THE ROLE OF STATISTICS IN RESEARCH TO IMPROVE CRITICAL THINKING SKILLS

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Abstract. Statistics is a science of collecting, processing, presenting, analyzing and interpreting data obtained into information to assist in making effective decisions. Statistics can also be used as a tool to facilitate the calculation of data in the form of numbers. In social research that is quantitative in nature, the role of statistics is very large. Starting from before the research, when conducting research to processing research data. The statistical process begins with sampling techniques, validity and reliability tests, hypothesis testing, data analysis and interpretation. Preliminary data presentation used descriptive statistics to prove quantitatively. Statistical literacy skills will improve critical thinking skills. Critical thinking is defined as an attitude of wanting to think deeply about problems and things that are within one's reach; knowledge of logical methods and reasoning. This study concluded that the ability to think critically in learning statistics to stimulate analytical skills in understanding statistics lessons and being able to implement statistics lessons in conducting research.

Keywords: statistics; critical thinking

I. INTRODUCTION

In the world of education, research is not something new, since the past until now it has been carried out by researchers. Research makes the world of education more developed and advanced because many findings are used to determine important policies both in matters relating to the development of knowledge and to serve as guidelines in making an effective decision [1]. All agencies or offices in districts/cities use statistics. Statistics plays an important role in research, especially quantitative research methods, statistics play a good role in. preparation of models, formulation of hypotheses, in developing data collection tools and instruments, in preparing research designs, in determining samples and in data analysis. In many cases, data processing and analysis cannot be separated from the application of certain statistical techniques and methods, whose presence can provide a basis for starting the analysis. Explain the relationships that occur. Statistics can be used as a tool to find out whether the causal relationship between two or more variables is truly related in an empirical causality or is the relationship just random or coincidental.

Statistics has provided simple techniques for classifying data and presenting data more easily, so that the data can be understood more easily. Statistics have been able to provide a measure that characterizes the population or expresses its variation, and provides a better picture of the mean trend of the variables. Statistics can help researchers to conclude whether a difference is actually significantly different. Are the conclusions drawn representative enough to provide inferences for a particular population? Statistical techniques can also be used in hypothesis testing, bearing in mind that the purpose of research is generally to test the hypotheses that have been formulated, statistics have helped researchers a lot in making decisions to accept or reject a hypothesis. Statistics can also increase the accuracy of researchers in making decisions about the conclusions they want to draw. Drawing conclusions statistically allows researchers to carry out scientific activities in a more economical manner in proving the truth of hypotheses (temporary allegations) that were previously formulated. Through statistics, it is hoped that students will have the ability to think logically, analytically, systematically, critically, and creatively. These competencies are needed in order to have the ability to obtain, manage, and utilize information to deal with conditions that are always changing and uncertain. From some of these competencies, critical thinking skills will be examined in this article.

Critical thinking is one of the most important skills in studying statistics. According to Krulick and Rudnick in Desti Haryani [2] critical thinking is thinking that involves the activity of examining, connecting, and evaluating all aspects of a situation or problem, including collecting, organizing, remembering, and analyzing information. Meanwhile, Ennis in Harlinda Fatmawati [3] states that critical thinking is reasoned and effective thinking by emphasizing making decisions about what to believe or do. The importance of critical thinking skills, according to Sumarno in Euis Istiana [4] for present needs, leads to understanding the concepts needed to solve statistical problems and other knowledge, besides that also for future needs or leads to the future, has meaning more broadly, namely statistics provides the ability to reason logically, systematically, critically, and carefully as

well as to think objectively and openly, which is very much needed in everyday life and to face an ever-changing future [5]. According to Haryani [2] attitudes and critical thinking can be developed through the learning process of statistics because statistics has a strong and clear structure and linkages between concepts so that those who learn it are skilled, think rationally, logically and critically.

The benefits of critical thinking in studying statistics are to stimulate analytical skills in understanding statistics lessons and being able to implement statistics lessons in conducting research, but the fact is that students often experience difficulties in conducting research due to the low ability of students' critical thinking. The low critical thinking of these students can be caused by their inactivity in the learning process, difficulty in understanding problems in research [6][7]. The inability to make the right conclusions from the results of the investigation of the problems studied. Therefore, learning statistics should train students to explore critical thinking skills, so that they can be implemented in conducting research.

