Chemistry Textbook Analysis Based on Science Literacy

Yuli Iswanti[1], Maria Ulfa[1*], Sulistyo Saputro[1], Sri Yamtinah[1], Mohammad Masykuri[1], Bakti Mulyani[1], Ari Syahidul Shidiq[1], Agung Nugroho Catur Saputro[1]

[1] Chemistry Education Study Program, Faculty of Teacher Training and Education, Universitas Sebelas Maret, Surakarta, Jawa Tengah, Indonesia.

Abstract: This research is included in the type of qualitative descriptive research that is used to analyzing the content of science literacy in chemistry textbooks for class XI SMA Negeri in Surakarta. The book that was selected using the purposive sampling technique is textbook chemistry used by public high schools in Surakarta. The science literacy category consists of four categories, which is science as a body of knowledge, science as a way of investigation, science as a way of thinking, and the interaction of science, technology, and society. Category fulfillment results in science literacy in book A has a ratio of the first category: second category: third category: the fourth category is 5:2:3:0. The ratio in book B is 6:2:2:0, the ratio in books C and D are 7:1:1:0, and the ratio in book E is 7:0:2:0. From the results of the study, it can be concluded that book A is closest to the ideal standard of the ratio of science literacy categories according to Wilkinson (1999) which is 4:2:2:2.

Keywords: Chemistry; Science literacy; Textbook

Introduction

In the XXI century, the learning process carried out is participant-centered education. This condition is different from the previous one where the teaching and learning process is centered on educators. Therefore, now a teacher as an educator, no longer the only source of learning for participants students but as a provider of learning facilities in the classroom (Yuliati, 2017). Source learning material that students must have is textbooks. Textbooks are one aspect that plays a major and important role in the learning process at school. Textbooks have a very strong influence on the learning process because they are one of the main sources for students to acquire knowledge (Tunga et al., 2022). Book selection teaching materials that will be used as learning resources must be in line with the applicable curriculum is to prioritize mastery of science. Mastery of science can be achieved by the process of science education so that it can create scientifically literate humans. Someone who masters science literacy is someone who can make good use of science concepts for applying them in every day. For example, they can use science process skills as the use of science concepts indecision-making in solving problems around them (Arohman et al., 2016). Books that are designed by the applicable curriculum and developed with a new paradigm will direct the learning process in the right direction according to the demands of the curriculum (Adisendjaja, 2010).

According to the Organization for Economic Cooperation and Development, science literacy is defined as the ability to use scientific knowledge, investigate questions and draw conclusions based on facts to understand the universe and make decisions from changes that occur as a result of human activities (OECD, 2016). Students will be better prepared to face challenges in the industrial revolution 4.0 era when they have good scientific literacy skills (Pertiwi et al., 2018).

The level scientific literacy of students in Indonesia can be known from the results of the PISA (Program for International Student Assessment) study. Based on PISA results in 2018, Indonesia was in 71st position out of 79

participating countries with an average scientific literacy score of 396 (PISA, 2019). According to Ni'mah et al. (2017) the factors causing low scientific literacy are influenced by the education system/curriculum, learning methods, teacher competence, learning tools and facilities, learning resources and teaching material. One thing that can cause low levels of scientific literacy is the learning resources used by students, such as textbooks.

Science literacy is crucial because it provides the context in solving various problems. Thus, someone who is in control of science literacy can overcome various problems better and make smart, informed decisions that can then affect the quality of life (O'Toole et al., 2020). According to Lewenstein (2003) when a person is faced with a problem that requires some science background discussions, such a person must have a level-specific science literacy. By mastering science literacy one can solve or solve problems well using science the knowledge he has.

Chiappetta et al. (2007) said that the content of scientific literacy in textbooks includes four aspects. They are science as a body of knowledge, science as a way of inquiry, science as a way of thinking, and the interaction of science with technology and society. Based on several studies regarding the analysis of scientific literacy content in textbooks, it shows that widely used science textbooks tend to emphasize aspects of science as a body of knowledge such as facts, concepts, principles, laws, theories, models and remembering information (Anbiya et al., 2018; Lasminawati et al., 2019; Maturradiyah et al., 2015; Nur'aini et al., 2017; Retno et al., 2017).

