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Sports Student Statistical Reasoning Ability as the Outcomes of Statistical Reasoning Learning Environment

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Abstract

This research aimed to describe the quality of sports student Statistical Reasoning Ability (SRA) through the Statistical Reasoning Learning Environment (SRLE). This research employed a qualitative analysis. The qualitative analysis was carried out using the grounded theory method. The research subjects were 29 Sports Coaching Education Study Program students receiving SRLE learning. The research finding shows that there are five categories to describe the quality of sports student Statistical Reasoning Ability: problem understanding, concept mastery, argument validity, well-ordered thinking process, and interpretation accuracy.

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INTRODUCTION

The role of statistics in sports is so significant because, in various competitions and competitions, there will be achievements that are expressed with speed (in sports and swimming), with the frequency (number of scores entered) for example, in basketball, soccer, badminton, volleyball and so forth so that the results of the competition and the race produce data that can be processed and presented statistically. Research on sports statistics has been widely carried out (Albert & Koning, 2008) in his book "Statistical Thinking in Sport," which provides information on survey results accessed from current research in statistics and sports. Among these studies is "Modeling The Development Of World Records in Running" research (Kuper & Sterken, 2007) from the University of Groningen illustrates a development of a world record model of a race running from 100 meters to marathon numbers for men and women by method times-series. Another research is "Statistical Analysis of the Effectiveness of the FIFA World Rankings," which the University of Salford examined (McHale & Stephen, 2007). This study builds a forecasting model for the results of football matches between national teams. It assesses the extent to which the information includes having been given the right weight in FIFA rankings.

Furthermore, (Tabor, 2013) in the book "Statistical Reasoning in Sport" provides an overview of how statistical learning is delivered with sports as its context. In the learning process, actual data for sports investigations are discussed in various media, both through the internet or directly from the field.

Building on the importance of statistics in sports for research, education, and evaluation for training or competition, literacy (literacy) and statistical reasoning skills for sports students are necessary. Statistical reasoning is defined as a way of reasoning involving statistical ideas and information (DelMas et al., 1999). For example: making interpretations based on data, data representations, or summary statistics from data. Statistical reasoning can combine ideas and probabilities, such as concluding and interpreting statistical results. Statistical reasoning means understanding concepts and being able to explain statistical processes, and being able to fully interpreting statistical results (Garfield, 2002). Later, (Lovett, 2001) interprets statistical reasoning as: "using statistical tools and concepts to summarize, make predictions about data, and draw conclusions from data." Similar statements are proposed by (Benzvi & Garfield, 2004) that statistical reasoning is a way of thinking using facts of statistical information. Thus statistical reasoning can be defined as using statistical ideas and information to summarize, make predictions about data, and conclude the data. Statistical reasoning is the ability to understand statistical concepts, explain statistical processes and interpret statistical results based on statistical ideas and information.

Traditional statistical learning only focuses on the calculation, skills, and knowledge of grouping / classifying data (Garfield, 2002). In sports student activities, many things can be used as statistical learning material in matches, test results, and measurements, for example, predicting achievements that can be achieved based on the training process and seeing the relationship between one variable and other variables and others. Based on the results of a preliminary study, it is shown that studying statistics for sports students is only used as a tool to calculate and process data, not to understand the concept and practice statistical literacy and statistical reasoning skills. From these results, it can also be concluded that innovative learning is needed so that statistics courses can be well understood, both procedurally and in their meanings and concepts.

The learning model used in this research is a learning model to develop statistical reasoning abilities introduced by (Garfield & Ben-Zvi, 2009), namely "Statistical Reasoning Learning Environment," abbreviated SRLE. SRLE is a learning model based on a constructivist social theory with six learning principles designed by Cobb and McClain (Garfield, 2002), which focuses on developing statistical content, using actual data, using classroom activities, using technology assistance, improving classroom conversation, and using alternative assessments. This SRLE learning model is student-centered. The SRLE learning model is expected to positively impact the quality of statistical learning outcomes for sports students so that it can improve statistical reasoning skills that are very useful for athletes as athletes, teachers, trainers, and sports people. Others.

