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Research Article

The analysis of student's statistical literacy based on prior knowledge and mathematical self esteem

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Abstract

Statistical Literacy is the ability of individuals to formulate, apply and interpret statistics in various contexts. This ability is very important possessed by students as a tool to solve problems when doing research or solve problems related to statistics. The ability of a person's statistical literacy is influenced by several factors such as prior knowledge and mathematical self esteem. So by optimizing these two factors, then the statistical literacy ability of students will develop well Based on these assumptions, this study aims to examine students' statistical literacy in terms of early knowledge and mathematical self esteem in basic statistics courses. Based on the purpose of the research, this research is descriptive quantitative research. Population as well as samples in this study are all students of Science Department of Sultan Ageng Tirtayasa University Academic Year 2018/2019 which amounted to 34 students. Data collection techniques use test of statistical literacy, test of early knowledge and mathematical self esteem scales. Data analysis in this research use descriptive and inferential statistic analysis. Based on the results of data analysis showed that (1) The mean of the prior knowledge of students that is equal to 9.79 (average), consists of a group of 10 students high prior knowledge, 14 students average prior knowledge and 10 students low prior knowledge; (2) the mean of student's mathematical self esteem of 65,38 (average), consist of high mathematical self esteem group as many as 12 students, 14 students average mathematical self esteem and 8 students low mathematical self esteem; (3) the average of statistical literacy ability 58,68 with average category; (4) There is a significant difference of students' statistical literacy in terms of prior knowledge category (high, average, and low); (5) there is a significant difference of students' statistical literacy in terms of student's mathematical self esteem category (high, medium, low).

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Introduction

The rapid development of information and communication at this time requires individuals to choose the right information. So it takes the ability of individuals who are proficient in making conclusions and decisions accordingly. This is in line with the abilities emphasized in the ability of the 21st century, one of which is the ability to think critically and solve problems. According to the 21st Century Learning Partnership states that the focus skill in the 21st century is "It's important to concentrate on imagination, critical thinking, communication and teamwork to prepare students for the future".

According to the 21st century capability framework (Scott, 2017), indicators of someone who has critical thinking and problem solving abilities are: (a) Effectively analyze and evaluate evidence, arguments, claims and beliefs; (b) Analyze and evaluate major alternative points of view; (c) Synthesize and make connections between information and arguments; (d) Interpret information and draw conclusions based on the best analysis; and (e) Reflect critically on learning experiences and processes. One important point is interpreting information and making conclusions based on good analysis. This point is very important to have by individuals who are confronted with the statistical information they encounter.

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In everyday life, we often see many newspapers, online media, graphic media present graphics or information on the main page. It is intended that the reader understands and appreciates the compressed information. Of course, the statistical information is not only intended for educated people but for the general public though. So we need the ability to read and interpret information properly so that statistical information can be understood.

Islami et al. (2019) research results show that the ability to interpret information presented in graphical form is still difficult for some groups. While (Kaplan et al. 2014; Lee & Meletiou-Mavrotheris, 2003; Nurtanto et al. 2019, Rahmatina & Zaid, 2019) Students had difficulty in completing punishment. The ability of individuals to formulate, apply and interpret statistics in various contexts is known as statistical literacy.

Here are some definitions of statistical literacy according to (Schield, 1999). The ability to read and interpret data is statistical literacy: the ability to use the statistics as facts inarguments (Garfield & Ben-Zvi, 2007). Statistical literacy includes basic and essential skills which can be used to interpret statistical information or research results. These skills include being capable of organizing data, creating and presenting tables, and interacting with various data representations. Statistical literacy also requires an understanding of definitions, terminology, and symbols, and involves an understanding of probability as a measure of uncertainty; and (Wallman, 1993) Statistical literacy is the ability to recognize and critically analyze statistical findings that permeate our everyday lives–combined with the ability to appreciate the contributions statistical analysis can bring to public and private, professional and personal decisions.

The opinion above, it can be concluded that statistical literacy is the ability to read, understand and interpret data or information and the ability to make conclusions or decisions based on these interpretations.

Statistical literacy is a very important ability to be mastered well by an individual. This will help the individual in solving various problems in daily life.

