

Analysis of Chemical Representation in Brady, Sudarmo, and Kuswati Books of Class XI High School in the Material of Chemical Reaction

Rifkatul Jannah, Latisma Dj

Chemistry Department, Faculty of Mathematics and Natural Sciences

Padang State University

Jl. Prof. Hamka, Air Tawar Barat, Padang, 25131, Indonesia



Abstract - This study aims to analyze chemistry textbooks of class XI SMA in terms of chemical representation with criteria developed by Gkitzia, et al, namely C1 (type of representation), C2 (interpretation of surface features), C3 (relatedness to text), C4 (existence and properties of a caption), and C5 (degree of correlation between representations comprising a multiple one). As a standard book, chemical textbooks "Chemistry The Molecular Nature of Matter" are used Brady The analysis was carried out on the Sudarmo Book (book A) and the Kuswati Book (book B). The results of the analysis showed that in terms of image representation, book A contains fourteen representations with type (C1) macro and hybrid comparable 10%, submicro and symbolic comparable 40%; (C2) explicit 10%; (C4) existence and properties of a caption 70%. Book B, contains fifteen representations with type (C1) macro 23%, submicro 4%, symbolic 35%, multiple and hybrid comparable 19%; (C2) explicit 69%; (C3) relatedness to text 59%; (C4) existence and properties of a caption 79%; and (C5) sufficiently linked 40%.

Keywords - Chemical Representation, Chemical Reaction, Analysis of Chemical Textbooks.

I. INTRODUCTION

Textbooks are books formally used to study subjects or courses in schools or colleges (Wirawan, 2011: 148). Textbooks have specific objectives, namely to help students understand the contents of the book. The intended objectives are schemes, diagrams, matrices, and illustrated images that lead students towards understanding the contents of the book (Banowati, 2007: 148).

Writing textbooks must pay attention to the rules of writing Indonesian language that are standard, good and correct (Muslimin, 2011: 88). It is intended that the information conveyed in the textbook is clear and easily understood by students so that students do not experience difficulties in interpreting the meaning of the textbook used. In addition, language mastery is also very influential on

students' ability to understand science textbooks (Head, et al, 2013: 1).

Given the main role of textbooks helps facilitate students in science learning (and chemistry in particular) (Nyachwaya, et al, 2014: 721-722). Chemistry is the science of the composition, structure, properties, and changes of a material (Brady, 2012: 1). In the learning process, chemistry is often considered difficult. The difficulty of students learning concepts is not only caused by the learning process, but also can be influenced by the textbooks used by students.

The textbook used by students should contain material presentations that present various levels of representation in chemistry (Nyachwaya, et al, 2014: 720). Representation is a way of presenting something in another situation or a way of expressing phenomena, objects, events, abstract concepts,

and ideas (Pinar Bala, 2015: 582). Representation is an integral part of the textbook. Because representation is useful for bridging between phenomena and abstractions. Chemists refer to chemical phenomena at three levels of representation, namely macro, submicro, and symbolic which are directly related to each other (Treagust, et al, 2003: 1354). The concept of representation is one of the foundations of scientific practice, because experts use representation as the main way of communicating and solving problems (Sunnyono, 2015: 8).

Special textbooks on chemistry need to be systematically and continuously analyzed or evaluated. Because every new school year the textbook used changes. For this reason, it is necessary to evaluate the chemical representation of high school chemistry textbooks. Where, so that teachers can choose the right teaching materials for students so that the possibility of conceptual errors in the images caused by textbooks can be minimized (Sugiarti & Farida, 2013: 216). In evaluating the chemical representation in the textbook, there are five criteria proposed by Gkitzia, et al., Namely:

Table 1. Criterion for evaluating the chemical representation and typology of each

No	Criterion	Tipologi untuk setiap kriteria
1.	Criterion 1 (C1) Type of representation	i. Macro ii. Submicro iii. Symbolic iv. Multiple v. Hybrid vi. Mixed
2.	Criterion 2 (C2) Interpretation of surface features	i. Explicit ii. Implicit iii. Ambiguous
3.	Criterion 3 (C3) Relatedness to text	i. Completely related and linked ii. Completely related and unlinked iii. Partially related and liked iv. Partially related and unliked v. Unrelated
4.	Criterion 4 (C4) Existence and properties of a caption	i. Existence of appropriate caption ii. Existence of problematic

		caption iii. No caption
5.	Criterion 5 (C5) Degree of correlation between representations comprising a multiple one	i. Sufficiently linked ii. Insufficiently linked iii. Unliked

II. METHOD

This research uses descriptive research methods that aim to describe the results of the analysis the chemical representation of the reaction rate found in the Class XI high school chemistry textbook, which is then compared to other chemical textbooks as standard text.