The reform of the learning of statistics among them was examined by (Loveland, 2014) that an activity-based learning approach provides an understanding of statistical concepts and the ability to apply statistical procedures better. Activity-based learning also gives

students a more positive attitude towards statistics. In addition, what (Amin et al., 2012) have examined gives results that engineering students at UTHM (Universit Tun Husein Onn Malaysia) who study statistics through laboratory activities with contextual learning gain higher cognitive outcomes than non-contextual learning, and statistical laboratory activities help understanding concepts and motivation in statistical learning. Her dissertation implies that contextual learning can be applied to students of Madrasah Aliyah to improve their statistical reasoning skills and self-efficacy (Ulpah, 2013). Takara concluded that there was an increase in statistical literacy skills and mathematical and self-concept representation of prospective elementary school teachers taught through the Collaborative Problem Solving model (Takaria, 2018). (Lanani, 2015) shows that the achievement of statistical reasoning ability of students who obtain ICT-assisted project-based learning is higher than students who obtain conventional learning, both at each class level and overall. (Nurashiken & Ismail, 2014) provide the results of research that statistical learning through SRLE with video (instructional video statistical reasoning (VPPS)) increases students' statistical understanding and receives video as a tool and reference in learning so that learning can be done without time and place limitations. (Chan et al., 2015) The study showed that the SRLE teaching significantly improved students' statistical reasoning ability based on the Rash analysis method.

From the preliminary study and the results of the above studies, the author encouraged the research to be applied to students in sports study programs to find out the impact of the Statistical Reasoning Learning Environment (SRLE) learning model to describe the quality of sports students' statistical reasoning ability.

METHODS

Participants

This article will be analyzed the work results of SRLE learning group students for PKO study programs totaling 29 people.

Sampling Procedure

Sampling procedures in this research are purposive sampling, taking the results of student work on question number two.

Materials and Apparatus

The instrument of statistical reasoning ability consists of 15 items related to giving arguments and drawing conclusions based on concepts, rules, and processes of testing hypotheses and providing a critical interpretation of data, concepts, and processes of statistical information for test samples in pairs, average test one sample, test the correlation coefficient, the average test for two independent samples, homogeneity testing, one-way ANOVA testing, and posthoc testing. Statistical reasoning ability is focused on inferential statistics, namely hypothesis testing.

Procedure

In the open coding stage, researchers captured the initial data by analyzing the results of student work, namely the posture of the statistical reasoning ability of the SRLE learning group students. The researcher determined seven categories focused on open coding: a) Identify known data and ask questions to determine students' understanding of the problem. b) How is the understanding of the assumptions or things that are known in the problem, and the extent to which students are careful in utilizing them? c) What is students' accuracy in composing or writing down arguments? Are the arguments conveyed meaningfully in the reach of the class community's understanding? d) What is the description of the flow of thought (process) in the whole work? Is the line of thinking drawn in coherently, or is there a leap of logic? e) Have written notations, formulas, and statistical symbols been used correctly? f) What is the level of mastery and utilization of related concepts needed in testing hypotheses? g) How does accuracy provide an interpretation of the results of hypothesis testing?.

The results of the answers to the high, medium, and low group students for each item, each construct, and sub-construction based on seven open coding categories, are presented in full. The researcher determines and deepens the core categories obtained in the open coding stage for the selective coding phase. The category is a deepening focus as the basis for preparing the conjecture that will be developed. This category is compiled based on findings obtained in the open coding stage. The description of the open coding stage shows the diversity of the quality of student work through the description of the statistical reasoning abilities presented in the appendix.

Of the seven categories analyzed in open coding, several categories are interrelated and lead to one category. The seven categories are:(1) Identify known data and ask questions to determine students' understanding of the problem. (2)Understanding the assumptions or things known in the matter and the students' accuracy in using them. (3) Accuracy in compiling or writing down arguments. (4) Describe a coherent line of thinking or a leap of logic. (5) Writing precise notations, formulas, and statistical symbols. (6) Level of mastery and utilization of related concepts needed in testing hypotheses. (7) Accuracy provides an interpretation of the results of hypothesis testing.

The seven open codings can be compacted into five core categories, namely:(1) Students can identify known and asked data (code 1) and write statistical notations, formulas, and symbols appropriately (code 5) tend to have these students have an understanding of statistical problems/questions. (2) Students who have an understanding of the assumptions and things that are known in the question (code 2) and have mastery and the utilization of related concepts needed in testing hypotheses (code 6) tend to have these students have mastery of statistical concepts. (3) Students have accuracy in composing or writing arguments that tend to have these students an argument (4) Students can describe coherent thinking, which tends to be the student has a thinking disorder (5) Students can provide interpretations of the results of hypothesis testing tend to have the ability to have the correct interpretation.

Codes 1 and 5 become categories of problem understanding, and codes 2 and 6 into one category, namely the mastery of concepts. In contrast, the code composes arguments, lines of thought, and interpretations of each of them into categories of validity of arguments, the clutter of thinking, and accuracy of interpretation.