Development of this ability is not easy, because indeed most students still think that statistics are difficult. This is not only students who find it difficult, but even teachers as teachers also find it difficult to convey the concept of statistics so that students can easily understand. The above is in line with the opinion of (Garfield & Ben-Zvi, 2007). "Given the increasing need for statistical instruction, many students have traditionally regarded statistical education as challenging and unpleasant to study, and many instructors as frustrating and unrewarding to teach. When more and more students participate in statistical introductory courses, teachers face many obstacles in helpingthese students excel in the course and know their ranking". Based on this opinion, the recommended learning is to approach active students, practice and hone students' awareness or metacognitive. It is expected that with this approach students will become more understanding and precise in drawing conclusions in each case given in learning.

One cognitive factor that affects student achievement in statistical literacy is mathematical initial knowledge. Initial knowledge is prior knowledge or experience possessed by an individual. This is in line with the opinion of (Sharma et al. 2016; Yang & Quadir, 2018) which states that initial knowledge generally has a positive effect on student performance or achievement.

Student's initial knowledge is a prerequisite ability possessed by a student to understand the concepts being learned so that the acquisition of new knowledge will be optimal. This is in line with Schleicher's opinion which states that initial knowledge is relevant knowledge and skills including other background information on the characteristics of students that he already has when he will begin to follow a teaching program (Schleicher et al. 1999). Chong & Cheah (2009) states that initial knowledge as knowledge, skills and competencies are prerequisites that must be possessed by students to be able to attend or learn new or next lessons. This initial knowledge is inherent in the individual as stock and is obtained through past experiences that are relevant to new experiences.

Initial knowledge is very important known by a teacher to determine the initial start of learning. By knowing the students' initial knowledge the concepts to be conveyed are adjusted to their initial conceptions. This is in line with the opinion of (Guerriero & Guerriero, n.d.; Hailikari et al. 2008) which states that by knowing initial knowledge can be determined from where teaching should begin. Ability Terminal abilities are the direction in which teaching objectives are terminated. So, teaching takes place from the initial ability to the ability of the terminal that is the teacher's responsibility.

It can be concluded that the initial knowledge is the ability and skills gained from previous experience throughout life's journey as an individual's readiness to accept new lessons or higher abilities. The initial ability of students is determined by giving the initial test Gerlach and Ely. The initial ability can be taken from the value that has been obtained before new material is obtained.

In addition to initial knowledge, there are other factors that influence individual success in learning statistics are non-cognitive issues such as students' feelings, attitudes, beliefs, interests, expectations, and motivations (Blazar &

Kraft, 2017; Gal & Ginsburg, 1994; Ramirez et al. 2012). Beliefs are the main capital of self esteem. In particular, our beliefs about values as individuals or what we feel are capable or unable. Self-esteem is defined as the complication of feelings that guide behaviour, influences attitudes, and drives motivation (Satriani, 2014). Meanwhile, according to Leeson (Zuffiano et al. 2013) self esteem reflects the way in which individuals evaluate their self worth.

Self esteem is an internal factor that influences individual behavior in doing something according to their abilities and beliefs. This internal factor has the potential to make a good contribution to achieving an individual's academic success.

Several studies mention that self esteem is a psychological aspect that gives a large role to student success and has a positive relationship with academic achievement (Baumeister et al. 2003; Berne & Savary, 1996; Kholik & Nainggolan, 2017).

Individuals with high self esteem tend to believe in social situations they face and are confident in handling the tasks they face, maintain a natural curiosity in learning and have enthusiasm and enthusiasm when facing new challenges. Conversely, individuals who have low self esteem avoid situations where the situation has the potential to make him feel embarrassed in front of others (Habrat, 2018).

Researchers analyzed the initial knowledge of students in terms of mathematical self esteem. Based on the description above, the problem formulation in this study is as follows:

- What is the description of initial knowledge, mathematical self esteem and statistical literacy skills of students?
- Are there differences in students' statistical literacy skills in terms of initial mathematical knowledge?
- Are there differences in students' statistical literacy abilities in terms of mathematical self esteem?

Methods

This study aims to describe and examine the statistical literacy of students in terms of initial knowledge and mathematical self-mathematics. Based on these objectives, this type of research is descriptive quantitative research.