Statistics is the study of how to plan, collect, analyze, interpret and present data. In short, statistics is a science that deals with data. The term 'statistics' is different from 'statistics'. Statistics is the science that deals with data, while statistics is data, information, or the result of applying statistical algorithms to data. From a collection of data, statistics can be used to conclude or describe data; this is called descriptive statistics. Most of the basic concepts of statistical probability theory assumes. Some statistical terms include: population, sample, sample unit, and probability. Statistics is a science of collecting, processing, presenting, analyzing and interpreting data. The research paradigm with a quantitative approach is a research approach that is based on a positivism view which essentially emphasizes concrete things, empirical tests and real facts. Statistics is widely applied in various scientific disciplines, both natural sciences (e.g., astronomy and biology as well as social sciences (including sociology and psychology), as well as in business, economics and industry. Statistics is also used in government for various purposes; population censuses are one of the most well-known procedures. Another statistical application that is now popular is the polling procedure (for example carried out before general elections), as well as quick counts (quick calculations of election results) or quick counts. In the field of computing, statistics can also be applied in pattern recognition and artificial intelligence. This paradigm believes that the only valid knowledge is science, namely knowledge that originates and is based on experience that is captured through the five senses and then processed by reason. Therefore, in practice, research with this quantitative approach provides meaning through the interpretation of statistical figures or not through language or culture. Statistics in quantitative approach research is one of the main components in the research phase, starting from research preparation, data collection techniques, data processing to efforts to make scientific decisions/conclusions. Thus, statistics in research with a quantitative approach has a fairly dominant role in facilitating the achievement of research objectives.

II. RESEARCH METHODS

This research was made in the literature review research method which provides output to existing data, as well as an elaboration of a finding so that it can be used as an example for research studies in compiling or making a clear discussion of the contents of the problem to be studied [8]. The author looks for data or literature material from journals or articles as well as references from books so that it can be used as a strong foundation in content or discussion. From this study, the contents related to the use of systematic literature review research methods. In the use of research in sociology, search for and collect several journals and draw several conclusions, then examine them in depth in a detailed way so that there is a final result that is good and in accordance with what is expected. expected.

III. RESULTS AND DISCUSSION

The Role of Statistics in Research

There are four roles of statistics in research, including: First, the Role of Statistics in Determining the Research Sample. The objective of the sampling technique is to obtain a representative sample for the population and to obtain an adequate sample size for conducting research. In connection with this role, statistics provides certain techniques and formulas in order to obtain a representative sample and an adequate sample size. Second, the Role of Statistics in the Development of Data Retrieval Tools. Before someone uses a data collection tool, he must have certainty that the tool he uses is of high quality. The quality of data collection tools can be seen from the side of validity and reliability. Therefore, each data collection tool needs to be tested for its level of validity and reliability, and the best way to test the validity and reliability of data collection tools is to use statistical methods. Third, the Role of Statistics in Presenting data. The data collected through certain data retrieval techniques is still raw data, therefore in order for the data to be more communicative it must be presented in such a way that the data is easy to read or understand. In connection with efforts to display data so that it is easy to read and understand, statistics provides certain techniques in processing data and presenting data, namely the descriptive statistical method. Fourth, the Role of Statistics in Data Analysis or Testing Hypotheses. The ultimate goal in research activities is to have conclusions as material for making decisions. In order to obtain valid and reliable research results, statistics have also been developed certain computational techniques and develop methods for testing hypotheses that can assist researchers. Statistics that di scusses data analysis or testing this hypothesis is the inferential statistical method.

Sugiyono [9] describes the role of statistics in research as follows: (1). Tool to calculate the size of the sample taken from a population. Thus, the number of samples required is more accountable. (2). Tool to test the validity and reliability of the instrument. Before the instrument is used for research, its validity and reliability must be tested first. (3). Techniques for presenting data, so that data is more communicative. Data

presentation techniques like this include: tables, graphs, pie charts and pictograms. (4). Tools for data analysis such as testing the proposed research hypothesis. In this case the statistics used include: correlation, regression, t-test, anova etc. Statistics that have been developed mathematically are then used in various fields to help solve various problems in each field. For some reason, we often don't have data from the entire population we want to observe. We usually only have data from a portion of the population which is called a sample. Measures that are directly obtained from calculations on sample data are called statistics. While the measurements that describe the characteristics or characteristics obtained directly from the population are called parameters. Statistics is a word used to express a set of facts, generally in the form of numbers arranged in tables or diagrams that depict or describe a collection of data that has meaning. While Statistics is the study of statistics, namely a knowledge related to the ways of collecting facts, processing, analyzing, and drawing conclusions as well as making reasonable decisions based on existing facts.