Mastery of students' science literacy on the material chemical equilibrium which is a material that is closely related to phenomena around (Fassenda et al., 2016) has been studied by several researchers. The results of the research by Primastuti et al. (2018) show the level of literacy students' science on the chemical equilibrium material is relatively low, namely 25.925%. This shows that not all students can apply their knowledge in solving science literacy problems on the concept of chemical equilibrium. From the description above, an analysis of the chemistry textbook is needed especially the Chemical Equilibrium material which is based on literacy the science. The method of analysis is by reading, observing, understanding, and listen to the elements contained in the book and then match them with science literacy indicators adapted from Chiappetta et al. (2007).

Method

The method used in this study is qualitative and is an analytical study that aims to obtain in-depth information. Science literacy information collected from class XI chemistry books through data in the form of words is narrative and descriptive, as well as the use of data supporters. The research data sources were obtained from five Class Chemistry textbooks XI with a different publisher, namely Book A from Erlangga publisher, Book B from Tiga Serangkai publisher, Book C from Intan Pariwara publisher, Book D from Bumi Aksara publisher, and Book E from Simpati publisher. Each unit of text that in the Chemical Equilibrium Chapter, it is analyzed by categorizing it into science literacy indicators in science textbooks set by Chiappetta et al. (2007).

The research procedure was carried out through three stages, namely the preparation stage, implementation stage, and final stage. At the preparation stage, the researchers conducted a literature study related to science literacy in chemistry books. After that, the researcher chose the chemistry textbook to be analyzed then validate the instrument that will be used in conducting book analysis. At the implementation stage, the researcher reads the contents of the selected textbook carefully and deeply and then collecting data. Data collection is done by matching the sheet's observations in the science literacy category in the appropriate sentence or paragraph with their respective indicators. After that test, the validity of the data between raters and perform expert justification. And at the final stage, researchers perform data processing as the final stage of research. Data that has been obtained, the analysis is carried out by calculating the percentage of the emergence of science literacy categories in each analyzed textbook. After that write the results that have been obtained and present the results of the analysis based on the science literacy category.

Result and Discussion

Based on Table 1, data regarding the emergence of categories can be obtained from science literacy on chemical equilibrium material in chemistry textbooks. According to the results of data analysis, the percentage of occurrences of the science literacy category is obtained varied in each of the books analyzed. In Table 2, it can be seen that the first category (science as the body of knowledge) dominates compared to the other three categories

Table 1. Relationship between Science Literacy Indicators and Chemical Equilibrium

Science Literacy	Chemical Equilibrium
Science as a body of knowledge a. Presenting facts, concepts, principles, and laws b. Presenting hypotheses, theories, and models c. Ask students to remember knowledge and information	KD 3.8 Explain the reaction balance in the relationship between the reactants and the products of the reaction. 3.8.1 Describe alternating reactions come back and reaction equilibrium
Science as the way of investigation a. Ask students to answer questions use material b. Ask students to answer questions use graphs, tables, and more c. Ask student make a calculation d. Ask the student for giving a reason for an answer e. Engaging students in trial planning or other activities f. Provide sources of information valid from the internet	KD 3.8 Explain the reaction balance in the relationship between the reactants and the products of the reaction. 3.8.2 Determining the calculation based on the connection between reactants and products reaction of a reaction equilibrium 3.8.3 Determining the composition of substances in equilibrium, degree of dissociation, constant equilibrium, and Kc and Kp. KD 4.9 Design, perform and conclude as well as present the experimental results factor which affects the shift in chemical equilibrium
Science as a way of thinking a. Describe how a scientist does experiment b. Explain the development history of an idea c. Emphasizes the empirical nature of objectivity of science d. Illustrate with using assumptions e. Show how science process with inductive and deductive reasoning f. Show cause relationship and consequence g. Discuss facts and evidence h. Presenting the scientific method and solution to problem observation result	KD 3.8 Explain the reaction balance in the relationship between reactants and products 3.8.4 Observing demonstration analogy equilibrium dynamic 3.8.5 Observing demonstration reaction equilibrium lead sulfate and potassium iodide 3.8.6 Discuss reaction equilibrium dynamic
Interaction of science, technology, and society a. Describe the positive impact of science and technology on society b. Explain the negative effects of science and technology on society c. Discuss problems social science-related science and technology d. Presenting careers or jobs in science and technology	KD 3.9 Analyzing factors which affect the direction shift balance and its application in industry 3.9.1 Applying factors that shift direction equilibrium to get optimum results in the industry (process of making ammonia and sulfuric acid).