The subjects in this study were first-year students of the Faculty of Mathematics and Natural Sciences Study Program at Sultan Ageng Tirtayasa University 2018/2019 Academic Year with 34 students. The research began with the provision of mathematical initial knowledge tests related to logic and statistics material in secondary schools. Furthermore, students get statistical learning within 2 months. At the end of the teacher, students are given a mathematical self-esteem scale with a Likert scale totally 25 statements and given a statistical literacy test in the form of a description with a total of 3 questions.

The instrument in this study consisted of literacy, statistical and initial knowledge tests as well as a mathematical self-esteem scale. Static Literacy Tests are the ability of individuals to formulate, apply and interpret statistics in various contexts. This ability is measured using a test in the form of a description with indicators presenting data in various forms that fit the problem, applying certain formulas in solving problems and interpreting statistical information in various contexts.

Initial Knowledge Test is the ability or knowledge possessed by students before learning takes place. The provision of this initial knowledge test aims to find out the student's knowledge before learning and is used for student placement based on his initial mathematical knowledge.

Student's initial knowledge is measured through a set of basic math ability test questions. Based on the initial mathematical knowledge scores obtained, students are grouped into three groups, namely high, medium, and low group students.

Mathematical Self Esteem Scale, This scale is used for classification of self esteem by using a Likert scale with a total of 25 statements. The self esteem measured in this study is the assessment of a person's ability, successes, significance, and worthiness of himself in mathematics.

Data analysis techniques are divided into two, namely descriptive statistical analysis and inferential analysis. Descriptive analysis aims to describe the data of the three variables according to their respective categories. While inferential analysis is used to draw conclusions from the proposed research hypothesis, namely to see differences in students literacy in terms of the students' initial knowledge and mathematical self-esteem categories.

Results, Discussion and Conclusion

The research data described include the mean, standard deviation, minimum and maximum values. The division of data categories uses the normative reference approach.

Early Knowledge

The following are descriptive statistics of students initial knowledge

Table 1.

Recapitulation of Initial Knowledge

N	Min	Max	Mean	Std. Deviation
34	2.00	19.00	9.79	4.51
Ideal Maximum Score = 20				

Based on table 1 above, it can be seen that the average initial mathematical knowledge reached 9.79 with a moderate achievement category. From 34 students the percentage of students who had initial knowledge above an average of 20 people, and the rest below an average of 14 people.

For more details, here are student group diagrams based on the mathematical initial knowledge category.

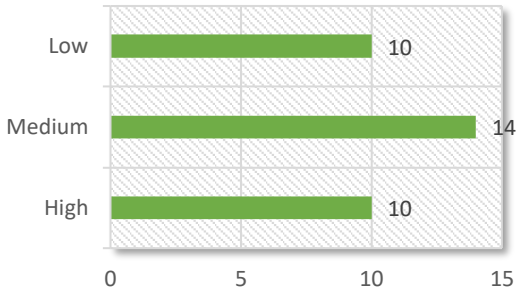

Figure 1.

Early Knowledge Categories

Based on the picture above, it appears that students who have high initial knowledge and 10 people or 29.41% and students who have moderate initial knowledge are 14 people or 41.18%. So based on these results the prerequisites of students have enough experience or knowledge to understand statistical material.

Mathematical self-esteem

The mathematics self-esteem scale is 25 items in the form of a Likert scale. The following are descriptive statistics of mathematical self-esteem.

Table 2.

Recapitulation of Mathematical Self Esteem

N	Min	Max	Mean	Std. Deviation
34	44.00	92.00	65.38	11.60
Ideal Maximum Score = 100				

Based on the table above, it can be seen that the average mathematical self-esteem reaches 65.38 or the percentage of acquisition of 65.38% is included in the medium category. The number of students who have SEM above the average is 15 people or 44.12%. For more details, here is a diagram of student categories based on their level of mathematical self-esteem.

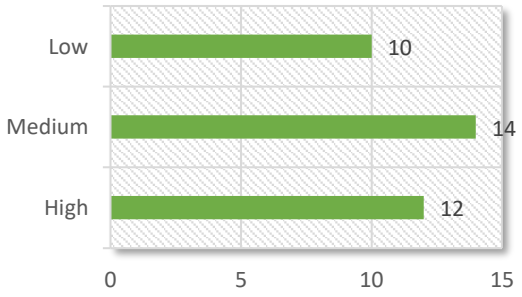

Figure 2.

