

# The Sport Students' Ability of Literacy and Statistical Reasoning

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**Abstract.** The ability of literacy and statistical reasoning is very important for the students of sport education college due to the materials of statistical learning can be taken from their many activities such as sport competition, the result of test and measurement, predicting achievement based on training, finding connection among variables, and others. This research tries to describe the sport education college students' ability of literacy and statistical reasoning related to the identification of data type, probability, table interpretation, description and explanation by using bar or pie graphic, explanation of variability, interpretation, the calculation and explanation of mean, median, and mode through an instrument. This instrument is tested to 50 college students majoring in sport resulting only 26% of all students have the ability above 30% while others still below 30%. Observing from all subjects; 56% of students have the ability of identification data classification, 49% of students have the ability to read, display and interpret table through graphic, 27% students have the ability in probability, 33% students have the ability to describe variability, and 16.32% students have the ability to read, count and describe mean, median and mode. The result of this research shows that the sport students' ability of literacy and statistical reasoning has not been adequate and students' statistical study has not reached comprehending concept, literary ability training and statistical reasoning, so it is critical to increase the sport students' ability of literacy and statistical reasoning

## 1. Introduction

Statistics in sport has an important role due to the measurement result is processed and analyzed by using statistics. This result is important in gaining conclusion or decision to increase the quality of sport education learning and to develop training program or to select appropriate measurement tools in increasing achievements. The use of statistics in sport cannot be denied because in many competitions and races, achievement is given by calculating velocity (in running and swimming competition), frequency (the total of gained scores) such as basketball, soccer, badminton, volley ball and other competitions so that the data result can be processed and provided statistically.

This statistical research in sport has been done a lot, the result of the survey accessed from recent research in statistical and sport. Among those researches is "Modelling the Development of World Records in Running," the research that conducted by Kuper and Elmer from University of Groningen describes a model development of world's record in 100 m to marathon running competition for male and female by using times-series method. Another research is "Statistical Analysis of The Effectiveness of The FIFA World Rankings" that conducted by Ian McHale and Stephen Davies from University of Salford. This research builds prediction model for national football competition result and discover how far the information is, including after appropriate value given in FIFA's rank [1]. Those articles can be



used as starting point for future research focusing on statistics in sport. Statistical learning is given with sport as its context. In the learning, real data is used for investigating sport discussed in various kinds of media either through internet or directly on the field [2].

Regarding to the important role of statistics in sport for research, education, and evaluation both in training and competition, the ability of literacy and statistical reasoning are necessarily needed by sport students. Literacy is the ability of comprehending information, identification, interpreting, communication and counting through gained source from printing media and being capable of writing in various contexts [3]. Literacy as an individual ability is an ability to comprehend, use, and reflect written text in reaching desired purpose as well as to be able to develop potential knowledge, therefore that individual can participate in community [4]. Along with the development of knowledge, the meaning and comprehension of literacy is rapidly developed and applied in many fields, such as information literacy, media literacy, science literacy, mathematical literacy, and statistical literacy.

Statistical literacy is the ability to understand statistics; words, symbols, and terms, the ability to interpret graphics and tables, the ability to read and understand statistics in news, media, policy, and others. Statistic comprehension is the ability to comprehend the concepts of statistics in the basic level. Statistical literacy is necessary to critically interpret and evaluate statistical information and argumentation-based data occurred in medias, as well as the ability to discuss the arguments [7].

Statistical literacy involves comprehension and use of basic language and statistical tools which is being familiar with the terms and meaning, comprehending the use of statistical symbols, and being familiar with and being able to interpret the data representation [8]. "... comprehend text and the meaning and implications of the statistical information in it, in the context of the topic to which pertains". Statistical literacy is crucial and becomes part of curriculum [9]. Several factors that contributes to the importance of the development of statistical literacy in schools are caused by 1) the expectation to participate as a citizen in accessing information related to the data; 2) encouraged by the importance of ability and skill in decision making towards the data. Regarding to the meaning above, the ability of statistical literacy is the ability to critically explain, describe, interpret and evaluate statistical information in symbols, tables, graphics, and others. Sport students need to have such ability.

