Does science writing heuristic increase secondary school students’ argumentation skills?

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Abstract. Argumentation plays an important role to build and develop students’ conceptual understanding and critical thinking skill. Factually, argumentation at secondary school is less scientific because of the lack of scientific discussion content. Science Writing Heuristic (SWH) is a solution because it offers direct observation and comprising experiments at laboratory. It also shapes students’ conception like a scientist. The research aims to implement SWH on environmental pollution learning and observe its effect on students’ argumentation skill. It applied quasi experiment method with 36 7TH grade students as a research subject. The result showed that students’ argumentation contain claim, and warrant. It means SWH plays important role to build and increase students’ argumentation on environmental pollution.

1. Introduction
The purpose of science learning in secondary schools is to provide direct experience to students so that students are able to develop competencies to understand the natural surroundings scientifically. The results of direct observation in several schools showed that science learning was not in accordance with the learning objectives. Errol, Kisoglu, and Buyukkasap also revealed that science learning in classrooms and laboratories (regardless of school level) is only directed at the process of remembering scientific facts [1]. Carillo, et al., in Errol, Kisoglu, and Buyukkasap revealed that teachers should reduce the learning process with lecture models, especially during learning in the laboratory [1]. The teacher must not explain the steps of the experiment with the lecture method. Various learning methods in the laboratory tend to facilitate teachers to give lectures so that the steps of the experiment are like a recipe. Hand and Keys offer an alternative approach to learning in the laboratory that is able to facilitate students to think, namely science writing heuristic (SWH) [2].

The SWH approach guides students to improve the thinking process and students' reasoning abilities towards data obtained during practicum [2]. Kingir, Geban, and Gunel [3] in his paper explained that the SWH approach is based on a constructivist philosophy because it encourages students to use guided inquiry laboratory activities and collaborative group work with the aim that students actively negotiate to build knowledge. The characteristics of the SWH approach are a combination of inquiry activities and interactive group work by involving writing to learn at each step of the lab in the laboratory.
Practicum reports made by students using the SWH format require students to discuss, think and write through the formulation of initial questions, make claims and evidence and also the reflection process [4]. SWH prioritizes collaborative learning science activities oriented to scientific arguments [5]. Arguments based on laboratory activities not only present scientific facts but build, consider, and debate various scientific phenomena from the point of view of a scientist [6].

The SWH approach is generally implemented in chemistry learning [1,4,7] because it is considered in line with material characteristics that involve multi representation so as to reconstruct knowledge conceptual students. Gunel, Hand, and McDermott revealed that SWH activity is an appropriate writing to learn activity used in junior high schools so that it is not only to help students to argue but also to construct conceptual knowledge [8]. Science as an integrated lesson allows students to build argumentation through the SWH approach because it is an integration of various exact materials. The science phenomenon that has the potential to be taught with the SWH approach is the issue of environmental pollution. Learning environmental pollution is able to bridge the relationship between scientific facts (experiments in the laboratory) with a collection of opinions spread on various social media so that it stimulates student argumentation. In addition the theme of environmental pollution is a potential theme to stimulate students to write contextual problems so that they are easily directed to give argumentation [9]. Based on these considerations, the purpose of this study was to determine whether the SWH approach was able to significantly improve students' argumentation skills in the material of environmental pollution.

2. Method
This research is a one group pretest-posttest design, where students study environmental pollution issues using the SWH approach. The research subjects were 34 students taken by Random Class Sampling technique. Random Class sampling is a predetermined population sampling technique [10]. The instruments used in pretest and posttest are essay questions that measure students' argument skills. The amount of the question is 5 which consisted of one issue of soil pollution and two of them concerning air pollution and water pollution.

These questions collect claims, data, and warrants that build a student argument. Furthermore, the student's argumentation was given an assessment by adapting the Inch et al., [11] framework in analyzing arguments. Table 1 describes the score of student argumentation. Furthermore, N-Gain was calculated to see how significant the influence of SWH learning on students' argumentation skills [12].

| No | Score | Argumentation Components                      |
|----|-------|---------------------------------------------|
| 1  | 0     | the claim is incorrect or there is no claim  |
| 2  | 1     | claim without data or warrant/claim is not appropriate the data is relevant |
| 3  | 2     | claim and data/claim and warrant            |
| 4  | 3     | claim, data, warrant                        |

3. Results and discussion
The results of data analysis showed that the SWH approach is able to improve students' argumentation skills as shown in Table 2. This indicates that the students' argumentation skills on the theme of environmental pollution increases with the moderate criteria with N-Gain 0.40.

| Test  | Ideal Score | Min Score | Max Score | Average Score | G  | <g> | Criteria |
|-------|-------------|-----------|-----------|---------------|----|-----|----------|
| Pretest| 15          | 1         | 11        | 5.72          | 3  | 0.40| Middle   |
| Posttest| 15         | 2         | 15        | 9.39          | 3  |     |         |
More detailed data regarding the improvement of the argumentation skills of each student is found in Figure 1.

![Figure 1. Increased student argumentation based on N-Gain.](image)

The majority of the improvement of students' argumentation ability in the medium criteria (53%) is normal because the practicum with SWH approach involves students in direct observation and familiarizing students to write reports. This report contains several formulations of questions that lead students to make assumptions and evidence [13]. The SWH approach facilitates students to formulate initial questions, perform initial procedures and tests, observe, make claims, include evidence, and read and reflect [4].

But the improvement of argumentation skills of some students is in the low criteria of 33%. This is due to the limitations of references that students have so that they have difficulty in showing supporting data such as warrant. Sukardi and Agustrianti [14] revealed that to start scientific argumentation it is necessary to understand relevant material including scientific terms. Students of secondary school were unable or unwilling to use scientific theories, new terms to make sense of natural phenomena and to evaluate scientific knowledge even building argumentation. Students of secondary school who are lack of reasoning skills (included argumentation) are incapable on delivering their view of something topic [15]. Therefore, to understand it all, students must enrich their reading references.

Analysis of student argumentation components shows that claims still dominate students' arguments both at pre-test and post-test as shown in Figure 2 below. In general, both the pre-test and post-test the number of claims has increased.

![Figure 2. 7 Students’ argumentation composition.](image)

The amount of the claim is not only because it being the easiest thing to do, but also because in the pre classroom activity stage and the participation stage, the students are stimulated to make guesses that will occur in the practicum. At this stage, students in groups formulate what steps will be taken to prove the initial question. The next activity continued with an experiment that allowed students to gain direct experience and build argumentation [1,4,16].

The teacher assists students in negotiating on experimental data and the observation results obtained. Collaborative discussion that takes place within and between groups provides opportunities for students...
to develop concepts or ideas in formulating guesses and directing students in seeking evidence from the experimental activities they do [4]. However, the lack of students’ initial knowledge leads to an ineffective amount of data and warrants obtained [14]. If students have good initial knowledge, then it is not difficult for students to write, explain, describe, and synthesize laws, theories, principles and concepts that have been taught to them in the classroom. The teacher's step in teaching students to ask questions and answer questions plays a role in stimulating students' reasoning [17].

4. Conclusion
Learning environmental pollution with the SWH approach is able to improve students' argumentation skills. N-Gain calculation shows that the improvement of students' argumentation skills is in the medium category (N-Gain = 0.40). The water pollution is a theme that is able to collect the most components of claim, data, and warrant compared to air and soil pollution themes.

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