The Scaffolding Approach to Enhance Senior High School Student’s Statistical Literacy Ability

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Abstract. This research aimed to analyze the enhancement of senior high school student’s statistical literacy ability (SLA) through teaching with scaffolding and direct approach. This research used a quasi-experimental design with pre-test post-test control group. This research held in two classes from XI MIIA classes in a state high school in Bandung. In this study there are two groups: experimental and control group. The experimental group consists of 33 students who learn mathematics by scaffolding approach, while the control group consists of 34 students, learning mathematics by direct approach. The main result obtain are: (1) the enhancement of student’s SLA who learn mathematics using scaffolding approach higher than student who learn mathematics using direct approach viewed from the whole students and all student’s ability level based on statistical prior knowledge, (2) there is no significant interaction effect between teaching approaches and ability level based on statistical prior knowledge in enhancing student’s SLA. (3) the enhancement’s quality of student’s SLA who learn mathematics using scaffolding approach are in the medium category while student who learn mathematics using direct approach are in the low category viewed from the whole students and all student’s ability level based on statistical prior knowledge.

1. Introduction
We find a lot of quantitative information in everyday life. Such as in newspapers or other mass media we can find various advertisements, arguments, or appeals that use statistics to display data. Therefore, the ability to evaluate data properly and argue based on data is an important skill that must be possessed by students. So, students should learn this skill as part of an education program. But many research indicate that even adults do not have the ability to think statistically about various important issues that might affect their lives [1].

Since statistics is important to study, it is not surprising that the Indonesian government included statistical content in the mathematics learning curriculum for primary and secondary education in Indonesia. In Permendikbud No. 64 of 2013 concerning the Content Standards of Primary and Secondary Education stated that one of the competencies that must be possessed by students in class X and XI of Senior High Schools in the mathematics content is being able to compare and assess the effectiveness of various methods of data presentation. Likewise in the attachment of Minister of Education Regulation No. 22 of 2006 concerning content standards in education stated that one of the competency standards that students must possess is able to use statistical rules, enumeration rules, and the characteristics of opportunities in problem solving. Althought statistical learning is a necessity for students, many students feel that statistics are difficult and unpleasant lessons to learn, so many
teachers feel frustrated about teaching statistics. According to [1], there are several challenges that may be faced by teachers to make students successful in studying statistics, including the following: (1) Many concepts and rules in statistics that are complex, difficult, and / or opposite with intuition. This makes it difficult to motivate students to try hard in studying statistics. (2) Many students experience difficulties with basic concepts in mathematics (such as fractions, decimals and algebraic formulas), and this interferes with students in learning material related to statistical content. (3) The contexts in many statistical problems may mislead students, causing them to rely on their experience and often wrong intuitions to produce an answer rather than choosing suitable statistical procedures. (4) Students equate statistics with mathematics and focus on numbers, calculations, formulas, and one correct answer. They do not feel comfortable with cluttered data, the possibility of different interpretations based on different assumptions, and the use of extensive writing and communication skills. In the midst of many challenges faced by the students in the study of statistics, the teacher should strive to develop statistical literacy.

Statistical literacy ability are very important in statistical learning, especially for high school students because it is very supportive in improving the quality of life. Based on [2], statistical literacy can be interpreted as a person's ability to interpret and critically evaluate statistical information and be able to communicate his opinions about statistical information. Statistical literacy is needed by every individual who must have full awareness and interest in social trends and phenomenon as well as personal needs, such as the level of crime, population growth, the spread of a disease, the production of an industry, the results of education, and so on. Statistical literacy ability can help individuals to make choices when faced with an opportunity-based situation. Many examples where statistical literacy is widely used in various aspects of life shows that most adults are consumers (not producers) of statistical information [2]. So it is clear that studying statistics and having good statistical literacy ability are needed by every student who will become the next generation. This is in line with what [3] stated: “In order for student to be able to acquire skills to achieve insight from data and think critically about statistics as evidence for inference, they need to develop statistical literacy.”