In this theoretical coding stage, the researcher conducts a deep analysis (compaction) of the core categories. The deepening analysis was conducted through interviews between researchers and students selected as respondents. The analysis was conducted to describe the statistical reasoning abilities of sports students in testing hypotheses reviewed based on five core categories. The results of the deepening analysis are presented in the following description.

To get an overview of statistical reasoning abilities, the analysis was carried out in two ways: (1) analysis of the students' textual work and (2) interviews between researchers and respondents. Textual work analysis and interviews were carried out for five subquestions representing group 1 construct with sub constructions a (number 1b, 1d, 2b, 3c, and 4b) represented by questions number 2b, 4b, then sub construction b (number 1e, 2c, 3d, 4c, 5f) represented by number 2c, 4c. Following sub, construction 1c (numbers 2d and 4d) is represented by numbers 2d and 4d, and construct 2 (question number 5c, 5d, and 5e) is represented by number 5d. Based on this, the analysis of statistical reasoning capabilities for inferential statistics in hypothesis testing is focused on student work in number 2b. 4b, 2c, 4c, 2d, 4d, and 5d or represented by questions number 2, 4, and 5. In this article, we will discuss only construct 1 with sub-construction b represented by questions 2b and 4b. In this article, only question number 2 is discussed.

Data Analysis

This research employs a qualitative analysis. The qualitative analysis is performed with a grounded theory method. Qualitative data analysis attempts to express the meaning of research data by collecting data by certain classifications. In this study, the data obtained in the form of student work results in writing and transcripts of interview results. The ability to be described is statistical reasoning ability through SRLE learning.

RESULT

Problem number 2 aims to reveal the statistical reasoning ability of sports students, which is related to verifying the validity of statistical information based on data orientation, concepts, rules, and the testing process of the average hypothesis of one sample. The results of work number 2 from students with high statistical initial abilities, namely M1 and M2, presented in Figures 1.

1) Understanding The Problem

Figures 1 show that M1 and M2 write down everything that is known in the question with the correct notation and understand what is being asked. This was revealed also during the interview between Researchers (R) and M1. The following part of the interview shows a good understanding of M1 towards understanding the problem / problem.

P: How does M1 (the researcher mention the name of the student) read the question number 2

M1: emm oh this is ma'am, there is a statement from the results of the study by knowing m (average) national limb power test which is 80, keep on knowing the average sample, the standard deviation is oh yes this is also the number of samples

P : what do you want to test?

M1: oh what huh? oh yeah, ma'am, from the coach's statement that the results of the limb athlete's power test results in his province are different from the average limb power test nationally, use the Z test, ma'am.

From the interview fragment, it is illustrated that student M1 understands what is known in the problem and what is asked.

Table 1. Problem number 2

1. Research reports that the national sprinter athlete's leg power test reached an average of 80. However, a regional training trainer from a province claimed that the results of the leg power test of running athletes in his province differed from the national average for a leg power test. To prove the coach's claim, a sample of 14 athletes was taken randomly in their province, then a leg power test was conducted, and the average leg power was 75 and a standard deviation of 6. Assuming that the data were normally distributed, was the coach's claim proven? a. Concerning the test, what are the problems presented above, and how is the formulation of the test hypothesis? b. Test the hypothesis at =0.05! c. Write a conclusion related to the claim of the Coach Earlier! d. Explain the reason why this test is used. e. Concerning the test, what are the problems presented above, and how is the formulation of the test hypothesis?

2) Mastery of the Concept

Mastery of concepts that need to be understood in order to solve problem number 2 well is the concept of testing the average hypothesis with a single sample. Students with high statistical initial abilities understand and make good use of the related concepts needed in testing this hypothesis. In addition, in writing, it appears that students master the concepts well, in the interview they also illustrated the mastery. The following interview fragment confirms this.

P: So this problem is proven by testing the hypothesis?

