Reading for tracing evidence: developing scientific knowledge through science text

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Abstract. The purposes of this study were to investigate students' learning progression on reading activity, science concept comprehension and how they imply it in scientific communication in the classroom. Fifty-nine biology education students participated in this study. This classroom research was developed to portray students' reading activity, factors affecting reading comprehension, and the development of reading motivation. Qualitative analysis was used to describe the whole activities, involve the instruction, process and the product of reading activity. The result concluded that each student has their own way in interpreting the information from scientific text, but generally, they can filter and apply it in their argument as a part of reasoning and evidence. The findings can be used to direct reading activity to the goal of inquiry in order to support the nature of reading as evidence.

1. Introduction
Science is a structured activity to gain knowledge in the real world systematically, so it requires a scientific method to observe, identify, explain and investigate problems. On the other hand, science also can not detach from the discourse includes the use of language, especially written language to formulate scientific discoveries and build a theory that explains natural phenomena, communicates knowledge, principles, ways of thinking and how to make arguments to others [1]–[3].

1.1 The essence of reading science text
Reading is basically an activity that can be cultivated, but the essence of reading is not merely putting together words, sentences or paragraphs, but looking for the essence or main idea contained in the text[4]. Cognition can be built and developed through appropriate strategies reading because the main purpose of reading literature critically is to bring innovation and move students as critical agents and subjects in making decisions [5]–[7].

However, reading scientific literature is more difficult than reading a popular article or non-scientific reading. People who able to understand the reading of science can interpret the text into semantic information and knowledge into the brain so that they get the equal understanding with the author, in the special degree.[8]. Learning to read science texts not only leads to how to understand the substantive content of science but also how does the epistemology [9], [10].
1.2 Reading as inquiry

The cumulative nature of science makes a researcher or potential researcher need to know everything that happens before they learn what's new. This can be done through reading science, especially research articles published from reputable journals. However, real cases or problems are often different from those from previous studies for various reasons, so there is a need for compromise in adapting the scientific literature used [10]–[12].

Reading scientific texts requires several strategies to help students think about what they are reading. Students do not only think of questions arise after reading but at the same time should be able to predict and anticipate what kind of material they should read after that to get what they want. Students view general reading content by skimming through titles, abstracts, content, and illustrations, then marking problems encountered. Next, the students read more detail to find the answer. After reading, they make some citation or reading paraphrasing and then answer the question with the conclusion of the citation and complete it with another source needed [13, 14].

Reading is a multidimensional activity involves complex cognitive processes [15]. Reading action by a scientist is categorized into inquiry activities so that reading as part of inquiry should be included as part of science learning, but unfortunately, science curriculum and science learning have not supported this yet [9, 16, 17]. The lecturer should understand the "message" present in the literature to support the students understanding of the reading used. Reputable science readings play an important role in introducing authentic examples, the complexities and actual sections of scientific arguments [18], [19]. A proper reading of science provides a strong foundation for students in arguing activity, especially in terms of formulating claims, showing evidence, reasoning, and positioning, whether they support a statement or not.

The purposes of this study were to investigate students’ learning progression on reading activity, science concept comprehension and how they imply it in scientific communication in the classroom.

2. Methods

2.1 Research Design

This study used a qualitative methods research design [20], [21]. Qualitative analysis data were used to explore students’ reading activity, science concept comprehension, factors affecting reading comprehension, and the development of reading motivation.

2.2 Participants

This research took place in a 2nd-grade biology education classroom in a state university in Central Java and taught by team members. The partners were 59 students (50 females and 6 males) who had taken plant embryology class. They are not experienced with related communication, especially on how to build scientific arguments to convince others. Based on the previous observation, the class discussion has been dominated by only a few students, and most of them rely on lecturer as their major learning resource.

2.3 Data collection and analysis

Data were taken during the eight-week period from many sources including students’ writing assignments, structured interviews and lecturer’s notes. Data used to capture students’ reading activities and habits, and how they use the information to support their statement as a part of evidence beyond analysing the difference between the before and after the intervention. Intervention by lectures was done in two weeks to develop students’ skill of science reading includes selecting necessary points, utilizing information and locating material in their library. To portray students’ reading activity and the use of information, data were analysed focusing on amounts of reading, process of reading, and developing skill in using information.