In connection with the world of statistical education, statistical literacy is seen by [4] as a meeting point between curriculum relating to data (statistics) and opportunities with everyday life, which is found in a spontaneous context and requires decision making based on the ability to apply statistical tools, general knowledge about the context used, and literacy skills critically. A broader definition of statistical literacy was presented by [5] which states that statistical literacy is the ability to understand and critically evaluate statistical results scattered in all aspects of our lives. The iteration has two dimensions, namely the dimensions of the general community and personal dimensions. This can motivate students to learn statistics better because statistical literacy is not only important for developing the welfare of society at large but also important for each individual for his own welfare. Statistical literacy can be used to make decisions in the lives of each individual based on information and risk analysis that might occur. Decisions such as choosing a place to live, a vehicle, a job, can be influenced by existing data from the community or based on the experience of others we know.

[6] states three levels of the main framework in statistical literacy, namely: (i) the understanding of basic statistical terminology, which means a person's understanding of basic statistical terms that are often used (including opportunities); (ii) the understanding of terminology when it appears in social contexts, this means how individuals are able to understand statistical terms (language and statistical concepts) that arise in a broad social context; and (iii) the ability to question claims that are made in context without proper statistical justification, this means the ability to doubt something made based on statistical truths that are inappropriate in a particular context. In contrast to [6], [7] proposed a main framework of statistical literacy which consists of three levels of data interpretation based on two context categories. The first level is reading values, at this level it requires technical understanding of the data displayed. For example, if someone is faced with a graph, then he must understand the contents of the graph, the title, the label, the scale used, the type of data, and other terms that are often used. The next level is comparing values, at this level requires awareness of relative and absolute differences, simple inference, and low level statistical tools. And at the last level that is analyzing the
data set, it takes attention to the entire data as a single object, the ability to observe and interpret variations, trends, and changes based on time or other variables. In addition to these three levels, there are two contexts in data interpretation, namely professional context and local context. Professional context is related to the knowledge of the application of information that is recognized in various professional fields while the local context consists of contextual understanding that someone might know about a particular data set but is not clear or unknown by others who have different professions.

From the various opinions above, it can be understood that statistical literacy is a set of abilities that students must possess that are concretely useful to solve problems that will be faced relating to statistical data. This ability consists of the ability to understand statistical information including understanding of concepts, vocabulary, and statistical symbols in a particular context, the ability to create and display data in the form of graphs or tables, and the ability to interpret statistical information or concepts into a particular context.

The results of the preliminary study conducted by the author on XI grade MIIA students in one of the State High Schools in the City of Bandung in 2016 resulted in the conclusion that students' statistical literacy ability were still relatively low. From the data the authors collected only a small percentage (21%) of students in the class were able to solve problems related to statistical literacy correctly. The lack of statistical literacy ability of students can be expected because students have not been able to develop their thinking skills in school as well as solving problems because students do more to mechanistic solutions based on examples that do not show good reasoning and creativity. [8] revealed several things that should be done by the teacher to make students more motivated and earnest in learning mathematics as follows. (1) Shows how useful mathematics is to life through examples of the application of mathematics that are relevant to the everyday life. (2) Using appropriate mathematical learning techniques, methods and approaches in accordance with the characteristics of the topics presented. (3) Utilizing varied techniques, methods, and approaches in learning mathematics so as not to be monotonous. One of the things that can be done to be able to improve students' statistical literacy ability is to use mathematical learning techniques, methods and approaches that require students to master the material without having to focus on the teacher in learning [9]. Students who study independently then feel difficulties then they are said to be in the ZPD (Zone of Proximal Development). Learning method or approach that can be used when students feel that difficulty is scaffolding [10].

Scaffolding in general can be understood as a process of interaction between a person as educator and a person who is learning in order to support the learning process of the person who is learning by providing appropriate and temporary assistance. In the world of mathematics education, scaffolding is a deliberate interaction in learning mathematical concepts and problem solving strategies [11]. This means that scaffolding can be interpreted as a gradual and temporary guidance given by someone who is more skilled so that someone who is learning is able to improve his abilities in order to achieve optimal abilities. In other words, the guidance of a more skilled person is able to make students move from the experience they have toward a new experience. Scaffolding is needed because basically everyone has enormous potential but does not yet have the ability to organize information or the initial ability he has. When learning a new thing students will be in their ZPD and need the ability to organize information or initial knowledge (metacognition skills) so that they need help in the form of scaffolding from more skilled people. Guidance provided is not by providing direct guidance by providing answers to problems or questions of students, but guidance in the form of direction, commands or statements that make students must involve their metacognition skills in learning new things. There are four main features in the scaffolding approach according to [12], namely: shared understanding (conveying the purpose of the activity to be carried out), ongoing diagnosis (monitoring student actions), and calibrated support (the teacher provides assistance in various types), fading the support (gradual transfer of learning responsibilities from teacher to student).