According to Riduwan [10] statistics can be used as a tool: (1). Communication as a liaison between several parties that have produced statistical data or in the form of statistical analysis so that these parties will be able to make decisions based on this information. (2). Description, namely presenting data and illustrating data, for example measuring production results, reports on news coverage, consumer price indexes, financial reports, inflation rates, population numbers, results of state income and expenditure and so on. (3). Regression is predicting the effect of one data on other data and to anticipate future symptoms. (4). Correlation is to look for the strength or magnitude of the data relationship in a study. (5). Comparison is comparing the data of two or more groups. Research must be carried out through processes, both how to determine the population, determine the sampling, determine the data, and how the data can affect efforts. The way we see the use of statistics is one tool that is often used for decision making in organizations, both government organizations or company. Apart from that, we actually apply statistics to everyday life, such as when estimating the average price. Judging from the role of statistics for academics, especially students. Statistics will really help how we display information data scientifically, how to organize data for example, collect, process, then analyze, transform; transforming data into information into input that can be used for decision making and so on. it is important to study statistics because numerical information or facts that can be converted into numbers are used everywhere. This numerical information can be processed and used for making decisions that have an impact on everyday life. there are two divisions of types of statistics namely, descriptive statistics. which displays and processes information or facts so that it is more interesting and easier to understand, and there is also inferential statistics, which is part of statistical methods for decision and policy making through an analysis process. This analysis further comes from population data based on a sample of quantitative variables with numerical information types, whether used on discrete variable qualifications, with the assumption that this variable can only

assume certain values that generally have gaps between these values, or also continuous variables which can be assumes any value within a certain range. Meanwhile, in determining the appropriate statistical method for processing information, there are four levels of measurement. These four levels are nominal level, interval level, ordinal level, and ratio level.

Critical Thinking Ability

Basically, to be able to carry out good scientific thinking activities, it needs to be supported by means of scientific thinking in the form of language, logic, mathematics, and statistics. Judging from the pattern of thinking, science is a combination of deductive and inductive thinking. Thinking using inductive logic is closely related to drawing conclusions from real individual cases into general conclusions. Meanwhile, thinking using deductive logic helps in drawing conclusions from things that are general to specific that are individual (Suriasumantri [11]). In essence, the process of thinking is needed by everyone in carrying out activities of daily life. The thought process is needed by everyone to be able to survive in today's ever-changing, uncertain and competitive circumstances. This is necessary so that a person has the ability to obtain, select and process information. This ability requires critical, systematic, logical, and creative thinking as well as having the ability to work together effectively. It is through thinking that humans are able to gain meaning or understanding of everything they encounter in life. According to Ennis [3], Critical thinking is reasonable reflective thinking focused on deciding what to believe or do. Basically, critical thinking is an active process – where you think about something deeply, ask questions yourself, try to find answers yourself, seek relevant information yourself rather than learn passively from others (Fisher [12]). According to Abdullah [13], critical thinking is a mental activity carried out using steps in the scientific method, namely: (1) understanding and formulating problems, (2) collecting and analyzing necessary and reliable information, (3) formulating presumptions and hypothesis, (4) logically testing the hypothesis, (5) drawing conclusions carefully, (6) evaluating and deciding something to believe or something to do, and (7) predicting the consequences that might occur.

