning achievement values of male and female at SMAN 1 Dumai.

E. Exercises :

- 1) Explain comparative hypothesis testing and explain it.
- 2) Name the types of comparative testing and explain them.
- 3) Determine the value of the comparative test results from the following data.
- 4) Research was conducted to determine the difference in employee productivity after training and work productivity. Data on employee productivity was collected before and after training. The data on employee productivity before training is X_b , and after training is X_s . The data on employee productivity before and after training are as follows: :

No	Before	After
1	85	102
2	87	89
3	97	95
4	75	82
5	90	95
6	82	81
7	86	89
8	102	105
9	69	72
10	80	84

- 5) Perform an analysis of question no. 3 using SPSS?

CHAPTER 09

VALIDITY AND RELIABILITY INSTRUMENT

Main Competencies

Students are able to explain the validity and reliability of research instruments, develop valid and reliable instruments, understand their quality, and conduct validity and reliability tests using SPSS.

Indicators

1. Students are able to explain the validity and reliability of research instruments.
2. Students are able to develop valid and reliable instruments.
3. Students are able to understand the quality of instruments.
4. Students are able to conduct validity and reliability tests using SPSS.

A. Introduction

Good research instruments must meet two main requirements: validity and reliability. Validity relates to the instrument's accuracy in measuring what it is supposed to measure, while reliability refers to the consistency of measurement

results when used repeatedly. A valid instrument is able to reflect the actual conditions of the variables being studied, while a reliable instrument will produce stable and consistent data under similar conditions (Arikunto, 2010). Therefore, these two aspects are the foundation for ensuring the quality of research results.

However, the validity and reliability of an instrument are determined not only by its design but also by several external factors. Sugiyono (2014) emphasized that the user (researcher) and the conditions of the research subjects also influence the quality of the measurements. A researcher who does not understand how to use the instrument has the potential to produce biased data. Similarly, the emotional, physical, or social conditions of the research subjects can influence the responses given, thereby reducing the accuracy of the measurements.

Therefore, systematic efforts are needed to ensure that the instruments used are truly valid and reliable. Validity and reliability testing are crucial steps that must not be overlooked before an instrument is widely used in data collection. Furthermore, improving researchers' competency in understanding basic measurement concepts, as well as their technical skills in properly managing and applying instruments, are also crucial factors in maintaining the quality of the resulting data. Careful instrument testing not only improves the quality of the instrument itself but also increases confidence in the research results.

Considering the crucial role of instruments in producing quality data, a discussion of instrument validity and reliability is highly relevant. This study seeks to delve deeper into the concepts, types, and techniques of validity and reliability testing, drawing on credible scientific literature. It is hoped that the results of this study will serve as a useful reference for researchers, particularly in the field of education, in designing and testing research instruments capable of producing accurate and reliable data.

According to Suharsimi Arikunto, a data collection instrument is a tool used by researchers to facilitate and organize the data

collection process. This opinion is supported by Sumadi Suryabrata, who explains that an instrument is a tool for recording various conditions or activities related to a person's psychological aspects, usually in the form of numbers or quantitative data. These psychological aspects are divided into two: cognitive (related to knowledge) and non-cognitive (related to attitudes or feelings). To explore the cognitive aspect, questions are used as triggers, while for the non-cognitive aspect, statements are used. Therefore, instruments are designed to facilitate researchers in obtaining data relevant to the research problem by combining elements of knowledge and attitudes through pre-designed questions and statements.

Research instruments play a crucial role in systematically and objectively measuring variables so that researchers can obtain accurate, consistent, and reliable data in understanding the phenomena being studied. The quality of the instrument significantly determines the extent to which the collected data represents the reality or phenomenon under study (Turcios & Watkins, 2012). Standardized instruments that have been proven valid and reliable can be reused in other studies, provided they align with the theoretical basis and constructs of the variables being measured (Liu et al., 2023; Selvi & Özge, 2023; Winkler & Berenbon, 2021). If a standard instrument is not available, it is necessary to develop a new instrument through a systematic process based on theoretical synthesis (Amir Behghadami et al., 2019; Ediyanto et al., 2022; Pittman & Bakas, 2010; Thomas, 2022).

When developing an instrument, the first step is to formulate a variable construct based on a strong theory, which serves as the basis for determining the variable's dimensions and indicators. Next, researchers develop an instrument framework that includes dimensions, indicators, and the number of questions or statements. This serves as a guideline for creating instrument items to measure all aspects of the construct. Researchers also need to determine a measurement scale, with the Likert scale being one of the most frequently used, as it allows respondents to rate their

level of disagreement to agreement. Instrument items are typically structured as positive and negative statements to avoid bias from repetitive response patterns. The next stage is theoretical validation through discussions with experts (expert judgment), which aims to ensure the appropriateness of the construct, dimensions, indicators, and instrument items. Input from these experts is then used to revise the instrument to improve its effectiveness.

After the instrument has been theoretically validated, the next stage is to conduct an empirical trial involving a number of samples to collect data (Eisend & Kuss, 2019). The minimum sample size required for an empirical test varies depending on the field of study and the methodological approach used. The sample size used must be large enough to ensure valid and reliable results (Subhaktiyasa, 2024a). According to Sugiyono (2021), a pilot study can be conducted with a minimum of 30 respondents. However, if the goal is to test construct validity through factor analysis, it is recommended to use more than 100 respondents (Anthoine et al., 2014; Clark & Watson, 2019; Holton III et al., 1997; Thompson & Daniel, 1996).

The pilot study sample can be drawn from a different population, provided its characteristics are comparable to those of the primary population, so that the test results can be generalized (Cha et al., 2016; Stuart et al., 2017). If the sample is drawn from the primary population, it must be ensured that the pilot study sample group is not the same as the sample group in the main study. This is important to prevent bias due to the "testing effect," which occurs when respondents who previously answered the instrument provide different responses during the main data collection (Pelletier & Sharma, 2015).

For researchers, understanding research methodology and determining appropriate data is not easy. Data collection involves more than simply gathering and processing data as desired; it also requires following the correct procedures for analyzing the data. Therefore, to ensure valid and reliable data, a good measuring

instrument is required. Arifin (2017) states that psychometric experts have established several criteria for assessing whether an instrument can be categorized as a good measuring tool. These criteria include validity, reliability, standards, economy, and practicality. Meanwhile, according to Mokkink et al. (2010), the main characteristics a measuring instrument must possess include validity, reliability, and usability.

To achieve research objectives, accurate data is necessary. This data describes the variables being studied. Valid data will produce conclusions that align with reality. Data accuracy is highly dependent on the quality of the instruments used to collect data or measure the objects of the research variables (Arikunto, 2010). The quality of a research instrument is determined by its level of validity and reliability. Instruments play a vital role in research. With the right instrument, the quality of a study can be measured. If the instrument used meets good criteria, then the research quality will also be good, and vice versa.

This is easy to understand because the instrument serves to transform facts into data. In other words, if the instrument used in the study is of good quality, namely valid and reliable, and has the appropriate level of difficulty, discriminating power, and distractors, then the data obtained will reflect the actual facts or conditions in the field. Conversely, if the instrument used is of low quality, with poor validity and reliability, and inappropriate levels of difficulty, discriminating power, and distractors, then the data obtained will be invalid and will not reflect the actual conditions in the field, which ultimately can lead to erroneous conclusions.