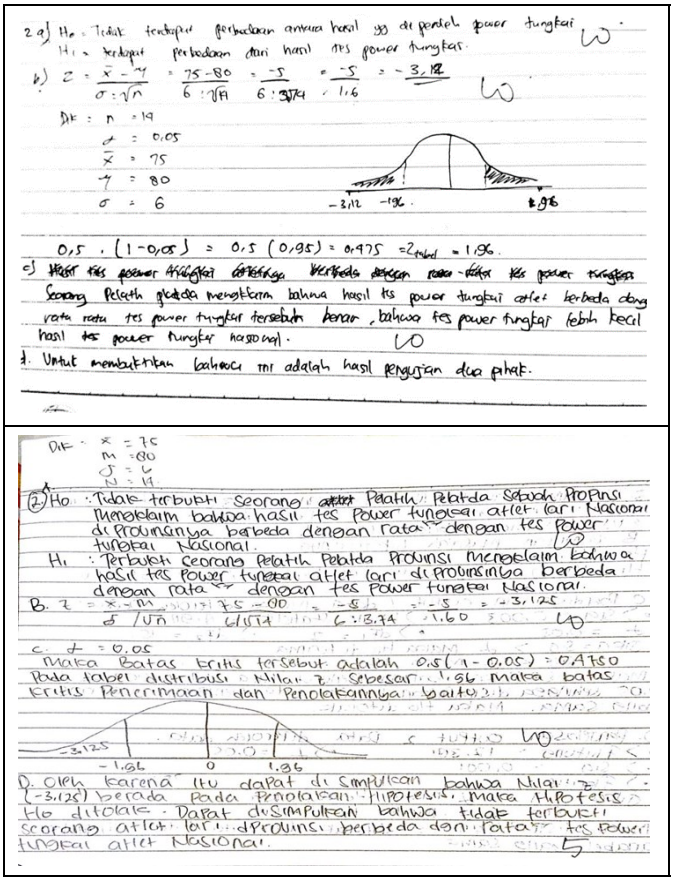

Figure 1. M1 dan M2 Answer for Problem Number 2

M1: testing the hypothesis, which is ... testing hypotheses to test the similarity of the two averages with one sample yes ma'am

3) Applicability of Arguments

Arguments are messages that are conveyed, whether through oral, written, performance or expressions through other media used to support an opinion or conclusion. Argument as a support for an opinion or conclusion is very necessary in testing the hypothesis. Work M1 reflects the submission of arguments that are not strong in their statements and conclusions. This is illustrated in the previous concluding sentence, not giving a clear reason or not even appearing.

Whereas for M2 students, it has been shown that there are arguments that reinforce conclusions as in the sentence ... because the value of z = -3.125 is in the area of rejection of the hypothesis, it can be concluded ... but the conclusions given are incorrect. The strength of the respondents' arguments was also seen at the interview. The following is a section on interviewing researchers

with the following M2 students:

P : Why is the null hypothesis (Ho) rejected

M2: because the calculated z -3.14 is in the area of rejection, ma'am

P : What can be concluded if the hypothesis is rejected?

M2: The conclusion is not proven that a running athlete in a province is different from the average national athlete's power test

P : Try to consider the formulation of the pair of hypotheses that have been formulated in the conclusions of the statement Ho or H1?

M2 : Ooh yes ma'am, upside down, the conclusion should be proven that an athlete running in a province is differen from the average leg test of a national athlete, now like this in testing the hypothesis I like to fear back and forth

From the interview fragment, it was illustrated that M1 dan M2 students even though they were able to formulate arguments well, the concept of material testing the hypothesis had not mastered it well.

4) Impulse Thinking

The results of the M1 and M2 work show a fairly coherent flow of thought, but still need to be corrected in the steps of testing the hypothesis that no words are connected.

5) Accuracy of Interpretation

Interpretation is to give meaning from the results of testing the hypothesis as a whole. This interpretation can be illustrated by the overall meaning, especially conclusions. From the results of the student work, it is illustrated that M1 and M2 have not shown the correct interpretation. Can be seen from the start of the steps, the selection of the type of test, in determining, accepting and rejecting the hypothesis and giving reasons to give conclusions, the interpretation given is not correct. It can also be proven from the following interview fragments:

P : Why is the null hypothesis (Ho) rejected

M2: because the calculated z -3.14 is in the area of rejection, ma'am

P: What can be concluded if the hypothesis is rejected?

M2: The conclusion is not proven that the average athlete's limb power test in the province is different from the national athlete's power test average.

P : Try to consider the formulation of the pair of hypotheses that have been formulated in the conclusions of the statement Ho or H1?

M2: Ooh yes ma'am, upside down, the conclusion should be proven that the average limb athlete's power test in the provinces is different from the national athlete's power test average, now like this, in testing the hypothesis I like to be afraid of reversing.

DISCUSSION

Qualitative analysis is used through Grounded Theory analysis (Bryant, 2017). From the seven determined open codings, there were five core categories from the selective coding stage: understanding the problem or questions, mastering concepts, and validating arguments. The orderliness of thinking and accuracy of interpretation.