Statistical reasoning involves the compilation of ideas on data and probabilities. Statistical reasoning is defined as a reasoning way by involving ideas and statistical information [10]. As an example: making interpretation based on data, data representation, or statistical conclusion from the data. Statistical reasoning can be the combination of ideas and probabilities, such as giving conclusion and interpreting statistics result. Statistical reasoning means comprehending the concepts and being able to define the process of statistics and being whole fully able to interpret statistic result [5]. Statistical reasoning as: "using statistical tools and concepts to summarize make data prediction and making conclusion from the data" [11]. Statistical reasoning is a way of thinking by using facts in statistical information [12]. Thus, statistical reasoning can be defined as reasoning way by involving ideas and statistical information to summarize, make data prediction and making conclusion from the dats. The ability of statistical reasoning is the ability to comprehend statistical concepts, explain statistical process, and interpret statistic result based on ideas and statistical information.

The ability of literacy and statistical reasoning is critical for sport students due to the materials of statistical learning can be taken from their many activities such as competitions, test and measurement result, predicting achievement based on training, finding variables among variables. Thus, this research is expected to be able to describe the ability of literacy and statistical reasoning of sport students.

Statistical literacy is the ability to comprehend, interpret and evaluate statistical information [13]. Statistical literacy is the ability to critically comprehend and evaluate statistic result in daily life [14]. Statistical literacy is the ability to read and interpret data, mostly about words from numbers, about proofs from formulas. Statistical literacy tends to have freedom of art instead of mathematics [15]. Statistics needs comprehension of basic statistical concept, while literacy needs the ability to reveal comprehension in words not in mathematics formulas [18]. Comprehending and interpreting statistical information need not only knowledge in statistics but also other basic knowledge. A model of statistical

literacy consists of two components; 1) the components of knowledge and 2) the dispositional components where the component of knowledge consists of five elements:

a) Literary ability, the ability of reading, writing, listening and speaking; b) statistical knowledge, the knowledge of data compiling, data presentation, data process, data analysis and making conclusion; c) Mathematical knowledge, the knowledge regarding to mathematical contents; d) Contextual knowledge, the comprehension of mathematical and statistical context that can be applied in daily life; e) Critical evolution towards statistical information that needs critical questions [7].

The component of disposition consists of two elements that are trust and attitude that are described in evaluating, constructing, recognizing, and communicating ideas. Critical attitude is shown by the ability of analyzing a report in detail, synthetically, and considerably.

The students must fulfill four criteria's in gaining the ability of statistical comprehension that are the realization of the data importance, the ability to comprehend statistical concepts, the ability to analyze, interpret and evaluate statistical information and the ability to conveying statistical information and comprehend it [8]. The important aspects of statistical literacy are comprehending the factor that makes trustable data as well as how the data resulted based on informational judgement form qualified data.

Rumsey, Garfield and Ben-Zvi & Garfield have shown the needs of comprehending basic statistical concepts and terms, including statistical symbols. The comprehension of statistical symbols is not similar with the comprehension of statistical mechanism (such as inputting numbers to the correct formula). Comprehending statistical concepts needs the ability of reading and using tools such as presentation, ratio, measures of dispersion, central tendency and variabilities, tables, graphics, and maps, the basic form of statistical tables, graphics, and maps, many kinds of proportions, presentation, and ratio. More complex statistical concepts such as the difference of median, mean, and mode.

The ability to organize data, make and present graphics and tables and work with different data representation is the basic achievement of statistical literacy [12] [17]. Students need to give reasons and take meaning from statistical information. This ability consists of explaining and summarizing data to comprehend and explain complex statistical concepts. It needs the ability of extracting, comprehending and explaining presented data in tables, graphics and maps.

A common theme in literature is that statistical literacy should not only about comprehending statistical concepts such as distribution, probability and sample collection but it should also make critical evaluation when the applied basic statistical concepts is not appropriate [18] [17]. Critical evolution of statistics basically needs the comprehension of whole statistical process from data collection through data analysis, assumption test and result evaluation [12] [19]. The ability to evaluate statistical information also needs the comprehension that all data and data collection are contextual.

Statistical information needs to be communicated effectively that it can impact on decision making [20]. The part of statistical literacy is the ability to discuss data comprehension, reaction towards data and criticize toward conclusion [7]. This aspect is not only related to statistical terms but also for the appropriate expression of information such as transforming data to become information by using words. It covers the ability of arranging and processing data compilation, accurate data report and how it is reported. Based on statistical literacy, a data arrangement that gives contribution for being interpretable must be comprehended.