B. Validity

The word validity comes from the Latin word *validus*, meaning "strong," or "robust." Generally, there are two types of validity concepts that need to be distinguished: research validity and measurement validity. Research validity relates to the degree of truthfulness of the conclusions drawn in a study, which depends on the research method used, the representativeness of

the sample, and the characteristics of the population from which the sample is drawn (Murthi, 2011). For example, in a meta-analysis involving 18 studies that concluded that cell phone use for more than 10 years increased the risk of brain tumors, such as acoustic neuroma and glioma (Hardell et al., 2007), the validity of these conclusions refers to the validity of the research. However, this paper focuses on the discussion of measurement validity.

MacKenzie et al. (2011) define measurement validity as "an expression indicating the extent to which a measurement measures what it is supposed to measure." Measurement validity refers to the extent to which the results obtained from an instrument correspond to what the researcher intended to measure. On the other hand, measurement is a procedure for assigning values, both quantitative and qualitative, to variables within a research subject (Blattman et al., 2016), also known as observation.

Instrument validity testing is the process of ensuring that a measuring instrument actually measures what it is supposed to. This is done by piloting the instrument on respondents and then analyzing the results using statistics such as Pearson's correlation (Product Moment). This is done by comparing the calculated r value (from SPSS/Excel) with the table r value, or by examining the significance value (Sig.). The instrument is valid if the calculated r value is greater than the table r value or Sig. < 0.05 . Content validity testing also involves subject matter experts to qualitatively assess the instrument's content.

According to Sugiyono (2019), calculating instrument validity generally uses the Pearson correlation to measure the accuracy of the questionnaire. An instrument is considered valid if the value is at a certain significance level (e.g., 5%), or if the item-total correlation value is > 0.3 .

Quantitative Validity Testing Method (Statistics)

- 1) Instrument Trial: Distribute the questionnaire to a number of respondents (at least 30 people).

2) Input Data into a Statistical Program: Enter the respondent's answers into SPSS, Excel, or another statistical program.

3) Correlation Analysis (Product Moment):

SPSS: Select Analyze > Correlate > Bivariate. Move all items to Variables, check Pearson, and then OK. The results will appear in the output table.

Excel: Use the correlation formula or the Data Analysis Toolpak.

Validity Test Analysis by Comparing Results:

- R-Calculated vs. R-Table Method: Find the r-table value from the r-value table (depending on the number of respondents N and the significance level, e.g., 5%). If r-calculated \geq r-table, the item is valid.
- Significance Method (2-tailed Sig.): If Sig. < 0.05, the item is valid. If Sig. > 0.05, the item is invalid.
- Furthermore, invalid items (r count < r table or Significant > 0.05) should be removed or revised for further research, while valid items will be used.

Qualitative Validity Testing Method (Content Validity)

- 1) Involve Experts: Ask at least two experts in the relevant field to review the instrument.
- 2) Expert Assessment: Experts assess whether each question item is relevant, clear, and measures the appropriate construct (content validity).
- 3) Revision: Revise the instrument based on expert input until it is approved without further revision.

Product Moment Correlation Formula

The formula often used to find the calculated r value is:

$$r = \frac{n \sum X_i Y_i - (\sum X_i)(\sum Y_i)}{\sqrt{\{n(\sum X_i^2) - (\sum X_i)^2\} \{n(\sum Y_i^2) - (\sum Y_i)^2\}}}$$

R_{xy} : Product moment correlation coefficient.

N : Number of respondents.

- Σxy : Sum of item score multiplication (x) with a total score (y).
- Σx : Total item score.
- Σy : Total score.
- Σx^2 : Sum of squares of item scores.
- Σy^2 : Sum of squares of total scores.

Example Question:

Calculating item validity is done by correlating item scores using the Pearson Product Moment correlation formula. A question is considered valid if $\alpha > \beta$ (can be used as 0.3) at a certain significance level (e.g., 5% or 0.05).

The following is an example of calculating validity manually and using Excel:

1. Question Data

Suppose 15 students completed the following questionnaire or instrument trial data. Determine the validity of the following instrument:

No	Responden	1	2	3	4	5	6	7	8	9	10	Skor Total
1	Ahmad Riza	5	4	4	4	4	5	4	5	5	5	45
2	Ana Samratul Mauna	5	5	5	1	5	5	5	5	5	5	46
3	Arif RS	4	3	4	4	4	3	4	4	3	3	36
4	Atikah Asna Kusuma	3	1	3	2	2	1	2	1	3	3	21
5	Dian Ayu Lestari	3	3	4	4	4	2	4	2	5	5	36
6	Eli Elvi Yanti	3	4	4	3	3	1	4	4	4	4	34
7	Fatmawati	4	3	4	4	5	3	4	3	3	2	35
8	Ilham Hidayat	2	3	4	4	4	2	4	5	2	5	35
9	Imam Muzakki	3	3	4	4	3	3	4	4	4	2	34
10	Maulana Dedi	3	3	3	4	3	2	2	3	3	2	28
11	Muhammad Asrul	3	3	4	2	5	5	4	5	5	5	41
12	Muhammad Sofyan	3	1	4	3	4	3	3	1	3	2	27
13	Novi Antika	3	3	4	2	4	3	4	4	5	5	37
14	Nurrohman	5	5	5	4	4	2	4	2	3	5	39
15	Nursafitri	4	5	4	4	4	4	4	5	4	3	41

Manually Analysis (Product Moment Correlation Formula):

To calculate r manually, use the following method:

$$r = \frac{n \sum X_i Y_i - (\sum X_i) (\sum Y_i)}{\sqrt{\{n (\sum X_i^2) - (\sum X_i)^2\} \{n (\sum Y_i^2) - (\sum Y_i)^2\}}}$$

No	Responden	Butir 1 (X)	Skor Total (Y)	X ²	Y ²	XY
1	Ahmad Riza	5	45	25	2025	225
2	Ana Samratul Mauna	5	46	25	2116	230
3	Arif RS	4	36	16	1296	144
4	Atikah Asna Kusuma	3	21	9	441	63
5	Dian Ayu Lestari	3	36	9	1296	108
6	Eli Elvi Yanti	3	34	9	1156	102
7	Fatmawati	4	35	16	1225	140
8	Ilham Hidayat	2	35	4	1225	70
9	Imam Muzakki	3	34	9	1156	102
10	Maulana Dedi	3	28	9	784	84
11	Muhammad Asrul	3	41	9	1681	123
12	Muhammad Sofyan	3	27	9	729	81
13	Novi Antika	3	37	9	1369	111
14	Nurrohman	5	39	25	1521	195
15	Nursafitri	4	41	16	1681	164
	Total	53	535	199	19701	1942

From the above table it is measured with below analysis:

- Item Analysis 1 (Product Moment Correlation)

n = 15, $\sum X_1 = 53$, $\sum Y = 535$, $\sum X_1 Y = 1942$, $\sum X_1^2 = 199$, $\sum Y^2 = 19701$

$$r_{y x_1} = \frac{n \sum X_1 Y - (\sum X_1) (\sum Y)}{\sqrt{\{n (\sum X_1^2) - (\sum X_1)^2\} \{n (\sum Y^2) - (\sum Y)^2\}}}$$

$$r_{y x_1} = \frac{15 (1942) - (53) (535)}{\sqrt{\{15 (199) - (53)^2\} \{15 (19701) - (535)^2\}}}$$

$$r_{y x_1} = \frac{29130 - 28355}{\sqrt{176 \times 9290}} = \frac{755}{1278,68}$$

$$r_{y x_1} = 0,606$$

▪ Item Analysis 2 (Product Moment Correlation)