From the five core categories, an overview of the quality of statistical reasoning abilities for PKO students was obtained through SRLE learning. Sports students with high categories already can understand questions, master concepts even though they are not optimal, have been able to provide arguments that can reinforce conclusions, and already have a relatively coherent line of thinking but have not demonstrated the ability to provide the correct interpretation.

Students in the medium KAS category already can understand questions, have little mastery of concepts, cannot yet provide arguments, and the flow of thinking is relatively coherent. However, it has not shown the ability to provide the correct interpretation. On the other hand, students in the low KAS category already can understand questions, have not mastered concepts, cannot give arguments, the flow of thinking is not coherent, has not shown the ability to give the correct interpretation.

Of these five categories, all levels of the picture show that the initial statistical ability greatly influences the statistical reasoning abilities obtained during SRLE learning. Therefore, initial knowledge of students who have been previously possessed will facilitate the learning outcomes obtained (Wahyudin, 2019).

The model "Statistical Reasoning Learning Environment" (SRLE) is built on social constructivist learning theory. The basis of this SRLE learning model is the paradigm of social constructivism theory. This paradigm comes from Piaget's constructivism, which states that learning is an active process in which students build their understanding and knowledge by making connections between new information and past experiences, beliefs, and knowledge in accepting knowledge. Social-constructivist epistemology extends where Piaget's theory emphasizes the socio-cultural aspects of the learning process and the critical role of social interaction and cultural artifacts in building a person's learning Vygotsky's theory. The ability to provide arguments, the flow of thinking is relatively coherent, has not shown the ability to provide the correct interpretation. Students in the low KAS category already can understand questions, have not mastered concepts, cannot give arguments, the flow of thinking is not coherent, has not shown the ability to give the correct interpretation.

Vygotsky emphasized the importance of utilizing the environment in learning. The environment around students/students includes people, culture, including experiences in that environment. Vygotsky emphasized the importance of individual relationships and the social environment in forming knowledge. According to him, that social interaction, namely the interaction of individuals with other people, is the most critical factor that can trigger a person's cognitive development.

Regarding learning, Vygotsky put forward four principles: (1) Social learning (social learning), the learning approach considered appropriate is cooperative learning students learn through interaction with adults or friends who are more capable. (2) ZPD (Zone of proximal development), students/students work in ZPD if students/students cannot solve problems on their own but can solve the problem after getting help from adults or friends (peers). Assistance is intended so that students can work on assignments or questions that are higher in complexity than the level of cognitive development of students. (3) Cognitive apprenticeship, a process that makes students gradually acquire intellectual skills through interaction with more skilled people or smarter friends. (4) In Mediated learning, Vygotsky emphasizes scaffolding. Students/students are given complex, complicated, and realistic problems and sufficient assistance in solving problems (Richard, 2008).

Many modern constructivist ideas are based on Vygotsky's theory which has been used to support learning methods emphasizing cooperative learning, activity-based learning, and discovery. SRLE learning model on the principle of learning using class activities, cooperative learning is an appropriate class activity. During this activity, sports students feel that statistical learning is more understood and meaningful because they can exchange ideas, help each other solve sports statistics problems, and improve their statistical literacy and reasoning abilities.

CONCLUSION

Of the seven open codings that were determined, five core categories were obtained from the selective coding stage: understanding the problem or problem, mastering the concept, and applying the argument. The tangle of thinking and the accuracy of interpretation. From the five core categories, we get a picture of the quality of statistical reasoning skills for PKO students in the SRLE learning group with a high category; high category students can already understand questions, master the concept even though it is not optimal, and have been able to provide arguments that can strengthen conclusions, have a plot thinking that is quite coherent but has not shown the ability to provide the proper interpretation.

RECOMENDATION

The results of the research using the grounded theory method show that the quality of statistical reasoning abilities can be reviewed based on five categories: problem understanding, concept mastery, the validity of arguments, coherence of thinking, and accuracy of interpretation. This emphasis can be done by making the five categories guidelines in obtaining statistical reasoning abilities and using the five categories as tools to reflect on statistical reasoning abilities. Grounded theory in this study is limited to revealing the level of students' abilities in one of three aspects of research observation, namely statistical reasoning abilities. Further research can be carried out by taking into account the findings of this study, namely the five categories of quality of statistical reasoning ability. The five categories need to be elaborated in the development of instru-

ments and the implementation of learning. Mastery of concepts, giving arguments, coherence of thinking, and the ability to provide interpretation in solving inferential statistical problems for sports students still need to be trained and improved. For this reason, it is recommended that further research be carried out on this issue.

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CONFLICT OF INTEREST

The authors declared no conflict of interest.

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