

PAPER • OPEN ACCESS

Volta-Based Cells Materials Chemical Multiple Representation to Improve Ability of Student Representation

To cite this article: I Helsy *et al* 2017 *J. Phys.: Conf. Ser.* **895** 012010

View the [article online](#) for updates and enhancements.

Related content

- [Student representation of magnetic field concepts in learning by guided inquiry](#)
Siska Desy Fatmaryanti, Suparmi, Sarwanto et al.
- [Newton's Cradle Experiment Using Video Tracking Analysis with Multiple Representation Approach](#)
A Anissofira, F D E Latief, L Kholida et al.
- [Development of Teaching Materials Based Interactive Scientific Approach towards the Concept of Social Arithmetic For Junior High School Student](#)
M K Abadi, H Pujiastuti and L D Assaat

Volta-Based Cells Materials Chemical Multiple Representation to Improve Ability of Student Representation

I Helsy^{1*}, Maryamah¹, I Farida¹ and M A Ramdhani²

¹Department of Chemistry Education, UIN Sunan Gunung Djati Bandung, Jl. A. H. Nasution No. 105 Bandung 40614, Indonesia

²Department of Informatics, UIN Sunan Gunung Djati Bandung, Jl. A. H. Nasution No. 105 Bandung 40614, Indonesia

*imeldahelsy@uin.ac.id

Abstract. This study aimed to describe the application of teaching materials, analyze the increase in the ability of students to connect the three levels of representation and student responses after application of multiple representations based teaching materials chemistry. The method used quasi one-group pretest-posttest design to 71 students. The results showed the application of teaching materials carried 88% with very good category. A significant increase ability to connect the three levels of representation of students after the application of multiple representations based teaching materials chemistry with $t\text{-value} > t\text{-crit}$ ($11.402 > 1.991$). Recapitulation N-gain pretest and posttest showed relatively similar for all groups is 0.6 criterion being achievement. Students gave a positive response to the application of multiple representations based teaching materials chemistry. Students agree teaching materials used in teaching chemistry (88%), and agrees teaching materials to provide convenience in connecting the three levels of representation (95%).

1. Introduction

The concept of electrochemistry is a chemical concept that requires an ability to integrate three representational levels (macroscopic, submicroscopic, and symbolic) in understanding it. The lack of the ability to integrate and understand the three levels of chemical representation causes students to consider chemistry as a difficult subject [1]. Volta cells, a sub-concept of electrochemistry, is a kind of abstract concept with concrete examples deemed difficult by most students, teachers, and student teachers [2]. One of the causes that make learners difficult to understand chemistry is the teaching materials used by learners do not contain the third level of representation so that multiple representations are not integrated in proportional learning. Many students or student teachers experience misconceptions and difficulties in understanding electrochemical material of Volta Cells [3]. Furthermore, their difficulties in learning Volta cell material may lead them to a conceptual error caused by the lack of the ability to link the three levels of representation to the learning process at High School [4].

Accordingly, to overcome the difficulties of students in integrating the three levels of representational ability over the Volta cell material, I perform a learning by applying the teaching material based on multiple representations. This study aims to describe the application of the teaching material, to analyze the improvement of students' ability in integrating the three levels of representation over the Volta cell material, and to obtain students' responses to the application of multiple presentation-based teaching material after applied.



Multiple representation-based teaching material is a tool used as a learning material that contains chemical representations combining text, real images, graphics, video and tables in delivering chemistry, that aims to make the concepts and chemical phenomena can be studied easier thoroughly [5]. Multiple representation is a form of representation combining real text or graphics. Learning using multimedia has a positive effect on students' learning outcomes [6, 7, 8].

2. Experimental Method

The method used in this research was quasi experiment method, one group Pretest - Posttest design. The research subjects involved 71 second semester students taking chemistry course 'Basic Chemistry II'. The instrument used in this research were an observation sheet containing criteria of activities performed by students while the teaching material was applied, some questionnaires used to obtain students' response to the application of multiple representation-based teaching material, and some questions testing the ability of three representational levels (pretest and posttest), consisting of 8 questions measuring 4 indicators of the relationship pattern of the three representational levels: 1) Macroscopic → Submicroscopic → Symbolic (Ma-Sub-Sym2) Microscopic → Symbolic (Ma-Sym); 3) Symbolic → Macroscopic → Submicroscopic (Sym-Ma-Sub); And 4) Macroscopic → Submicroscopic (Ma-Sub).