No	Responden	Butir 1 (X)	Skor Total (Y)	X2	Y2	XY
1	Ahmad Riza	4	45	16	2025	180
2	Ana Samratul Mauna	5	46	25	2116	230
3	Arif RS	3	36	9	1296	108
4	Atikah Asna Kusuma	1	21	1	441	21
5	Dian Ayu Lestari	3	36	9	1296	108
6	Eli Elvi Yanti	4	34	16	1156	136
7	Fatmawati	3	35	9	1225	105
8	Ilham Hidayat	3	35	9	1225	105
9	Imam Muzakki	3	34	9	1156	102
10	Maulana Dedi	3	28	9	784	84
11	Muhammad Asrul	3	41	9	1681	123
12	Muhammad Sofyan	1	27	1	729	27
13	Novi Antika	3	37	9	1369	111
14	Nurrohman	5	39	25	1521	195
15	Nursafitri	5	41	25	1681	205
	Total	49	535	181	19701	1840

$n = 15$, $\sum X_1 = 49$, $\sum Y = 535$, $\sum X_1 Y = 1840$, $\sum X_1^2 = 181$, $\sum Y^2 = 19701$

$$r_{y x_1} = \frac{n \sum X_1 Y - (\sum X_1)(\sum Y)}{\sqrt{\{n(\sum X_1^2) - (\sum X_1)^2\} \{n(\sum Y^2) - (\sum Y)^2\}}}$$

$$r_{y x_1} = \frac{15(1840) - (49)(535)}{\sqrt{\{15(181) - (49)^2\} \{15(19701) - (535)^2\}}}$$

$$r_{y x_1} = \frac{27600 - 26215}{\sqrt{314 \times 9290}} = \frac{1385}{2917,60}$$

$$r_{y x_1} = 0,811$$

The results are:

If the r-value is greater than the table r, it has a positive and high value (approaching 1) or the item has a value greater than 0.3 (>0.3), then the item is valid.

The results of the manual testing of the first and second items (Pearson Product Moment Formula) obtained:

- The results of the Item 1 instrument trial showed a calculated r-value of 0.606, meaning the calculated r-value is greater than the table r-value (or compared to 0.3), so item 1 is declared valid.
- The results of the Item 1 instrument trial showed a calculated r-value of 0.811, meaning the calculated r-value is greater than the table r-value (or compared to 0.3), so item 1 is declared valid.

The results of the Excel trial of all 10 instrument items showed :

0,606	0,811	0,723	-0,049	0,713	0,746	0,856	0,742	0,593	0,609
Item1	Item2	Item3	Item4	Item5	Item6	Item7	Item8	Item9	Item10

The results above show that 9 out of 10 items are declared valid, because they are more than 0.3 and only item 4 is invalid because its value is below 0.3.

C. Reliability

Reynolds (2006: 91) states that reliability relates to the consistency or stability of assessment results. Meanwhile, Cohen (2007: 146) briefly states that reliability is stability. Ebel & Frisbie (1991: 76) add that if a test demonstrates high consistency, it can be considered accurate, reproducible, and generalizable across multiple testing occasions and the same instrument.

Mehrens & Lehmann (1973: 249) explain that reliability refers to the level of consistency between two measurements of the

same object. This definition can be illustrated by measuring a person's height, which will produce consistent results even when using different measuring instruments or scales. In an educational context, a student's achievement or ability is considered reliable if the measurement results are consistent. This means that the measurement results will still provide the same information even if administered by different examiners, with different correctors, or using different items with similar characteristics.

Allen & Yen (1979: 62) state that a test is considered reliable if the scores obtained from observations have a high correlation with the actual scores. They also explain that reliability is the correlation coefficient between two observed scores obtained through measurements using parallel tests. Therefore, it can be concluded that a test is considered reliable if the measurement results closely reflect the actual conditions of the test takers. In education, measurements cannot be made directly on the traits or characteristics to be measured due to their abstract nature. This makes it difficult to obtain a stable measuring instrument for assessing a person's characteristics (Mehrens & Lehmann, 1973: 103).

Reliability in the context of a measuring instrument is closely related to the possibility of error in the measurement process, reflecting the extent of inconsistency in results when measurements are repeated on the same group of subjects. Meanwhile, reliability referring to measurement results relates to sampling error, namely inconsistency in results when measurements are conducted on different groups. Sudjana (2004: 16) explains that the reliability of an assessment instrument refers to the level of accuracy and consistency of the instrument in assessing the object being assessed. This means that a reliable assessment tool will produce relatively consistent results even when used at different times.

Based on the previous explanation, designing measurement tools in education requires high precision and must adhere to the principles established by educational measurement

experts. The level of reliability of an instrument, expressed in the form of a reliability index, can be analyzed statistically. This index is commonly known as the reliability coefficient. To determine the reliability value of a test, software such as SPSS can be used or manual calculations can be performed using specific formulas.

The reliability of a test instrument can be determined using correlation techniques, where the correlation results range from -1 to +1. Negative and positive signs indicate the direction of the relationship between variables. A perfect correlation with a value of 1 is rarely achieved in educational contexts; correlation values are generally below that figure. If the correlation value is above 0.60 but less than 1, the instrument is considered to have high reliability. Conversely, if the correlation value is below 0.50, the instrument has low or even unreliable reliability (Basuki & Haryanto, 2014: 144).

In addition to validity and reliability, quantitative item analysis also includes three important components based on empirical data from each item: difficulty level, discriminating power, and distractor analysis. This empirical data is obtained from the results of testing the items administered to respondents.

Calculating reliability using the Split-Half method according to Sugiyono is done by dividing the instrument (questionnaire) into two groups (odd and even) and then correlating the total scores of both halves using the Product Moment correlation and adjusting it using the Spearman-Brown formula.

The following are the systematic steps for calculating Split-Half reliability according to Sugiyono's concept (2019):

1) Data Preparation

- Ensure the instrument is valid.
- Tabulate questionnaire data from respondents (e.g., 30 respondents).
- Divide the instrument items into two halves. A common method is to divide the items into odd and even halves (items 1, 3, 5... and 2, 4, 6...).

2) Calculate the Total Score for the Half-Half

Calculate the total score for the odd-numbered group for each respondent.

Calculate the total score for the even-numbered group for each respondent.

1) Hemispheric Correlation (Half Reliability)

Calculate the correlation between the total odd scores and the total even scores tested using the Pearson Product Moment formula as follows:

$$r = \frac{n \sum X_i Y_i - (\sum X_i)(\sum Y_i)}{\sqrt{\{n(\sum X_i^2) - (\sum X_i)^2\} \{n(\sum Y_i^2) - (\sum Y_i)^2\}}}$$

r_{xy} here is the correlation coefficient between the first and second halves (often called or Correlation Between Forms).

2) Spearman-Brown Correction

Since the correlation above is only for half of the instruments, use the Spearman-Brown formula to find the reliability of all instruments :

$$r_{ii} = \frac{2 \cdot r_{1/2}}{1 + r_{1/2}}$$

Where:

r_{ii} = Total instrument reliability.

$r_{1/2}$ = Product moment correlation between odd and even halves.

Score Interpretation

- According to general guidelines, an instrument is considered reliable if the r_{xy} (correlation) value is greater than 0.70.
- Note: Some references often use the standard of 0.60, but 0.70 is considered a fairly high level of reliability.

D.Example Question

A researcher administered a six-item learning interest questionnaire to five respondents (scale 1-5). Calculate the instrument's reliability..

Respondent	Q1	Q2	Q3	Q4	Q5	Q6	Total
A	5	4	5	4	5	4	27
B	3	3	2	3	3	2	16
C	4	4	4	4	4	4	24
D	2	2	3	2	2	3	12
E	4	5	4	5	4	5	27

Step 1: Splitting the Instrument

Divide the items into two equal parts, usually Odd (Q1, Q3, Q5) and Even (Q2, Q4, Q6)..