Critical thinking is thinking that involves testing, connecting and evaluating all aspects of a situation or problem, including collecting, organizing, remembering and analyzing information. Critical thinking is also the ability to read with understanding and identify the materials needed. According to Nasrun [14], critical thinking is defined as a set of skills that encourage someone to think logically, the ability to argue proportionally and evaluate arguments logically with others. The definition of critical thinking is confirmed by Robert Ennis in Kowiyah [15] who states that, "Critical thinking is reasonable, reflective thinking that is focused on deciding what to believe or do". Critical thinking is reasonable and reflective thinking that focuses on deciding what to believe or do. Critical thinking can be defined as a process in which we examine arguments and determine which ones have advantages and which do not (Darmawan [16]). Critical thinking emphasizes that students in solving problems from

various sources need to plan strategies, create lots of ideas, theories or previous experiences compared to various strategies. The development of a strategy owned by students will be added in detail by an object, idea, or situation. Critical thinking invites students to 1). Able to use his thinking mathematically, 2). Careful in analyzing the problems encountered, 3). Thinking correctly, 4). Giving freedom to think mathematically to provide conclusions with responsibility (Syutharidho and Rosida Rakhmawati M [17]).

Critical thinking ability is a student's ability to identify the assumptions given and provide reasons for a mathematical concept, generalize concepts based on observed data, analyze algorithms in solving problems, and solve problems [18]. According to Sulistiani & Masrukan [18]), the development of critical thinking skills in statistics learning is very necessary because critical thinking and statistics are an inseparable unit. Statistical material is understood through critical thinking and critical thinking is trained through a series of processes in learning statistics. Critical thinking skills can be based on indicators: (1) Clarification, namely being able to show what is known clearly, (2) Assessment, being able to find important questions, (3) Strategic, being able to make conclusions about values that often appear, and (4) Inference, is a way of thinking openly in solving problems. In the current reform era, the ability to think critically is an indispensable ability so that students are able to face changing circumstances or challenges in an ever-evolving life. Critical thinking skills train to make decisions from various perspectives carefully, thoroughly, and logically. Fahrudi Faiz [19] can be said that critical thinking is thinking rationally and precisely in the context of making decisions about what to believe or do. Therefore, indicators of critical thinking ability can be formulated in the following critical activities: (1) Looking for clear answers to each question (2) Looking for reasons or arguments (3) Trying to find out the right information (4) Paying attention to the situation and overall conditions (5) Trying to stay relevant to the main idea (6) Understand the original and basic goals (7) Be open-minded and open-minded (8) Take a stand when there is sufficient evidence to do something (9) Seek as much explanation as possible when allows (10) to think and behave systematically and regularly by paying attention to the parts of the whole problem. Critical thinking indicators can be seen from their characteristics so that by having these characteristics a person can be said to have the ability to think critically.

The Urgency of Statistical Literacy Skills in Improving Critical Thinking Skills

Statistical literacy is the ability to read and interpret data, namely the ability to use statistics as evidence in arguments. Statistical literacy is a basic skill, namely the ability to think critically. Gal [20] stated that statistical literacy includes the ability to interpret, evaluate critically, and communicate statistical information and messages. The following are three examples of events that can illustrate how modern society requires statistical literacy skills. (1) Many newspapers present graphs or data on their front pages.

Apparently, the reader is expected to understand and appreciate the condensed information. Of course, statistical information is not only intended for educated readers. Based on the research results, it has been shown that interpreting statistical information presented in graphical form is still something that is considered difficult for some circles. This can also be interpreted that the newspaper, through the presentation of statistical information tries to create a scientific impression so that the news can be trusted. (2) More and more large companies are setting policies for almost all of their employees to provide teaching on some of the basic concepts of statistics. Frequently given material is part of the quality control method. In this context, statistics becomes an instrument for a value of economic success. (3) Often a political and economic policy involves statistical information in the process.

In this context, statistics is used as a powerful language. The example above shows that the need for statistical competence in modern society is a must. As a result, if we want people to have adequate statistical literacy skills, we need to teach students statistical data analysis as early as possible. At a minimum, students are able to process data, interpret statistical data in the form of tables, graphs and diagrams, and are able to read statistics to develop the potential of reasoning and thinking skills (Suandito [21]). In addition, statistics in a way of thinking has a structured format and learning statistics connects competent concepts in statistics so that students are able to develop their thinking according to the times, namely in the 21st century reform era (Johar [22]). One of the learning skills in education in the industrial era 4.0 (21st century) is critical-thinking or critical thinking (Abidin [23]). The importance of critical-thinking is being able to make decisions and be accountable for them and these decisions require reliable information so that someone will do it seriously (Abdullah [13]). The ability to think critically in the current reform era is really needed in learning statistics, through learning statistics, students' mathematical critical thinking skills will be obtained (Paradesa [24]). The existence of learning statistics in class makes students able to solve problems, make and make decisions logically. So that critical thinking is very important for every student to have, given the development of science and technology which is very developed. Read and translate data presented in the form of tables, graphs and diagrams.