The subject of this research are two types of high school chemistry textbooks namely chemistry books for SMA/MA Class XI written by Superior Sudarmo, et al. (2014) which is then called Book A, and the chemistry student books of SMA/MA written by Tine Maria Kuswati, et al. (2013) which is then referred to as Book B. The reason for choosing these two books is because based on the preliminary study, Book A and Book B are the most widely used books in schools as a source of learning. While the standard textbook was chosen by Jespersen Brady Hyslop, because in college this book is widely used by students as a source of reference in learning. So Jespersen Brady Hyslop's book was chosen as a standard text book.

The data is collected using the documentation *check list*, a list, where respondents only need to add a mark *check* (✓) to the appropriate column (Arikunto, 2010: 195). The data analyzed in this study are chemistry textbooks in class XI SMA with standard text books. The steps in analyzing the data in this study are as follows:

1. Create concept map
2. General description of chemical representation

General descriptions of chemical representations include photographs (scientists, laboratory equipment and glassware, and scenery), photographs of chemical phenomena (chemical reactions and separation techniques), diagrams (chemical equations, concept maps, graphs, structural formulas of organic compounds), and drawings (pictures of chemical reactions, electrochemical

cells, and the arrangement of laboratory equipment). Representations that are classified as photos in the general description, then analyzed only based on criteria 3 (C3) and criterion 4 (C4). While other chemical representations in the general description are analyzed based on criteria 1 (C1) to criteria 4 (C4). And only chemical representations with multiple classifications on criteria 1 (C1) are then analyzed using criteria 5 (C5) (Shehab & BouJaoude, 2016).

3. Analyzing chemical representations in standard textbooks and chemistry textbooks with five criterion (Gkitzia, et al, 2011).
4. Classify the appropriate typology from Criterion 1 to Criterion 5.
5. Using deskriptif statistical analysis with percent calculation

Descriptive statistical analysis techniques use the following formula:

$$P = \frac{n}{N} \times 100\%$$

Description:

- P = Percentage number obtained
 n = Number of typologies that appear
 N = Total number of typologies
 100 = Fixed numbers

III. RESULTS AND DISCUSSION

1. Description general chemical representation

Table 2. General description of the chemical representation of the three textbooks on the chemical reaction material

The name of the author of the book	Number of photos	Number of photos of chemical phenomena	Number of Diagrams	Number of pictures	Number of representations
Brady	3	2	16	1	22
Sudarmo	0	0	9	1	10
Kuswati	8	6	13	7	34

Based on Table 2., Kuswati's book published by PT Bumi Aksara shows the highest number of image representations.

2. Analysis image representation

Table 3. Results of chemical representation analysis of five textbooks on chemical reaction material

Typology	Brady	Sudarmo	Kuswati
	Text Standard	Book A	Book B
Macro	3	1	6
Submicro	2	4	1
Symbolic	7	4	9
Multiple	4	0	5
Hibrid	3	1	5
Mixed	0	0	0
Explicit	15	1	18
Implicit	2	5	3
Ambiguous	2	4	5
Completely related and linked	12	0	20
Completely related and unlinked	1	2	0
Sebagian terkait dan terhubung	4	3	3
Partially related and unlinked	0	1	0
Unrelated	5	4	11
Existence of appropriate caption	21	7	27
Existence of problematic caption	1	2	7
No caption	0	1	0
Sufficiently linked	2	0	2
Insufficiently linked	2	0	3
Unlinked	0	0	0

Based on the above analysis, it can be seen that Book A has a difference with standard text in terms of number of image representations. Book A contains fourteen image representations, while standard text contains sixteen image representations in the chemical reaction material.

Whereas in book B has a difference with standard text in terms of the number of image representations. Book B contains fifteen image representations, while standard text contains sixteen image representations in the chemical reaction material.