Respondent	Odd (O)	Even (E)
A	$5+5+5=15$	$4+4+4=12$
B	$3+2+3=8$	$3+3+2=8$
C	$4+4+4=12$	$4+4+4=12$
D	$2+3+2=7$	$2+2+3=7$
E	$4+4+4=12$	$5+5+5=15$

Step 2: Calculate the Interhemispheric Correlation (r)

Calculate the Product Moment Correlation (r) between the Odd and Even item totals.

(Using a calculator/Excel, the correlation r between columns G and N above is 0.917.)

Step 3: Calculate Reliability (Spearman-Brown)

Use the formula:

Rumus Spearman Brown :

$$r_i = \frac{2r_b}{1+r_b}$$

Keterangan

r_i = reliabilitas internal seluruh instrumen

r_b = korelasi product moment antara belahan pertama dan kedua

$$r_i = \frac{2 \times 0,9171}{1 + 0,9171}$$

$$= \frac{1,8342}{1,9171}$$

$$r_i = \frac{1,834}{1,917}$$

$$= 0,957$$

$$r_i = 0,957$$

Step 4: Interpretation

According to Sugiyono, the reliability coefficient value is $0.957 > 0.60$, indicating that the instrument has very high reliability.

Conclusion: The questionnaire instrument is consistent and suitable for use..

E. Validitas and Reliability Test with Using SPSS

Validity and reliability tests using SPSS ensure the questionnaire is accurate and consistent. Validity (Pearson Correlation) measures item validity by comparing

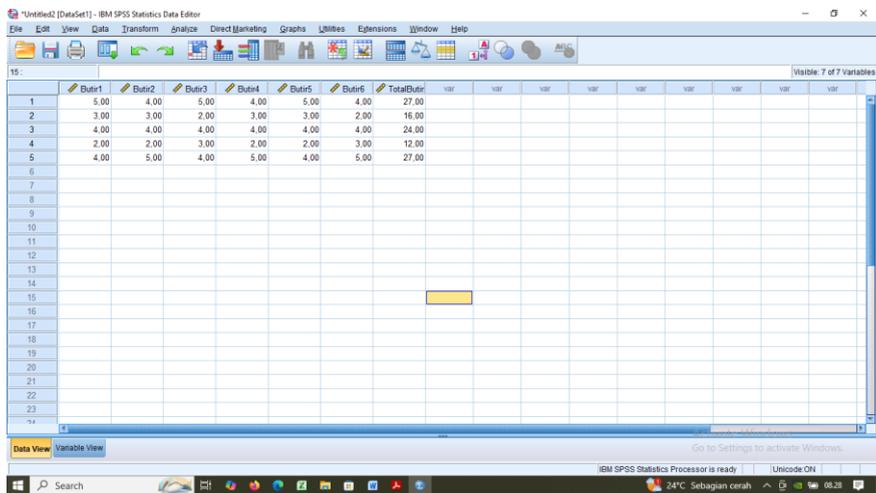
$$r_{count} > r_{table}$$

While reliability (Cronbach's Alpha) measures consistency, generally reliable if $\alpha > 0.60$. An instrument is considered reliable if the Cronbach's alpha value is greater than 0.60.

The main steps include Analyze > Correlate > Bivariate (Validity) and Analyze > Scale > Reliability Analysis.

Steps for Validity Testing (Pearson Product Moment):

Data Input: Open SPSS, enter the total score data per respondent into Data View.



The screenshot shows the IBM SPSS Statistics Data Editor interface. The main window displays a data table with 7 variables and 23 rows. The variables are Butir1, Butir2, Butir3, Butir4, Butir5, Butir6, and TotalButir. The data is as follows:

	Butir1	Butir2	Butir3	Butir4	Butir5	Butir6	TotalButir
1	5.00	4.00	5.00	4.00	5.00	4.00	27.00
2	3.00	3.00	2.00	3.00	3.00	2.00	16.00
3	4.00	4.00	4.00	4.00	4.00	4.00	24.00
4	2.00	2.00	3.00	2.00	2.00	3.00	12.00
5	4.00	5.00	4.00	5.00	4.00	5.00	27.00
6							
7							
8							
9							
10							
11							
12							
13							
14							
15							
16							
17							
18							
19							
20							
21							
22							
23							

Analysis : Click menu **Analyze > Correlate > Bivariate**.

Variable : Enter each statement item and total score in the Variables box.

Ensure Pearson is checked.

Item-1 Correlation (r = 0,943)

Correlations

		Butir1	TotalButi r
Butir1	Pearson Correlation	1	,943*
	Sig. (2-tailed)		,016
	N	5	5
TotalButi r	Pearson Correlation	,943*	1
	Sig. (2-tailed)	,016	
	N	5	5

*. Correlation is significant at the 0.05 level (2-tailed).

Item-2 Correlation

Correlations

		Butir2	TotalButi r
Butir2	Pearson Correlation	1	,943*
	Sig. (2-tailed)		,016
	N	5	5
TotalButi r	Pearson Correlation	,943*	1
	Sig. (2-tailed)	,016	
	N	5	5

*. Correlation is significant at the 0.05 level (2-tailed).

Item-3 Correlation (r = 0,815)

Correlations

		Butir3	TotalButi r
Butir3	Pearson Correlation	1	,815
	Sig. (2-tailed)		,093
	N	5	5
TotalButi r	Pearson Correlation	,815	1
	Sig. (2-tailed)	,093	
	N	5	5

Item-4 Correlation ($r = 0,943$)

Correlations

		Butir4	TotalButi r
Butir4	Pearson Correlation	1	,943*
	Sig. (2-tailed)		,016
	N	5	5
TotalButi r	Pearson Correlation	,943*	1
	Sig. (2-tailed)	,016	
	N	5	5

*. Correlation is significant at the 0.05 level (2-tailed).

Item-5 Correlation ($r = 0,943$)

Correlations

		Butir5	TotalButi r
Butir5	Pearson Correlation	1	,943*
	Sig. (2-tailed)		,016
	N	5	5
TotalButi r	Pearson Correlation	,943*	1
	Sig. (2-tailed)	,016	
	N	5	5

*. Correlation is significant at the 0.05 level (2-tailed).

Item-6 Correlation ($r = 0,815$)

Correlations

		Butir6	TotalButi r
Butir6	Pearson Correlation	1	,815
	Sig. (2-tailed)		,093
	N	5	5
TotalButi r	Pearson Correlation	,815	1
	Sig. (2-tailed)	,093	
	N	5	5

Output : Click OK. View the total column (item-total correlation).

Item-1 correlation ($r = 0,943$)

Item-2 correlation ($r = 0,943$)

Item-3 correlation ($r = 0,815$)

Item-4 correlation ($r = 0,943$)

Item-5 correlation ($r = 0,943$)

Item-6 correlation ($r = 0,815$)

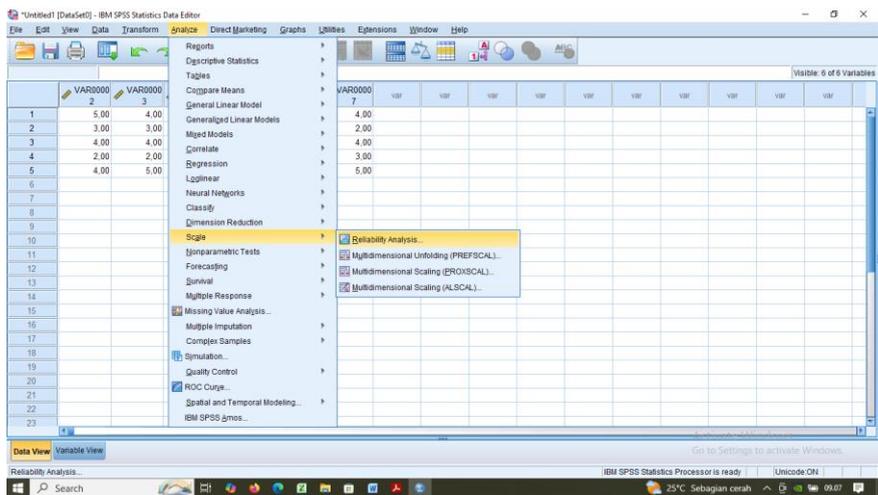
Interpretation: An item is declared valid if the Pearson Correlation value (r count $>$ r table) is at a significance level of 5%.