According to Dadan Dasari [25], there are two directions of reform that affect the process of learning statistics for all levels of education. (1) renewal that focuses on content and pedagogical aspects, this is marked by a shift in focus that is computational and procedural towards an emphasis on reasoning and statistical thinking. (2) renewal in the scope of student assessment, this is marked by clarifying learning objectives (learning out come) and the use of assessment as a tool to improve student learning. Statistical Literacy is one of the many basic abilities. Meanwhile, Gal [20] introduces two components of statistical literacy: (1) knowledge elements and dispositional elements. The element of knowledge is the ability to interpret and evaluate statistical information related to data or statistical phenomena in various

contexts. The disposition element is the ability to discuss or communicate statistical information including an understanding of the meaning of the information, the implications of the information, or concerns about conclusions.

Table 1. The Statistical Literacy Components According to Gal **[20]**

Elements of Knowledge	Elements of Dispositions
Literacy ability	Attitude
Statistics knowledge	Trust
Mathematical knowledge	Critical attitude
Context knowledge	
Critical Questions	

The National Council of Education and the Discipline defines seven elements, which characterize quantitative literacy. These elements according to Steen in M.Nusrang **[26]** are: (1) Arithmetic, the use of simple calculations for numbers; (2) Data, using data to draw conclusions, understand graphs and diagrams; (3) Computers, for recording data, creating and displaying graphs, and complete calculations; (4) modeling, the ability to understand linear, exponential, multivariate and simulation models; (5) Statistics, to understand the importance of variability in a data set, recognize the difference between correlation and causation, the difference between experiments and non-experiments, the difference between statistical significance values and the practical use of statistics; (7) Chance events, to evaluate risk, understand the value of random samples and understand that it is impossible for chance events to be rare; and (8) Reasoning, to be careful in making generalizations, examining hypotheses and using logical thinking. Learning statistics is expected to be able to equip students with skills and abilities to deal with various problems in everyday life (Martalia Ardiyaningrum **[27]**). Statistical literacy is a science that can be used to make decisions. Statistical literacy skills will improve critical thinking skills, as Schield said in M.Nusrang **[26]** states that statistical literacy is a competency for critical thinking. Critical thinking according to Edward Glaser **[28]** is defined as an attitude of wanting to think deeply about problems and things that are within one's reach; knowledge of logical methods and reasoning; and some kind of skill to apply the methods. Meanwhile, according to Kowiyah **[15]**, critical thinking ability is an activity or cognitive process and mental action to acquire knowledge, understanding and skills in order to be able to find a way out and make decisions deductively, inductively and evaluatively in accordance with the stages which are carried out by thinking critically. in-depth knowledge of matters that can be reached by one's experience, examination and logical reasoning as measured by interpretation skills, analysis, knowledge of assumptions, deduction, inference evaluation, explanation/explanation, and self-regulation.

Critical thinking is the result of the learning process experienced by students with the aim of making a decision and it will be implemented (Paradesa **[24]**). The indicator of

critical thinking ability refers to Ennis' theory (Yudhanegara **[29]**), namely providing a simple explanation (elementary clarification); Building basic skills (basic support); Build conclusions (inference); Make further explanations (advances clarification); Determine the strategy and tactics (strategy and tactics) to solve the problem.

IV. CONCLUSION

Statistical literacy skills will improve students' critical thinking skills in solving problems in everyday life. Critical thinking is thinking rationally and precisely in order to make decisions about what to believe or do. Critical thinking skills are activities or cognitive processes and mental actions to acquire knowledge, understanding and skills in order to be able to find solutions and make decisions deductively, inductively and evaluatively according to the stages which are carried out by thinking deeply about things that can be reached by experience. a person, checking and doing logical reasoning which is measured through the skills of interpretation, analysis, knowledge of assumptions, deduction, evaluation of inference, explanation/explanation, and self-regulation. This study concluded that the ability to think critically in learning statistics to stimulate analytical skills in understanding statistics lessons and being able to implement statistics lessons in conducting research.

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