Table 2. Percentage of the Appearance of Science Literacy Indicators

Science Literacy Category	Book Appearance Presentation (%)					Average (%)
	A	B	C	D	E	
Science as a body of knowledge	50.00	64.37	68.13	67.27	67.93	63.54
Science as the way of investigation	21.82	17.24	13.19	14.55	5.66	14.49
Science as the way of thinking	26.36	17.24	14.29	13.64	20.75	18.46
Interaction science, technology, and society	1.82	1.15	4.40	4.55	5.66	3.52

Science as the Body of Knowledge

This category contains three indicators, namely presenting facts, concepts, principles, law, presenting hypotheses, theories, models, and asking students to remember knowledge and information. According to Wilkinson (1999), the ideal standard category science as the body of knowledge is 42%. From the five books that were analyzed, book A is the book that is closest to the ideal standard with 50% percentage. The presentation of this first category, it includes things that are important because with this category and the three categories of science literacy. In other words, students can make decisions to solve problems in understanding an event or events (Arief et al., 2015). Besides by loading various forms of text units such as images, paragraphs, until the questions in the first category show good things. Visual images in science textbooks can improve students' understanding and also serves to describe something

that cannot be delivered in written texts (Ge et al., 2018). Therefore, the inclusion of this category can be a starting point for students in developing their critical thinking level. On the equilibrium material chemistry presents the category of science as the body of knowledge. For example, a statement regarding the meaning related to chemical equilibrium and types of chemical equilibrium.

Apa yang dimaksud dengan sistem tertutup? Sistem tertutup adalah suatu sistem reaksi di mana zat-zat yang bereaksi dan zat-zat hasil reaksi tidak ada yang meninggalkan sistem. Sistem tertutup bukan berarti reaksi tersebut dilakukan pada ruang (wadah) yang tertutup (meskipun, kadang-kadang diperlukan ruangan tertutup untuk reaksi yang melibatkan gas). Reaksi antara larutan $FeCl_3$ dengan larutan KSCN tidak perlu dilakukan dalam wadah yang tertutup, sebab meskipun dalam wadah yang terbuka tidak ada zat yang meninggalkan sistem. Reaksi antara timbal(II) sulfat dengan larutan natrium iodida, tidak mungkin akan dapat balik jika timbal(II) iodida yang terbentuk pada reaksi tersebut dibuang (hilang) dari sistem.

Figure 1. Example results of the science as a body of knowledge analysis (Sudarmo et al., 2019)

Science as the Way of Investigation

This category is divided into six indicators, namely asking students to answer questions using materials, graphs or tables, and calculations, giving reasons for an answer, and involving students in experiments, as well as presenting sources of information valid from the internet. Book A is good at presenting the science category as a way of investigation due to the high percentage of occurrence 21.82% is close to the ideal standard of Wilkinson (1999) which is 19%. Therefore, book A is quite good because it can allow students to carry out investigations and understand the importance of chemistry (Lumpe et al., 1996). In the matter of chemical equilibrium, statements regarding the form of experimental activities on the factors that influence the shift in direction equilibrium represent the category of science as the way of investigation.

Science as the Way of Thinking

Indicators that fall into the category of science as a way of thinking are describe how scientists' experiment, show historical development of ideas, emphasizing the empirical nature and objectivity of science, provide illustrations through the use of assumptions, demonstrate the science process inductively and deductively, cause and effect, discuss facts and evidence, as well as presenting the scientific method and problem-solving. According to Wilkinson (1999) the ideal standard for this category is 19%, so book E is a bookthat is close to the ideal standard with a percentage of 20.75%. On the material chemical equilibrium, some statements show science as theway of thinking about the process of making ammonia by Carl Bosch and Fritz Haber (Haber-Bosch Process).
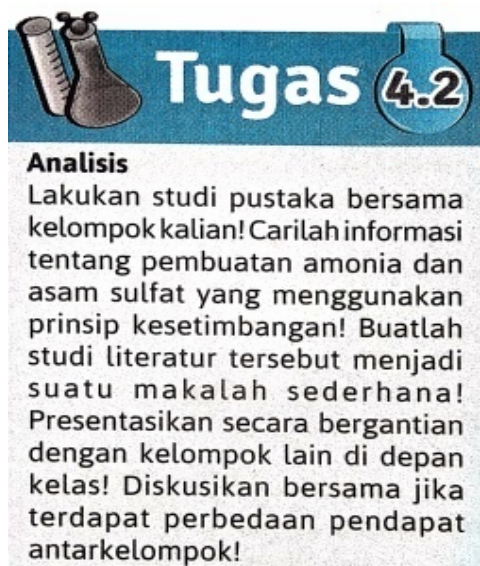