The results of the validity test using SPSS above show the following conclusions:

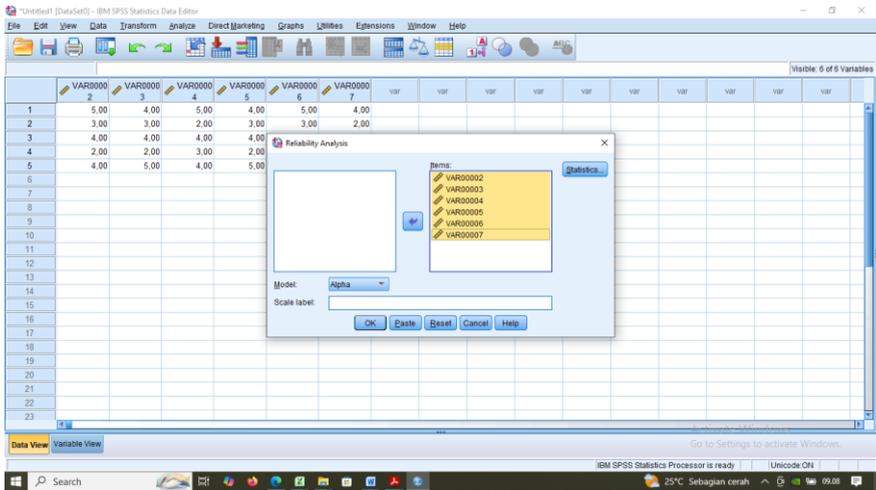
All items (items 1-6) are above 0.3 (r count $>$ r table), so all items are declared valid..

Reliability Test Steps (Cronbach's Alpha):

Analysis : Click **Analyze > Scale > Reliability Analysis**.

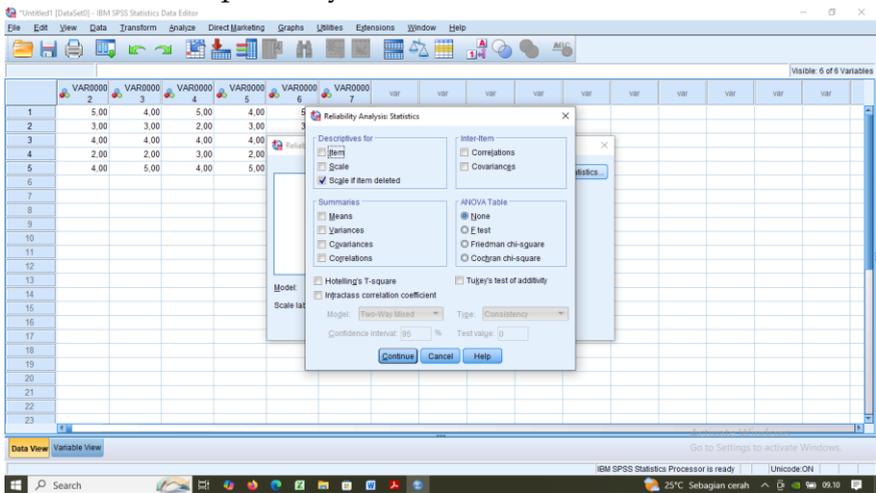


Variable: Move all statement items (except total score) to the Items box.



Model : Make sure the model selection is **Alpha**.

Statistics : Click the Statistics button, check Scale if item deleted for in-depth analysis, then click Continue.



Output: Click OK. Check the table *Reliability Statistics*.

Reliability Statistics	
Cronbach's	
Alpha	N of Items
,956	6

Interpretation: An instrument is considered reliable if the Cronbach's Alpha value is > 0.60 . The reliability statistical analysis results above show that the Cronbach's Alpha value is 0.956. This value is greater than 0.6 ($0.956 > 0.6$), so the variable is considered reliable.

Additional Notes:

- r-table
- Determine the r-table value based on the number of respondents $(N-2)$ N (Number of Data) - 2
- $n-2$ at a significance level of 5%.

If Invalid: Invalid items should be removed or revised, then repeat the test.

If Unreliable: Check "Cronbach's Alpha if Item Deleted" to see which items need to be removed to improve the value, as mentioned in

F. Exercises

1. Explain the concepts of instrument validity and reliability.
2. Explain the benefits of instrument validity and reliability testing in research.
3. Explain the criteria for determining the validity and reliability of a research instrument.
4. Conduct instrument validity and reliability testing using SPSS using the data for the following questions?

No	Responden	Nomor Butir														Skor Total	
		1	2	3	4	5	6	7	8	9	10	11	12	13	14		15
1	Ahmad Riza	2	2	2	1	2	2	3	3	2	1	3	3	3	3	3	35
2	Ana Samratul Mauna	3	4	4	1	3	2	5	2	3	1	3	4	5	5	4	49
3	Arif RS	2	3	4	2	2	4	4	4	4	2	3	4	5	5	5	53
4	Atikah Asna Kusuma	4	3	3	3	4	4	5	3	3	1	3	4	5	5	5	55
5	Dian Ayu Lestari	4	4	5	2	4	3	5	4	4	3	3	5	5	5	4	60
6	Eli Elvi Yanti	3	2	3	2	3	4	4	2	3	1	1	3	3	4	3	41
7	Fatmawati	3	5	4	1	3	2	4	3	3	2	3	4	4	3	1	45
8	Ilham Hidayat	4	3	4	2	4	3	4	3	3	2	3	4	4	3	3	49
9	Imam Muzakki	2	2	4	2	2	2	4	3	3	2	3	5	5	5	4	48
10	Maulana Dedi	4	3	4	3	4	4	4	5	4	2	4	5	5	5	5	61
11	Muhammad Asrul	3	3	2	3	3	5	3	5	3	1	2	5	5	5	5	53
12	Muhammad Sofyan	2	2	3	1	2	3	3	2	3	2	2	2	3	4	3	37
13	Novi Antika	3	5	5	1	3	1	4	4	4	2	1	2	3	3	2	43
14	Nurrohman	3	4	4	1	3	2	5	5	5	1	1	5	5	5	4	53
15	Nursafitri	3	3	3	3	3	4	3	3	2	1	3	4	4	4	3	46

BIBLIOGRAHY

- Anas Sudijono. 2011. *Pengantar Statistik Pendidikan*. Penerbit Rajawali Grafindo Persada, Jakarta.
- Barbara Monsky et al. 2013. *Introductory Statistics*. Open Stax College. Rice University, 6100 Main Street MS, 375, Houston, Texas. 863 pp.
- Cochran, William G. (1991). *Teknik Penarikan Sampel. Edisi Ketiga Edisi Bahasa Indonesia*. Jakarta: UI-Press.
- David M. Lane. 2013. *Introduction to Statistics*. Published by Rice University. Mikki Hebl, Online Edition, University of Houston.
- Douglas S. Shater & Zhiyi Zhang. 2012. *Beginning Statistics*. Creative Cosmos
- Ghozali, Imam. 2011. *Aplikasi Analisis Multivariate Dengan Program IBM SPSS 23*. Undip Press, Semarang.
- Nur Inriantoro & Supomo. (2002). *Metodologi Penelitian Bisnis Untuk Akuntansi Dan Manajemen*. Yogyakarta: BPFE.
- Hartono. 2012. *Statistika untuk Penelitian*. Penerbit PT Zanafra, Pekanbaru.
- Rasdihan, Rasyad. 2003. *Metode Statistik Deskriptif*. Penerbit Grasindo, Jakarta. 144 halaman.
- Riduwan. 2011. *Belajar Mudah Penelitian Untuk Guru Karyawan dan Peneliti Pemula*. Penerbit Alfabeta, Bandung.
- Riduwan dan Sunarto. 2011. *Pengantar Statistika*. Penerbit Alfabeta, Bandung.
- Subana, Moersetyo R dan Sudradjat. 2000. Penerbit CV. Pustaka Setia, Bandung.
- Singgih Santoso. 2014. *Statistika Parametrik*. PT. Elex Media Komputindo, Jakarta.