Each student basically has different abilities so that the approach to learning scaffolding will be very suitable for learning with one teacher-one student. This will be an obstacle for teachers to apply mathematics learning with a scaffolding approach in the class consisting of dozens of students. [13]
make a concept that is theoretical and empirical Whole-Class Scaffolding (WCS). The WCS concept does not deny the existence of ZPD differences in each student, but tries to view the class as a whole. There are three main characteristics of WCS proposed by Smit et al., Namely: Diagnosis (the process of recognizing the ability and development of students' abilities during learning), Responsiveness (the teacher's response or reaction to the activities carried out by students), and Handover (the teacher gradually submit the responsibility of learning entirely to students).

The results of Dewanti's study [14] state that students' statistical literacy ability are good when learning by using learning methods that have the following characteristics: 1) learning is guided by challenging problems; 2) students work in small groups; and 3) teachers take on the role of facilitator in learning. Based on the discussion about scaffolding previously explained it can be concluded that scaffolding also fulfills these characteristics where students are guided to exceed their ZPD by facing challenging problems and grouped into small groups in each class with the teacher as facilitator. So that it is suspected that learning with the scaffolding approach is also able to improve students' literacy skills. In learning with the scaffolding approach, students are expected to use their metacognition abilities and also diagnoses and the responses given by the teacher to students in the class so they are able to develop a new knowledge. Students are required to be able to know what they already know and what they need to know. So that if this learning strategy is applied in the classroom in learning mathematics it is expected to be able to improve students' statistical literacy ability.

Some influential factors in improving students' abilities is their intelligence and cognitive levels and motivation [15]. Students’ learning outcomes will depend on the level of readiness of students to face learning. The higher the initial ability and motivation, the more prepared students will be in dealing with learning so that it will facilitate students in receiving learning material. According to [16], prior knowledge is one of the causes of students experiencing difficulties in understanding a particular knowledge. This shows that the prior statistical ability (PSA) of students can influence the improvement of statistical literacy ability (SLA) of students who get learning using the scaffolding approach. So it can be predicted that there is an interaction between the initial ability and the learning approach in improving students' statistical abilities. Based on the description, in this study will examine the comparison of the enhancement in statistical literacy ability of high school students who obtain mathematics learning using scaffolding approach and who obtain direct learning.

2. Method
This research is a quasi-experimental study using the Nonequivalent Control Group Pretest-posttest Design, which is involving two groups that are compared. In quasi-experimental design, subjects are not randomly grouped, but researchers accept the state of the subject as it is [17].

The population in this study was all students of XI MIIA grade in one of the state high school in Bandung City. While the sample in this study were students in class XI MIIA 3 as an experimental class who would get mathematics learning using a scaffolding approach and students in class XI MIIA 7 as a control class who would get mathematics learning using a direct approach. The instrument used in this study consisted of prior statistical ability test (PSA) and statistical literacy ability test (SLA), and non-test instruments consisting of student questionnaires, student observation sheets, and teacher observation sheets.

3. Results and Discussion
In this section, the results of the statistical calculation and analysis for student SLA are reviewed based on students' PSA and learning approaches. Description of the mean (\( \bar{x} \)) and the standard deviation (s) of students’ SLA according to PSA and the learning approach described in Table 1. The aims of data analysis is to find out the description of students’ SLA enhancement who learn with the scaffolding approach and direct approach, and the differences. Pretest and posttest data will reveal students’ SLA before and after learning while gain data will illustrate the proportion of students’ SLA enhancement.