Mathematical Self Esteem Categories

The picture above, it appears that the number of students who have a high category is 12 people or 35.29%, the medium category is 14 people or 41.18% and the low category is 10 people or 29.42%. This shows that most students have good mathematical self-esteem. This means that students' self-esteem has formed before lectures.

Statistics Literacy

The students' statistical literacy ability test is obtained by giving a final test in the form of a description. The following is a recapitulation of students' statistical literacy skills.

Table 3.

Summary of Statistical Literacy

N	Min	Max	Mean	Std. Deviation
34	20	95	58,68	15,97
Ideal Maximum Score = 100				

The table above shows that the achievement of students' statistical literacy ability was 58.68 or the percentage of their acquisition compared to the ideal maximum score was 58.68%. The achievement of statistical literacy capabilities is included in the medium category.

For more details, here is a student group diagram based on the statistical literacy category.

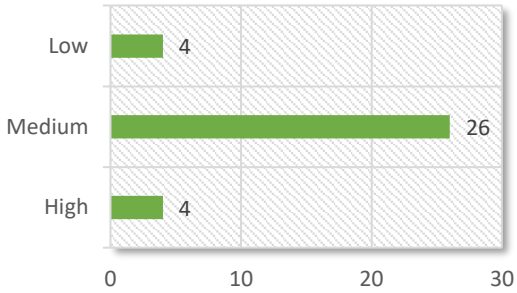

Figure 3. Statistics Literacy Category

Statistical literacy is based on initial knowledge and mathematical self-esteem

The following will describe the ability of statistical literacy in terms of initial knowledge (IKE) and mathematical self esteem (SEM). The following is a table of statistical literacy recapitulations.

Table 4.

Statistics Literacy Recapitulation by IKE and SEM Categories

No	Category	Early Knowledge	*Self Esteem*
1	High	70,00	69,58
2	Medium	61,46	58,57
3	Low	52,00	42,50

The table above shows that students who have high initial knowledge and self esteem categories have a higher average compared to other categories. This shows that there is harmony between the categories of initial knowledge, self esteem and statistical literacy. The following will show a statistical average literacy diagram based on the categories of initial knowledge and mathematical self-esteem.

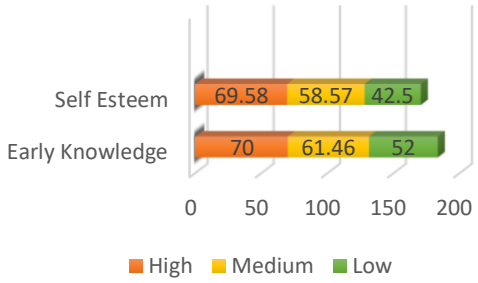

Figure 4.

Statistics Literature Category Based on IKE and SEM

The diagram above shows the statistical literacy ability of students based on the IKE and SEM categories showing the corresponding associations. Students who have high IKE and SEM categories have high literacy skills and vice versa.

Hypothesis Test 1

Hypothesis testing is done to prove whether the proposed hypothesis is proven or not. Hypothesis testing in this study was carried out by one way ANOVA test with Scheffe advanced tests.

The research hypothesis proposed in this study is whether there are differences in the ability of statistical literacy in terms of the category of students' initial mathematical knowledge. Following are the results of the one-way ANOVA test using the help of a statistical processing program.

Table 5.

One Way Anova Test Results

	df	Mean Square	F	Sig.
Between Groups	2	941,113	4,47	0,020
Within Groups	31	210,749		
Total	33			

Ho: There is no difference in students' statistical literacy abilities in terms of initial mathematical knowledge.
Ha: There are differences in students' statistical literacy abilities in terms of initial mathematical knowledge.

Based on the table above, it is known that the p-value is less than the 5% level of significance, that is 0.020 <0.05. This shows that Ho was rejected and Ha was accepted. Thus there are differences in students' statistical literacy abilities in terms of the category of initial mathematical knowledge. To see which groups are different, then proceed with the Scheffe test. The following is a summary of further tests.

Table 6.