- Sugiyono. 2015. *Statistik Non Parametris*. Penerbit Alfabeta, Bandung.
- Sugiyono. 2012. *Metode Penelitian Kuantitatif, Kualitatif Dan R & D*. Penerbit Alfabeta, Bandung.
- Sugiyono. 2014. *Metode Penelitian Pendidikan*. Penerbit Alfabeta, Bandung.
- Singarimbun, Masri Dan Sofian Effendi. (1995). *Metode Penelitian Survei*. Jakarta: LP3ES.
- Singgih Santoso. (2002). *SPSS Mengolah Data Statistik E cara Profesional*. Jakarta: Elex Media Komputindo.
- Sitepu, Nirwana. S.K. (1994). *Analisis Jalur (Path Analysis)*. Bandung: Jurusan Statistika UNPAD.
- Jurnal-jurnal Terkait dari Sumber Internet
Buku/Sumber lainnya yang relevan.

ATTACHMENT 1

t Table Value

d.f	$t_{0.10}$	$t_{0.05}$	$t_{0.025}$	$t_{0.01}$	$t_{0.005}$	d.f
1	3,078	6,314	12,706	31,821	63, 657	1
2	1,886	2,920	4,303	6,965	9,925	2
3	1,638	2,353	3,182	4,541	5,841	3
4	1,533	2,132	2,776	3,747	4,604	4
5	1,476	2,015	2,571	3,365	4,032	5
6	1,440	1,943	2,447	3,143	3,707	6
7	1,415	1,895	2,365	2,998	3,499	7
8	1,397	1,860	2,306	2,896	3,355	8
9	1,383	1,833	2,262	2,821	3,250	9
10	1,372	1,812	2,228	2,764	3,169	10
11	1,363	1,796	2,201	2,718	3,106	11
12	1,356	1,782	2,179	2,681	3,055	12
13	1,350	1,771	2,160	2,650	3,012	13
14	1,345	1,761	2,145	2,624	2,977	14
15	1,341	1,753	2,131	2,602	2,947	15
16	1,337	1,746	2,120	2,583	2,921	16
17	1,333	1,740	2,110	2,567	2,898	17
18	1,330	1,734	2,101	2,552	2,878	18
19	1,328	1,729	2,093	2,539	2,861	19
20	1,325	1,725	2,086	2,528	2,845	20
21	1,323	1,721	2,080	2,518	2,831	21
22	1,321	1,717	2,074	2,508	2,819	22
23	1,319	1,714	2,069	2,500	2,807	23
24	1,318	1,711	2,064	2,492	2,797	24
25	1,316	1,708	2,060	2,485	2,787	25
26	1,315	1,706	2,056	2,479	2,779	26
27	1,314	1,703	2,052	2,473	2,771	27

d.f	$t_{0.10}$	$t_{0.05}$	$t_{0.025}$	$t_{0.01}$	$t_{0.005}$	d.f
28	1,313	1,701	2,048	2,467	2,763	28
29	1,311	1,699	2,045	2,462	2,756	29
30	1,310	1,697	2,042	2,457	2,750	30
31	1,309	1,696	2,040	2,453	2,744	31
32	1,309	1,694	2,037	2,449	2,738	32
33	1,308	1,692	2,035	2,445	2,733	33
34	1,307	1,691	2,032	2,441	2,728	34
35	1,306	1,690	2,030	2,438	2,724	35
36	1,306	1,688	2,028	2,434	2,719	36
37	1,305	1,687	2,026	2,431	2,715	37
38	1,304	1,686	2,024	2,429	2,712	38
39	1,303	1,685	2,023	2,426	2,708	39
40	1,303	1,684	2,021	2,423	2,704	40
41	1,303	1,683	2,020	2,421	2,701	41
42	1,302	1,682	2,018	2,418	2,698	42
43	1,302	1,681	2,017	2,416	2,695	43
44	1,301	1,680	2,015	2,414	2,692	44
45	1,301	1,679	2,014	2,412	2,690	45
46	1,300	1,679	2,013	2,410	2,687	46
47	1,300	1,678	2,012	2,408	2,685	47
48	1,299	1,677	2,011	2,407	2,682	48
49	1,299	1,677	2,010	2,405	2,680	49
50	1,299	1,676	2,009	2,403	2,678	50
51	1,298	1,675	2,008	2,402	2,676	51
52	1,298	1,675	2,007	2,400	2,674	52
53	1,298	1,674	2,006	2,399	2,672	53
54	1,297	1,674	2,005	2,397	2,670	54
55	1,297	1,673	2,004	2,396	2,668	55
56	1,297	1,673	2,003	2,395	2,667	56
57	1,297	1,672	2,002	2,394	2,665	57
58	1,296	1,672	2,002	2,392	2,663	58
59	1,296	1,671	2,001	2,391	2,662	59
60	1,296	1,671	2,000	2,390	2,660	60
61	1,296	1,670	2,000	2,389	2,659	61
62	1,295	1,670	1,999	2,388	2,657	62
63	1,295	1,669	1,998	2,387	2,656	63

d.f	$t_{0.10}$	$t_{0.05}$	$t_{0.025}$	$t_{0.01}$	$t_{0.005}$	d.f
64	1,295	1,669	1,998	2,386	2,655	64
65	1,295	1,669	1,997	2,385	2,654	65
66	1,295	1,668	1,997	2,384	2,652	66
67	1,294	1,668	1,996	2,383	2,651	67
68	1,294	1,668	1,995	2,382	2,650	68
69	1,294	1,667	1,995	2,382	2,649	69
70	1,294	1,667	1,994	2,381	2,648	70
71	1,294	1,667	1,994	2,380	2,647	71
72	1,293	1,666	1,993	2,379	2,646	72
73	1,293	1,666	1,993	2,379	2,645	73
74	1,293	1,666	1,993	2,378	2,644	74
75	1,293	1,665	1,992	2,377	2,643	75
76	1,293	1,665	1,992	2,376	2,642	76
77	1,293	1,665	1,991	2,376	2,641	77
78	1,292	1,665	1,991	2,375	2,640	78

Source : *Aplikasi Analisis Multivariate Dengan Program SPSS* (Dr. Imam Ghozali)