The results of the data analysis presented in Table 1 can explain that the average SLA pretest data of students who obtained learning with scaffolding approach was higher than those of students who
obtained learning with direct approach. Likewise with the average posttest score and the gain of students after obtained learning with scaffolding approach is higher than students who obtained learning with direct approach both overall and if viewed from grouping students based on student PSA. However, to conclude whether the average enhancement in SLA of students who obtained learning with scaffolding approach is significantly higher than students who get direct learning, it needs inferential statistics tests. This test aims to examine the research hypothesis that the enhancement in SLA of students who obtain learning with scaffolding approach is higher than students who obtain learning with direct approach both overall and if viewed from student PSA. The results of inferential statistics analysis of SLA are presented in Table 2.

Table 1. Description of overall pretest, posttest, and gain value of students in experiment and control classes and reviewed by PSA.

| PSA    | Learning Approach |  |  |  |  |
|--------|-------------------|---|---|---|---|
|        | stat | Pretest | Posttest | Gain | n | stat | Pretest | Posttest | Gain |
| High   | 10    | 28.40 | 78.00 | 67.52 | 11 | 24.36 | 45.27 | 26.92 |
|        | s     | 10.319 | 9.707 | 18.81 |    | 8.755 | 8.356 | 13.13 |
| Medium | 13    | 19.54 | 61.69 | 51.99 | 13 | 17.85 | 37.23 | 23.13 |
|        | s     | 6.489 | 17.007 | 22.90 |    | 9.433 | 11.505 | 14.39 |
| Low    | 10    | 19.60 | 54.40 | 43.95 | 10 | 19.40 | 40.20 | 25.32 |
|        | s     | 7.589 | 25.765 | 29.36 |    | 8.168 | 10.518 | 13.65 |
| Total  | 33    | 22.24 | 64.42 | 54.26 | 34 | 20.41 | 40.71 | 24.99 |

Table 2. Results of normality, homogeneity, and mean differences test for students’ SLA in experiment and control group at significance levels $\alpha = 0.05$.

| Variables | Group | Normality Test | Statistics | Mean Diff. Test |
|-----------|-------|----------------|------------|-----------------|
| Pretest   | Experiment | 0.011 Not Normal | Mann-Whitney U 0.476 | No Significant Differences |
|           | Control   | 0.200 Normal     |            |                 |
| Posttest  | Experiment | 0.002 Not Normal | Mann-Whitney U 0.000 | There is a Significant Differences |
|           | Control   | 0.200 Normal     |            |                 |

The results of inferential statistics of students’ SLA based on high, medium, and low PSA groups are presented in Table 3. Based on the results of the analysis it can be concluded that there are differences in the enhancement in statistical literacy ability for students with high and medium prior statistical ability between students who obtain mathematics learning with scaffolding approach and students who obtain mathematics learning with direct approach. It is also known that the average of posttest scores on SLA of students who have high and medium PSA who obtain mathematics learning with scaffolding approach are higher than those who obtain mathematics learning with direct approach, thus enhancement of students’ SLA who have high and medium PSA who obtain mathematics learning with scaffolding approach is higher than students who obtain mathematics learning with direct approach. Whereas for students who have low statistical prior ability, there is no difference in the enhancement of SLA between students who obtain mathematics learning with scaffolding approach and students who obtain mathematics learning with direct approach. That is, the scaffolding approach is more appropriately applied to students with high and medium PSA than students with low PSA to enhance students’ SLA. The results of the research in the high and medium PSA category are relevant to the findings of Fardillah's research [18] which shows that the enhancement in SLA of students in the high, medium and low PSA categories who obtain learning with the Rigorous Mathematical Thinking (RMT) approach is significantly better than students who obtain learning with expository approach. Conversely, the results of this study contradict the findings...
of [18] for students with low PSA levels. The enhancement in SLA of students in the low PSA category who obtained learning with the scaffolding approach was not significantly different from those students who obtained learning with direct approach. The difference is thought to be due to differences in the learning approach used, the statistical material studied, the education level of the research population and the attitudes of students from the sample studied.