Summary of the Scheffe Test

Group	Sig	Note
High >< Low	0,066	There is no difference
High >< Low	0,032	There is a difference
Medium >< Low	0,856	There is no difference

It was shown that there were differences in students' statistical literacy skills between high and low initial knowledge groups. whereas in the pairs of high and medium and medium and low initial knowledge groups there was no difference.

Hypothesis Test 2

The research hypothesis proposed in this study is whether there is a difference in the ability of statistical literacy in terms of students' mathematical self-esteem categories. Following are the results of the one-way ANOVA test using the help of a statistical processing program.

Table 5.

One Way Anova Test Results

	df	Mean Square	F	Sig.
Between Groups	2	1760,55	11,15	0,00
Within Groups	31	157,88		
Total	33			

Ho: There is no difference in students' statistical literacy abilities in terms of mathematical self esteem.
Ha: There are differences in students' statistical literacy abilities in terms of mathematical self esteem.

Based on the above table, it is known that the p-value is less than the 5% level of significance, that is 0,000 <0.05. This shows that Ho was rejected and Ha was accepted. Thus there are differences in students' statistical literacy abilities in terms of the mathematical self-esteem category. To see which groups are different, then proceed with the Scheffe test. The following is a summary of further tests.

Table 7.
Summary of the Scheffe Test

Group	Sig	Note
High >< Low	0,100	There is no difference
High >< Low	0,000	There is a difference
Medium >< Low	0,025	There is a difference

Based on the table above, it is known that there are differences in students' statistical literacy abilities between the high and low mathematical self-esteem groups, as well as the moderate and low mathematical self-esteem groups. Whereas in the pair of high and medium mathematical self-esteem groups there was no difference.

This study aims to analyze students' statistical literacy skills in terms of their initial knowledge and mathematical self-esteem in statistical learning. Based on the results of the research described above it is known that the average initial knowledge and mathematical self-esteem of students related to statistics courses belong to the sufficient category. So hopefully the competencies that will be achieved by students related to this subject are achieved well.

With sufficient initial knowledge and self-esteem conditions, the students' achievement in statistical literacy ability is moderate. This shows that these two factors contribute well to developing students' statistical literacy abilities. This is in line with the opinion (Pamungkas et al. 2017) which states that there are a relationship and differences in initial knowledge and mathematical self-esteem on students' thinking abilities.

Lectures are carried out by taking into account the student's initial knowledge factor, the lecturer starts learning by providing illustrations in daily life that contains data or statistical information. With this illustration, students are expected to be able to use their initial knowledge in analyzing and interpreting the information to make statistical learning meaningful.

Results of analysis of initial knowledge tests and student statistical literacy obtained the fact that students who have high initial knowledge, get high statistical literacy scores as well. This condition is in accordance with the proven hypothesis that there are differences in the ability of statistical literacy in terms of the initial knowledge category.

The facts above are in line with the opinion of (Pamungkas et al. 2017) which states that students who have good initial knowledge show good performance in class such as a quick understanding of new material, actively discussing in the classroom and enthusiastic in doing the exercises. In addition, initial knowledge affects individuals in the acquisition of new concepts. This is in accordance with the assertion that initial knowledge influences the acquisition of new concepts (Bringula et al. 2015; Thompson & Zamboanga, 2004).

The results of the analysis of student statistical literacy tests with a mathematical self-esteem scale obtained data that the average mathematical self-esteem of students is quite sufficient. This shows that students' beliefs regarding their mathematical abilities are good. In addition, it is found that students who have high self esteem get high statistical literacy scores. This is in accordance with the hypothesis that has been tested for truth which shows that there are differences in the ability of statistical literacy in terms of students' self-esteem categories.

Students who have high self esteem perform well in class during statistics lectures. Characterized by actively asking questions in class, enthusiastic in every activity, and have high competitiveness in doing every given exercise. On the other hand, students who have low mathematical self esteem exhibit a less active appearance in class and are not too enthusiastic about doing the exercises. This is consistent with the results of the study (Habrat, 2018).

Based on data analysis and discussion of research results, it can be concluded that:

- Initial knowledge, mathematical self esteem and statistical literacy of students are good.
- There are differences in students' statistical literacy abilities in terms of mathematical initial knowledge.
- There are differences in students' statistical literacy abilities in terms of mathematical self esteem.

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