ATTACHMENT 2

r Table *Product Moment*

N	r	N	r	N	r	N	R	N	r	N	r
1	0.997	41	0.301	81	0.216	121	0.177	161	0.154	201	0.138
2	0.95	42	0.297	82	0.215	122	0.176	162	0.153	202	0.137
3	0.878	43	0.294	83	0.213	123	0.176	163	0.153	203	0.137
4	0.811	44	0.291	84	0.212	124	0.175	164	0.152	204	0.137
5	0.754	45	0.288	85	0.211	125	0.174	165	0.152	205	0.136
6	0.707	46	0.285	86	0.21	126	0.174	166	0.151	206	0.136
7	0.666	47	0.282	87	0.208	127	0.173	167	0.151	207	0.136
8	0.632	48	0.279	88	0.207	128	0.172	168	0.151	208	0.135
9	0.602	49	0.276	89	0.206	129	0.172	169	0.15	209	0.135
10	0.576	50	0.273	90	0.205	130	0.171	170	0.15	210	0.135
11	0.553	51	0.271	91	0.204	131	0.17	171	0.149	211	0.134
12	0.532	52	0.268	92	0.203	132	0.17	172	0.149	212	0.134
13	0.514	53	0.266	93	0.202	133	0.169	173	0.148	213	0.134
14	0.497	54	0.263	94	0.201	134	0.168	174	0.148	214	0.134
15	0.482	55	0.261	95	0.2	135	0.168	175	0.148	215	0.133
16	0.468	56	0.259	96	0.199	136	0.167	176	0.147	216	0.133
17	0.456	57	0.256	97	0.198	137	0.167	177	0.147	217	0.133
18	0.444	58	0.254	98	0.197	138	0.166	178	0.146	218	0.132
19	0.433	59	0.252	99	0.196	139	0.165	179	0.146	219	0.132
20	0.423	60	0.25	100	0.195	140	0.165	180	0.146	220	0.132
21	0.413	61	0.248	101	0.194	141	0.164	181	0.145	221	0.131
22	0.404	62	0.246	102	0.193	142	0.164	182	0.145	222	0.131
23	0.396	63	0.244	103	0.192	143	0.163	183	0.144	223	0.131
24	0.388	64	0.242	104	0.191	144	0.163	184	0.144	224	0.131
25	0.381	65	0.24	105	0.19	145	0.162	185	0.144	225	0.13
26	0.374	66	0.239	106	0.189	146	0.161	186	0.143	226	0.13
27	0.367	67	0.237	107	0.188	147	0.161	187	0.143	227	0.13
28	0.361	68	0.235	108	0.187	148	0.16	188	0.142	228	0.129
29	0.355	69	0.234	109	0.187	149	0.16	189	0.142	229	0.129

N	r	N	r	N	r	N	R	N	r	N	r
30	0.349	70	0.232	110	0.186	150	0.159	190	0.142	230	0.129
31	0.344	71	0.23	111	0.185	151	0.159	191	0.141	231	0.129
32	0.339	72	0.229	112	0.184	152	0.158	192	0.141	232	0.128
33	0.334	73	0.227	113	0.183	153	0.158	193	0.141	233	0.128
34	0.329	74	0.226	114	0.182	154	0.157	194	0.14	234	0.128
35	0.325	75	0.224	115	0.182	155	0.157	195	0.14	235	0.127
36	0.32	76	0.223	116	0.181	156	0.156	196	0.139	236	0.127
37	0.316	77	0.221	117	0.18	157	0.156	197	0.139	237	0.127
38	0.312	78	0.22	118	0.179	158	0.155	198	0.139	238	0.127
39	0.308	79	0.219	119	0.179	159	0.155	199	0.138	239	0.126
40	0.304	80	0.217	120	0.178	160	0.154	200	0.138	240	0.126

ATTACHMENT 3

Table of Chi Square (X^2)

dk	Taraf Signifikansi					
	50%	30%	20%	10%	5%	1%
1	0.455	1.074	1.642	2.706	3.481	6.635
2	0.139	2.408	3.219	3.605	5.591	9.210
3	2.366	3.665	4.642	6.251	7.815	11.341
4	3.357	4.878	5.989	7.779	9.488	13.277
5	4.351	6.064	7.289	9.236	11.070	15.086
6	5.348	7.231	8.558	10.645	12.592	16.812
7	6.346	8.383	9.803	12.017	14.017	18.475
8	7.344	9.524	11.030	13.362	15.507	20.090
9	8.343	10.656	12.242	14.684	16.919	21.666
10	9.342	11.781	13.442	15.987	18.307	23.209
11	10.341	12.899	14.631	17.275	19.675	24.725
12	11.340	14.011	15.812	18.549	21.026	26.217
13	12.340	15.19	16.985	19.812	22.368	27.688
14	13.332	16.222	18.151	21.064	23.685	29.141
15	14.339	17.322	19.311	22.307	24.996	30.578
16	15.338	18.418	20.465	23.542	26.296	32.000
17	16.337	19.511	21.615	24.785	27.587	33.409
18	17.338	20.601	22.760	26.028	28.869	34.805
19	18.338	21.689	23.900	27.271	30.144	36.191
20	19.337	22.775	25.038	28.514	31.410	37.566
21	20.337	23.858	26.171	29.615	32.671	38.932
22	21.337	24.939	27.301	30.813	33.924	40.289
23	22.337	26.018	28.429	32.007	35.172	41.638
24	23.337	27.096	29.553	33.194	35.415	42.980
25	24.337	28.172	30.675	34.382	37.652	44.314
26	25.336	29.246	31.795	35.563	38.885	45.642
27	26.336	30.319	32.912	36.741	40.113	46.963
28	27.336	31.391	34.027	37.916	41.337	48.278
29	28.336	32.461	35.139	39.087	42.557	49.588
30	29.336	33.530	36.250	40.256	43.775	50.892