Table 3. Results of normality, homogeneity, and mean differences tests of students’ SLA in experiment and control group based on PSA at the level of significance \( \alpha = 0.05 \).

| PSA Group | Normality Test | Test of Homogeneity | Mean Diff. Test |
|-----------|----------------|---------------------|----------------|
|            | Sig. | Conc. | Sig. | Conc. | Sig. | Conclusion |
| Pretest    |      |       |      |       |      |            |
| High       | E    | 0.200 | Normal | 0.603 | Homogen | t-test | 0.344 | No Significant Differences |
|            | C    | 0.200 | Normal | 0.501 | Mann-Whitney U | |
| Med        | E    | 0.023 | Not Normal | - | Mann-Whitney U | |
|            | C    | 0.200 | Normal | 0.100 | Homogen | t-test | 0.955 | No Significant Differences |
| Low        | E    | 0.191 | Normal | 0.143 | Homogen | t-test | 0.000 | No Significant Differences |
| Posttest   | High | C    | 0.200 | Normal | 0.009 | Not Homogen | t’-test | 0.066 | No Significant Differences |
|            | Med  | C    | 0.200 | Normal | 0.729 | Homogen | t-test | 0.000 | No Significant Differences |

To find out the direct effect and interaction effect between learning approach and PSA factors on enhancing students’ SLA statistically used a two ways analysis of variance test (two-way ANOVA). The requirement to use this two-way ANOVA test is that the enhancement in students’ SLA is normally distributed. The data used for this test are the gain SLA of experimental and control class. Based on the results of the analysis, the gain SLA data of the experimental class were not normally distributed at a significance level \( \alpha = 0.05 \). Because there is data on gain SLA that is not normally distributed, testing the interaction between learning approach and PSA factors to enhance students’ SLA cannot be done using the two-way ANOVA. So as to analyze the effect of interaction between learning approach and PSA factors on enhancing students’ SLA is done by utilizing the profile plots estimated marginal means diagram (Figure 1).

From Figure 1 it appears that the gain SLA of students in the experimental class is higher than students in the control class. This occurs in high, medium and low groups. In the experimental class, if the SLA gain value is sorted from the largest to the smallest, the sequence is (1) SLA gain for high PSA group, (2) SLA gain for the medium PSA group, and (3) low PSA group. Whereas in the control class, the order is (1) the SLA gain in the high PSA group, (2) the SLA gain in the low PSA group, and (3) the SLA gain in the medium PSA group. The difference in the order of the SLA gain position based on the PSA group (high, medium, and low) between students in the experimental class and the control class is an indication of the influence of the interaction between learning approach and PSA factors to the enhancement of students’ SLA. However, before deciding that the effect of this interaction is significant, there needs to be confirmation through a test of the mean differences in the gain value of SLA between PSA groups (high, medium and low) for students in the experimental class as well as for students in the control class.
The results of inferential statistics analysis for SLA of high, medium and low PSA students in the experimental and control groups are presented in Table 4. The results of the analysis in the experimental group using a one-way ANOVA test obtained the value of $\text{Sig.} = 0.098$ which is more than $\alpha = 0.05$. This means that $H_0$ is received. So there is no significant difference in the mean data on the SLA gain of students in the experimental class between high, medium and low PSA groups. Similarly, the results of the analysis in the control group using the one-way ANOVA test obtained the value of $\text{Sig.} = 0.799$ which is more than $\alpha = 0.05$. This means that $H_0$ is received. So there is no significant difference in the average data on the SLA gain of students in the control class between high, medium and low PSA groups. Based on the results of the analysis on Figure 1, it appears that there is a difference in the SLA gain sequence position according to the group between the experimental and the control class. Nevertheless, based on the results of statistical tests it turns out that there is no significant difference in the average SLA gain between PSA groups (high, medium, and low) both in the experimental and in the control class. Thus, there is no significant interaction effect between the learning approach and student PSA factors (PSA*learning approach) on enhancing students’ SLA.

**Table 4.** Normality, homogeneity, and mean difference test results for students’ gain SLA value of experiment and control group of high, medium and low PSA at significance level $\alpha = 0.05$.

| Group | PSA | Normality test | Homogeneity Test | Difference Test |
|-------|-----|----------------|------------------|----------------|
|       |     | Sig.  | Conc.  | Sig.  | Conc. | Statistics | Sig.  | Conc.  |
| **Experiment** | High | 0.061 | Normal | 0.133 | Homogeneous | One Way Anova | 0.098 | No difference |
|       | Medium | 0.200 | Normal |        |        |        |        |        |
|       | Low | 0.200 | Normal |        |        |        |        |        |
| **Control** | High | 0.196 | Normal | 0.646 | Homogeneous | One Way Anova | 0.799 | No difference |
|       | Medium | 0.200 | Normal |        |        |        |        |        |
|       | Low | 0.200 | Normal |        |        |        |        |        |