The reasoning ability occurs when someone thinks of a problem or solves a problem. When the object is problem in mathematics, the reasoning is called mathematical reasoning. Statistical reasoning is defined as a way to reason by involving ideas and statistical information [10], for example; making interpretation based on data, data representation, or statistical conclusion of data. Statistical reasoning is a combination of ideas and probabilities such as concluding and interpreting statistical result. Important ideas such as the central tendency, scope, connection, probability, random, and samples collection are parts of statistical reasoning. In detail, statistical reasoning has three components that are conceptual entity, common and data informal [19]. The example types of reasoning ability in statistics are reasoning data, reasoning data representation, reasoning statistical size, reasoning chances, reasoning samples, reasoning association [5]. The model of statistical reasoning has five levels that are arranged

hierarchically, they are idiosyncratic reasoning, verbal reasoning, transitional reasoning, procedural reasoning and integrated process reasoning [5].

The interview result between Journal of Statistics Education represented by Alan Roosmann with statistics teacher from Canyon del Oro High School and the author of “Statistical Reasoning in Sport” [22] relates to the statistics learning through sport is that the book of “Statistical Reasoning in Sport” is used in high schools all over the country and even in some universities. It is interesting to see students are interested in learning statistics because of this book. Many students told how they enjoy the class more than other mathematics courses taken. But the best compliment regarding the book came from a student whom did not know I had listened to. He said to his friend “I cannot watch sport any longer now without thinking about statistics!”

From the definition of literacy and statistical reasoning as well as the interview result above, it is concluded that literacy and statistical reasoning in sport is the literacy and statistical reasoning with sport as the context, the use of sport as a context in statistical study can increase students’ interest and motivation in learning statistics due to a lot of interesting topics in sport that can be analyzed by using statistics.

Context has two meanings; first, context is the existing statistical problem or matter faced daily by people, or in non-statistical knowledge. Second, context is symptom or phenomena experienced by students exists in ‘reality,’ or statement that caught by students as something that possibly be experienced by them or statement regarded to ‘reality’ that contains matter or problem that can be solved statistically [23]. Context in this research is problem or matter in sport that can be statistically solved. For example, A coach states that the maximum VO<sub>2</sub> ability of a tennis athlete must reach 80 mm/gr. Next 12 athletes of West Java Regional Training for National Sport Competition that will be sent to compete in National Sport Competition have the average maximum of VO<sub>2</sub> 75 mm/gr. Based on experience, it is known that the standard deviation of outstanding athlete is 8 mm/gr. Has the physical condition of the tennis athlete met the standard with the real level ( $\alpha=0,05$ ),?

## 2. Methods

The research method used is descriptive method through survey. The tested instrument is exercise contained questions that measuring the ability of literacy and statistical reasoning in sport. This research tests the instruments to measure the ability of literacy and statistical reasoning related to the identification of data classification, probability, table reading, displaying and interpreting through bar and pie graphic, describing variability, reading, counting and describing mean, median and mode. The exercise contains 10 questions that have fulfilled the validity of medium and high question (above 0.5) as well as the reliability of 0.65. The exercise contains 1 question about identification of data classification, 1 question about probability, 2 questions about table and graphic, 1 question about variability, 1 question each about median and mode, and 2 questions about mean. The samples are 50 college students majoring sport that have finished statistics subject.

## 3. Result and Discussion

The research results only 26% of all students have the ability above 30% while others still below 30%. Observing from all subjects, 56% of students have the ability of identification data classification, classification, 49% of students have the ability to read, display and interpret table through graphic, 27% students have the ability in probability, 33% students have the ability to read variability, and 16.32% students have the ability to read, count and describe mean, median and mode. The result shows that the sport students' ability of literacy and statistical reasoning has not been adequate [16]. Thus, the sport students' ability of literacy and statistical reasoning is necessary to be increased.

From the gained result, it can be seen that the sport students’ ability of literacy and statistical reasoning still needs to be increased because 74% students have the ability under 30%. Observing from each material, all materials need to be increased as well especially the materials whose ability under 50% that are central tendency (mean, median, and mode) with 16,32% of ability, probability with 27% of ability and variability with the ability of 33%. On the other hand, the material of identification data

classification that has the ability above 50% that is 56% and the ability of reading, displaying and describing table and graphic that has the ability nearly 50% have been good enough yet not optimal so that it is necessary to increase it to better condition.

#### 4. Conclusion

Considering the role and benefit of statistic in sport are important and the result of the research that shows the sports students' ability of literacy and statistical reasoning, it is concluded that the sport students' ability of literacy and statistical reasoning has not been adequate and students' statistical study has not reached comprehending concept, literary ability training and statistical reasoning, so it is critical to increase the sport students' ability of literacy and statistical reasoning

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