3. Percentage of chemical representation

Table 4. Percentage of chemical representation of five textbooks on material of chemical reaction

Typology	Brady Text Stan dard	Sudarmo Book A	Kuswati Book B
Macro	16%	10%	23%
Submicro	10%	40%	4%
Symbolic	37%	40%	35%
Multiple	21%	-	19%
Hibrid	16%	10%	19%
Mixed	-	-	-
Explicit	79%	10%	69%
Implicit	10%	50%	11%
Ambiguous	10%	40%	19%
Completely related and linked	54%	-	59%
Completely related and unlinked	4%	20%	-
Sebagian terkait dan terhubung	19%	30%	9%
Partially related and unlinked	-	10%	-
Unrelated	23%	40%	32%
Existence of appropriate caption	95%	70%	79%
Existence of problematic caption	4%	20%	20%
No caption	-	10%	-
Sufficiently linked	50%	-	40%
Insufficiently linked	50%	-	60%
Unlinked	-	-	-

A book can be said to have a standard criteria for good chemical representation of images in chemical textbooks according to Gkitzia, et al, Criterion 1 (C1) is a multiple (C1), Criterion 2 (C2) is explicit, Criterion 3 (C3) is completely related and linked, Criterion 4 (C4) is existence of appropriate caption, and Criterion 5 (C5) is sufficiently linked.

IV. CONCLUSIONS

Analysis that has been done can be concluded that from image representation, when compared to book A, book B raises more representations that are in accordance with the standard criteria of book representation and almost matches the same representation with standard text, except that the C5 gives the highest percentage is insufficiently linked.

ACKNOWLEDGEMENT

Thank you to Dr. Latisma Dj, M.Si who has provided guidance in the preparation of this paper.

REFERENCES

- [1] Wirawan. (2011). *Evaluasi Teori, Model, Standar, Aplikasi, dan Profesi (Contoh Aplikasi Evaluasi Program, Pengembangan Sumber Daya Manusia, Program Nasional Pemberdayaan Masyarakat (PNPM) Mandiri Perdesaan, Kurikulum, perpustakaan, dan Buku Teks)*. Jakarta: PT. Raja Grafindo Persada.
- [2] Banowati, Eva. (2007). Buku Teks dalam Pembelajaran Geografi di Kota Semarang. *Jurnal Geografi FIS UNNES*, 4(2), 147-158.
- [3] Muslimin. (2011). Analisis Buku Teks Bahasa Indonesia untuk SMP Kelas IX dengan Pendekatan Tematik, *Jurnal Bahasa, Sastra, & Budaya*, 1(2), 87-98.
- [4] Head, M, L., Yoder, K., Genton, E., & Sumperl J. (2013). A Quantitative Method to Determine Preservice Chemistry Teachers' Perceptions of Chemical Representations. *Royal Society of Chemistry, Journal of Chemical Education Research and Practice*, 00, 1-3. doi:10.1039/x0xx00000x
- [5] Nyachwaya, J., M., & Wood, N., B. (2014). Evaluation of Chemical Representations in Physical Chemistry Textbooks. *Chemistry Education Research and Practice*, 15, 720-728. doi:10.1039/c4rp00113c
- [6] Brady, James, Neil D. Jespersen, Alison Hyslop. (2012). *Chemistry The Molecular Nature Of Matter Sixth Edition*. USA: Jhon Wiley and Sons Inc.

- [7] Pinar Bal, Ayten. (2015). Skills of using and Transform Multiple Representations of The Prospective Teachers. *Procedia Social and Behavioral Sciences*, 197, 582-588. doi:10.1016/j.sbspro.2015.07.197
- [8] Treagust, D., Chittleborough, G., & Mamiala, T. (2003). The Role of Submicroscopic and Symbolic Representations in Chemical Explanations. *International Journal of Science Education*, 25(11), 1353-1368. doi:10.1080/0950069032000070306
- [9] Sunyono. (2015). *Model Pembelajaran Multiple Representasi; Pembelajaran Empat Fase dengan Lima Kegiatan Orientasi, Eksplorasi Imajinatif, Internalisasi, dan Evaluasi*. Yogyakarta: Media Akademi.
- [10] Sugiarti, R & Farida, I. (2013). Analisis Buku Teks Kimia SMA pada Konsep Keseimbangan Kimia Ditinjau dari Kriteria Representasi. *Prosiding Simposium Nasional Inovasi dan Pembelajaran Sains 2013 (SNIPS 2013)*, 216-219.
- [11] Arikunto, Suharsimi. (2010). *Prosedur Penelitian Suatu Pendekatan Praktik*. Jakarta: Rineka Cipta.
- [12] Shehab, S, S., & BouJaoude, S. (2016). Analysis of the Chemical Representations in Secondary Lebanese Chemistry Textbooks. *Int J of Sci and Math Educ*. doi:10.1007/s10763-016-9720-3
- [13] Gkitzia, V., Salta, K., & Tzougraki, C. (2011). Development and application of suitable criteria for the evaluation of chemical representations in school textbooks. *Chemistry Education Research and Practice*, 12, 5-4. doi:10.1039/C1RP90003