Furthermore, information will be presented on the number of students in each criterion for enhancing SLA. Interpretation of the gain value obtained by each student is based on the criteria...
proposed by Hake [19]. Based on the information in Table 5 it can be seen that the number of students who have an enhancement in SLA classified as high and medium in the experimental class is 26 students from 33 students (or 78.79%) while in the control class are 13 students from 34 students (or 38.24%). And if it is reviewed based on the student's PSA level for the whole class, 57.14% of students with high PSA level have an enhancement in SLA scores which are classified as high and medium, 61.54% students with medium PSA level and 55% students with low PSA level. Thus it can be seen that the scaffolding approach contributing the highest number of students who achieved high and medium SLA enhancement scores of 78.79% compared to direct learning approach which only had 38.24% of students. The average SLA gain value of students in the experimental class is 0.54 so the average enhancement in SLA of students in the experimental class is moderate, while the control class has an average of 0.25 which is low. Likewise, the average SLA gain index score of students in the experimental class based on PSA is classified as moderate for all ability levels with the average scores for high, medium and low PSA respectively: 0.68; 0.52; and 0.44. Whereas the average score of the SLA gain value of students in the control class was low for all ability levels with the average scores for high, medium and low PSA respectively: 0.27; 0.23 and 0.25.

| PSA      | Interpretation | Experiment | Control | Total   |
|----------|----------------|------------|---------|---------|
| High     | High           | 3 (30%)    | 0 (0%)  | 3 (14.28%) |
| Medium   | Medium         | 6 (60%)    | 3 (27.27%) | 9 (42.86%) |
|          | Low            | 1 (10%)    | 8 (72.73%) | 9 (42.86%) |
|          | High           | 3 (23.08%) | 0 (0%)  | 3 (11.54%) |
| Medium   | Medium         | 8 (61.54%) | 5 (38.46%) | 13 (50%)   |
|          | Low            | 2 (15.38%) | 8 (61.54%) | 10 (38.46%) |
|          | High           | 2 (20%)    | 0 (0%)  | 2 (10%)   |
| Low      | Medium         | 4 (40%)    | 5 (50%)  | 9 (45%)   |
|          | Low            | 4 (40%)    | 5 (50%)  | 9 (45%)   |
|          | High           | 8 (24.24%) | 0 (0%)  | 8 (11.94%) |
| Total    | Medium         | 18 (54.55%)| 13 (38.24%)| 31 (46.27%)|
|          | Low            | 7 (21.21%) | 21 (61.76%)| 28 (41.79%)|

4. Conclusion and Recommendation

Based on the results of the study and discussion about enhancing statistical literacy ability between students who obtained mathematics learning with a scaffolding approach and students who obtained mathematics learning with direct approach, the following conclusions were obtained. (1) The enhancement of students’ SLA who had learning with scaffolding approach significantly higher than the students who had learning with direct approach viewed from the whole students and all students’ ability level based on prior statistical ability. (2) There is no significant interaction effect between teaching approaches and ability level based on statistical prior knowledge in enhancing student’s SLA. (3) The enhancement’s quality of student’s SLA who learn mathematics using scaffolding approach are in the medium category while student who learn mathematics using direct approach are in the low category viewed from the whole students and all student’s ability level based on statistical prior knowledge.

Based on the results of research that has been obtained in this study, the authors propose the following recommendations. (1) The assistance provided by the teacher which is gradually reduced in scaffolding learning can trigger students to exceed their ZPD. Therefore it is recommended for teachers to consider scaffolding as one of the learning approaches used in the classroom. (2) The assistance to be used must be prepared and predicted in advance by the teacher based on learning obstacles that students may experience in learning mathematics using the scaffolding approach. (3) In applying the scaffolding learning approach to students with low PSA skills, intensive assistance, motivation from teachers and good learning facilities are needed. (4) This research was applied at the
high school education level. To see whether this approach can be applied to other education levels, further research is needed in this regard. Therefore, researchers recommend similar research at both junior and tertiary level to enhance statistical literacy.

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