ATTACHMENT 4

Table of F Distribution

df2\df1	1	2	3	4	5	6	7	8	10
1	161.448	199.500	215.707	224.583	230.162	233.986	236.768	238.883	241.882
2	18.513	19.000	19.164	19.247	19.296	19.330	19.353	19.371	19.396
3	10.128	9.552	9.277	9.117	9.013	8.941	8.887	8.845	8.786
4	7.709	6.944	6.591	6.388	6.256	6.163	6.094	6.041	5.964
5	6.608	5.786	5.409	5.192	5.050	4.950	4.876	4.818	4.735
6	5.987	5.143	4.757	4.534	4.387	4.284	4.207	4.147	4.060
7	5.591	4.737	4.347	4.120	3.972	3.866	3.787	3.726	3.637
8	5.318	4.459	4.066	3.838	3.687	3.581	3.500	3.438	3.347
9	5.117	4.256	3.863	3.633	3.482	3.374	3.293	3.230	3.137
10	4.965	4.103	3.708	3.478	3.326	3.217	3.135	3.072	2.978
11	4.844	3.982	3.587	3.357	3.204	3.095	3.012	2.948	2.854
12	4.747	3.885	3.490	3.259	3.106	2.996	2.913	2.849	2.753
13	4.667	3.806	3.411	3.179	3.025	2.915	2.832	2.767	2.671
14	4.600	3.739	3.344	3.112	2.958	2.848	2.764	2.699	2.602
15	4.543	3.682	3.287	3.056	2.901	2.790	2.707	2.641	2.544
16	4.494	3.634	3.239	3.007	2.852	2.741	2.657	2.591	2.494
17	4.451	3.592	3.197	2.965	2.810	2.699	2.614	2.548	2.450
18	4.414	3.555	3.160	2.928	2.773	2.661	2.577	2.510	2.412
19	4.381	3.522	3.127	2.895	2.740	2.628	2.544	2.477	2.378
20	4.351	3.493	3.098	2.866	2.711	2.599	2.514	2.447	2.348
21	4.325	3.467	3.072	2.840	2.685	2.573	2.488	2.420	2.321
22	4.301	3.443	3.049	2.817	2.661	2.549	2.464	2.397	2.297
23	4.279	3.422	3.028	2.796	2.640	2.528	2.442	2.375	2.275
24	4.260	3.403	3.009	2.776	2.621	2.508	2.423	2.355	2.255
25	4.242	3.385	2.991	2.759	2.603	2.490	2.405	2.337	2.236
26	4.225	3.369	2.975	2.743	2.587	2.474	2.388	2.321	2.220
27	4.210	3.354	2.960	2.728	2.572	2.459	2.373	2.305	2.204
28	4.196	3.340	2.947	2.714	2.558	2.445	2.359	2.291	2.190
29	4.183	3.328	2.934	2.701	2.545	2.432	2.346	2.278	2.177
30	4.171	3.316	2.922	2.690	2.534	2.421	2.334	2.266	2.165
35	4.121	3.267	2.874	2.641	2.485	2.372	2.285	2.217	2.114
40	4.085	3.232	2.839	2.606	2.449	2.336	2.249	2.180	2.077
45	4.057	3.204	2.812	2.579	2.422	2.308	2.221	2.152	2.049
50	4.034	3.183	2.790	2.557	2.400	2.286	2.199	2.130	2.026
55	4.016	3.165	2.773	2.540	2.383	2.269	2.181	2.112	2.008
60	4.001	3.150	2.758	2.525	2.368	2.254	2.167	2.097	1.993
70	3.978	3.128	2.736	2.503	2.346	2.231	2.143	2.074	1.969
80	3.960	3.111	2.719	2.486	2.329	2.214	2.126	2.056	1.951
90	3.947	3.098	2.706	2.473	2.316	2.201	2.113	2.043	1.938
100	3.936	3.087	2.696	2.463	2.305	2.191	2.103	2.032	1.927
110	3.927	3.079	2.687	2.454	2.297	2.182	2.094	2.024	1.918
120	3.920	3.072	2.680	2.447	2.290	2.175	2.087	2.016	1.910
130	3.914	3.065	2.674	2.441	2.284	2.169	2.081	2.010	1.904
140	3.909	3.061	2.669	2.436	2.279	2.164	2.076	2.005	1.899
150	3.904	3.056	2.665	2.432	2.274	2.160	2.071	2.001	1.894
160	3.900	3.052	2.661	2.428	2.271	2.156	2.067	1.997	1.890
180	3.894	3.046	2.655	2.422	2.264	2.149	2.061	1.990	1.884
200	3.888	3.041	2.650	2.417	2.259	2.144	2.056	1.985	1.878
220	3.884	3.037	2.646	2.413	2.255	2.140	2.051	1.981	1.874
240	3.880	3.033	2.642	2.409	2.252	2.136	2.046	1.977	1.870
260	3.877	3.031	2.639	2.406	2.249	2.134	2.045	1.974	1.867
280	3.875	3.028	2.637	2.404	2.246	2.131	2.042	1.972	1.865
300	3.873	3.026	2.635	2.402	2.244	2.129	2.040	1.969	1.862
400	3.865	3.018	2.627	2.394	2.237	2.121	2.032	1.962	1.854
500	3.860	3.014	2.623	2.390	2.232	2.117	2.028	1.957	1.850
600	3.857	3.011	2.620	2.387	2.229	2.114	2.025	1.954	1.846
700	3.855	3.009	2.618	2.385	2.227	2.112	2.023	1.952	1.844
800	3.853	3.007	2.616	2.383	2.225	2.110	2.021	1.950	1.843
900	3.852	3.006	2.615	2.381	2.224	2.109	2.020	1.949	1.841
1000	3.851	3.005	2.614	2.381	2.223	2.108	2.019	1.948	1.840
∞	3.841	2.996	2.605	2.372	2.214	2.099	2.010	1.938	1.831

ATTACHMENT 5

Critical Value Table for the U-Statistic in the Mann-Whitney Test

Critical values for the Mann-Whitney U test

		N_b															
		5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
N_a																	
$p \leq 0.05$ (one-tailed), $p \leq 0.10$ (two-tailed)																	
5	4	5	6	8	9	11	12	13	15	16	18	19	20	22	23	25	
6	5	7	8	10	12	14	16	17	19	21	23	25	26	28	30	32	
7	6	8	11	13	15	17	19	21	24	26	28	30	33	35	37	39	
8	8	10	13	15	18	20	23	26	28	31	33	36	39	41	44	47	
9	9	12	15	18	21	24	27	30	33	36	39	42	45	48	51	54	
10	11	14	17	20	24	27	31	34	37	41	44	48	51	55	58	62	
11	12	16	19	23	27	31	34	38	42	46	50	54	57	61	65	69	
12	13	17	21	26	30	34	38	42	47	51	55	60	64	68	72	77	
13	15	19	24	28	33	37	42	47	51	56	61	65	70	75	82	84	
14	16	21	26	31	36	41	46	51	56	61	66	71	77	82	87	92	
15	18	23	28	33	39	44	50	55	61	66	72	77	83	88	94	100	
16	19	25	30	36	42	48	54	60	65	71	77	83	89	95	101	107	
17	20	26	33	39	45	51	57	64	70	77	83	89	96	102	109	115	
18	22	28	35	41	48	55	61	68	75	82	88	95	102	109	116	123	
19	23	30	37	44	51	58	65	72	80	87	94	101	109	116	123	130	
20	25	32	39	47	54	62	69	77	84	92	100	107	115	123	130	138	

		N_b															
		5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
N_a																	
$p \leq 0.01$ (one-tailed), $p \leq 0.02$ (two-tailed)																	
5	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	
6	2	3	4	6	7	8	9	11	12	13	15	16	18	19	20	22	
7	3	4	6	7	9	11	12	14	16	17	19	21	23	24	26	28	
8	4	6	7	9	11	13	15	17	20	22	24	26	28	30	32	34	
9	5	7	9	11	14	16	18	21	23	26	28	31	33	36	38	40	
10	6	8	11	13	16	19	22	24	27	30	33	36	38	41	44	47	
11	7	9	12	15	18	22	25	28	31	34	37	41	44	47	50	53	
12	8	11	14	17	21	24	28	31	35	38	42	46	49	53	56	60	
13	9	12	16	20	23	27	31	35	39	43	47	51	55	59	63	67	
14	10	13	17	22	26	30	34	38	43	47	51	56	60	65	69	73	
15	11	15	19	24	28	33	37	42	47	51	56	61	66	70	75	80	
16	12	16	21	26	31	36	41	46	51	56	61	66	71	76	82	87	
17	13	18	23	28	33	38	44	49	55	60	66	71	77	82	88	93	
18	14	19	24	30	36	41	47	53	59	65	70	76	82	88	94	100	
19	15	20	26	32	38	44	50	56	63	69	75	82	88	94	101	107	
20	16	22	28	34	40	47	53	60	67	73	80	87	93	100	107	114	

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Dr. Sri Yuliani, M.Pd. was born in Pekanbaru on July 20, 1971, the first child of 12 siblings of father Ali Amran and mother Parinten (deceased). The author completed the Bachelor of English Education Program at the University of Riau in 1995, Master of Education in 2011 and Doctoral Program in Educational Science – Major in English Education at Padang State University in 2015. The author had experiences working in several foreign companies in Batam and Cikampek, has taught as a Lecturer at the Jakarta State Polytechnic, as a teacher at SMK Pharmacy LPK South Jakarta, SMAN 5 North Bintan, SMKN 1 North Bintan and SMKN 3 Tanjungpinang. Currently the author is a Permanent Lecturer at English Education Department, the Faculty of Teacher Training and Education and several other universities and from 2025 she was appointed as the Head of Library at Riau Islamic University (UIR).

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