Figure 2. Example results of the science as a way of investigation analysis (Kuswati et al., 2018)
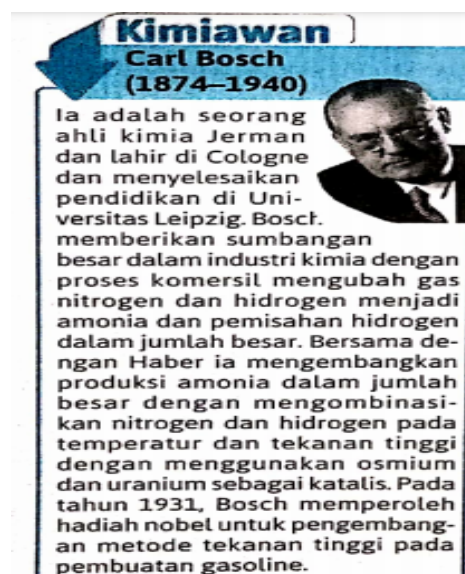

Figure 3. Example results of the science as a way of thinking analysis (Kuswati et al., 2018)

Interaction of Science, Technology, and Society

This category is presented in textbooks in the form of describing the impact positive and negative impacts of science and technology in society, discuss social issues regarding science and technology, as well as providean overview of work in science and technology. According to Wilkinson (1999) the ideal standard for this category is 20% so that book E is a book that is closest to the ideal standard. However, the percentage occurrence of this category in book E is still very small, namely 5.66%.If this category is contained more in chemistry textbooks, it will increase students' interest in learning and understanding the lesson chemical. This category can also help students to improve their ability to use knowledge in decision-making (Toharudin et al., 2011). On the equilibrium material in chemistry, there are statements about the benefits of sulfuric acid in daily life that shows the interaction categories of science, technology, and society on indicators describing the positive impact of science and technology in society.

Figure 4. Example results of the interaction of science, technology, andsociety analysis (Wulandari et al., 2020)

From the results of the research analysis that has been carried out, the five chemistry text books contain four categories of science literacy. The ratio of science literacy categories in book A which is 5:2:3:0, book B which is 6:2:2:0, book C and book D are 7:1:1:0, and in book E it is 7:0:2:0. Thus it can be concluded that book A is the book that is closest to the ideal standard ratio the

category of science literacy according to Wilkinson (1999) is 4:2:2:2. From result, research shows that science as the body of knowledge dominant while the interaction of science, technology, and society is the most little appearance. Therefore, students tend to understand science knowledge by memorizing rather than using their thinking ability. In addition, students are less interested in the learning process because the application of chemical equilibrium material in everyday life is lacking contained in the textbook used.

Conclusion

From the research that has been done, the results of literacy analysis are obtained science on book A, book B, book C, book D, and book E, by comparison, the percentage of occurrences of the average category of science as the body of knowledge: science as the way of investigation: science as the way of thinking: science interaction, technology, and society is 6:1:2:0. A result like this indicates that the five textbooks analyzed are not yet able to present science literacy with the ideal proportion of 4:2:2:2. Therefore it needs to be improved presentation of the second and fourth categories, namely the category of science as a way of investigation and interaction of science, technology, and society. Besides that, you can also divert the presentation of the first category into another category so that the first category is not too dominant.

Author Contributions
Conceptualization, M.U. and Y.I.; methodology, S.S.; software, M.M and S.Y.; formal analysis, M.U. and B.M.; investigation, M.U. AND A.S.S; resources, D.P.; data curation, M.U., A.N.C.S. and Y.I.; writing—original draft preparation, M.U.; writing—review and editing, M.U. and Y.I; visualization, M.M.; supervision, M.U. and S.S.; project administration, S.Y.; funding acquisition, A,S,S. All authors have read and agreed to the published version of the manuscript.

Conflicts of Interest
The authors declare no conflict of interest for this reasearch.

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