3. Results and Discussion

The lessons focused on three topics, i.e. self-infertility, apomixes and embryo rescue. Observation was done to examine the importance of reading in science education. Findings showed several facts from the data: (1) students’ reading habit, included amount of references and citation management, (2)
process of reading, (3) science concept comprehension, and (4) developing skill in using information as an evidence. Writing assignments analysis showed students’ reading behaviour as follows:

Table 1. Students’ Reference Resources and Reading Activities Before The Interventions

| Amounts of citations | Type of references | Use of Citation |
|-----------------------|---------------------|-----------------|
| < 3 references (11 students) | Textbook, primary literature, research journal (8 students) | Support a claim (27 students) |
| 3 – 5 references (26 students) | Textbook, research journal (14 students) | As data (59 students) |
| 6 – 8 references (14 students) | Textbook, research journal (37 students) | Agreement (59 students) |
| > 8 references (8 students) | Journal and web/blog (37 students) | |

Table 1 described that based on the number of references, most students refer less than 8 sources to support the paper he wrote. Based on the reference type, only 8 students complete a complete three genre of reading including textbook literature, primary literature, and research journal. These three genres have been recommended as an ideal reference source for scientists and science students [17]. Popular magazines, web or blogs that are referred to by students though can be used as reference sources, are actually addressed to the general public, not for the science community. Students who refer more web pages or popular news shows low motivation and reading habit because they take information instantly from internet browsing or refer to the conclusions of previous research without seeing scientific process happened in it [22], [23], [12]. It has an impact on the students’ lack of understanding of science comprehensively, especially in appreciating how scientists think and act, how a study leads to new findings and how to use the results of research as empirical foundation of further research[24], [25].

In connection to how students locate the information and use it, it is found that more students use information from references to express approval of a statement or use data taken to indicate support for a particular claim. However, many students do not yet understand how to distinguish raw data from evidence, whereas raw data can not be regarded as an evidence without a strong theoretical foundation [26], [27]. This is apparent with the writings of the students using the words "I support the research ... which shows that ...", "I agree with the results of the research which shows that, ...", "I agree with the research ... which results ...". Some examples of the use of information from science reading are shown in Figure 1.

Figure 1. The Way Students Locating The Information and Using It Before The Interventions
The figure showed students' weakness in taking scientific information from science reading as a component of evidence, as they review the results but do not integrate it with the discussion and use it to support claims. There are still many students who cannot distinguish between "data" and "evidence".

Intervention is done through tutoring science reading by teacher, including selection of up-to-date reference sources and suitable for scientific community, use of citation management, reading strategy to develop comprehension and use the information as a part of evidence[22], [23], [28]. After the intervention, the data obtained as follows:

| Amounts of citations | Type of reference | Use of Citation |
|----------------------|------------------|----------------|
| < 3 references       | Textbook, primary literature, research journal (32 students) | Support a claim (59 students) |
| 3 – 5 references     | Textbook, research journal (27 students) | As evidence (59 students) |
| 6 – 8 references     | Textbook, research journal and web/blog (0 students) | Positioning (59 students) |
| > 8 references       | (0 students) | |

After the intervention was done, the students' behaviour changes especially in choosing the scientific reading source. Sources from non-reputable articles and blogspot are no longer used, and more and more reference counts are used, especially from the Adapted Primary Literature (APL) category, i.e. research articles. This source contains elements of evidence and reasons inside to reinforce claim and arguments [17], [25], [29]. The observation results showed that students who make citations of accurate science text genre are more skilled in expressing their ideas and able to provide clear scientific explanations, a strong theoretical foundation is accompanied by accurate evidence. Some student activities in the discussion activities are described as follows:

![Figure 2. Students’ Explanation and Evidence](image-url)

The synergy between science and literacy is undeniable in science learning, proved by a better understanding of students' science concepts as they become more familiar with reading appropriate scientific references. In the discussion activities, it appears that students who are actively answering are students who have more references. The claim they propose is clearer with apparent empirical and theoretical evidence. Some sample student dialogs are summarized in Figure 3 below:
The facts clearly illustrate the synergy between science and literature. Students are no longer accustomed using the phrase “in my opinion” or “I think, ...” or other expressions of doubt, but using "previous research shows that ...", "from the experiment ... ...", which shows evidence and arguments clear. This shows that students' understanding of the concept of science increases as they become more experienced with scientific reading. Students sportively want to revise their answers when they get a more accurate reference. In relation to the search for evidence to support the assertion, students should be able to link textual content with previously owned knowledge structures, build meaning, represent knowledge through different perspectives, and retain their interests and motivations[17], [29].

4. Conclusions

The result concluded that each student has their own way in interpreting the information from scientific text, but generally they can filter and apply it in their argument as a part of reasoning and evidence. The findings can be used to direct reading activity to the goal of inquiry in order to support the nature of reading as evidence.

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