3. Result and Discussion

At each stage, activities performed during this research concerning on the implementation of Volta cell materials based on multiple chemical representations run very well. The following table 1 presents the Performance of the implementation at each stage based on the result of the observation sheet.

Table 1. The Performance of The Implementation Stages of Learning Material Based on Multiple Chemical Representations Based on The Result of The Observation Sheet

No	Implementation Stages	Average Performance (%)	Category
1	Observing	91	Excellent
2	Asking question	87	Excellent
3	Forming a hypothesis	83	Excellent
4	Collecting data	80	Excellent
5	Analyzing data	95	Excellent
6	Communicating	92	Excellent
Average Performance		88	Excellent

According to Table 1, the highest percentage of the performance lies at the stage of analyzing data. It is because based on the observation, at the stage of analyzing data, student used teaching material equipped with multimedia animation. While the lowest percentage of the performance lies at the stage of collecting data because students did not use the teaching materials optimally.

The analysis of students' ability to integrate the three levels of representation is obtained from pretest and post test data. The result of significance test (t-test) at significance level 0,05 obtained $t\text{-value} > t\text{-crit} = 11,402 > 1,991$. This value indicates that there is a significant difference of students' ability of representation after the application of Volta cells teaching material based on multiple chemical representation.

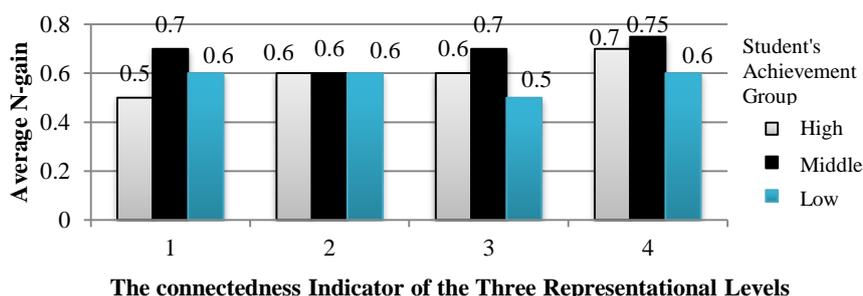
According to Table 2, the improvement of the ability to integrate the three levels of representation occurred in each achievement group of student i.e. in high, middle, and low group on medium criterion with the average N-gain value 0.6. The following Table 2, presents the recapitulation of students' pre test, post test, and N-gain data

Table 2. The score and average value of students' pre test, post test, and n-gain based on high, middle and low group

Student Group	Pre test		Post test		Average N-gain	Interpretation
	Score	Average	Score	Average		
High	760	54	1170	84	0,6	Medium
Middle	2085,5	50	3251,9	77	0,6	Medium
Low	441,5	29	1051	70	0,57	Medium
Average		44		77	0,6	Medium

As shown in Table 2, the improvement of the ability of three chemical representational levels is considered as a result of using relevant teaching materials during the process of applying the materials to improve the ability to integrate the three levels of representation. The result shows that teaching materials have an effect on students' ability. In addition, the improvement of students' ability is also influenced by the learning process and practicum activities reinforced by research [4].

At each indicator, the improvement of the ability of three chemical representational levels obtains N-gain 0,6, medium criterion. The highest percentage lies at the fourth indicator with N-gain 0,7, high criterion while other improvement of the ability to integrate the representation on one indicator to indicator (1), (2), and (3) obtains N-gain relatively the same namely 0,6, medium criterion. The following graphic shows the improvement of students' ability to integrate the three chemical representational levels for each indicator.

**Figure 1.** The graphic of the improvement of students' ability to integrate the three representational levels

Note:

1. Integrating Macroscopic-submicroscopic-symbolic level
2. Integrating Macroscopic to symbolic level
3. Integrating symbolic-Macroscopic-submicroscopic level
4. Integrating macroscopic to submicroscopic level

N-gain got a more increasing value on the indicator of the connectedness between macroscopic with submicroscopic representation. This increase is considered as a result of the presence of teaching material carrying the three levels of representation, equipped with animated video submicroscopically about the movement of electrons that occurs in the Volta cell circuit, and students used it optimally.

A learning that involves submicroscopic media can help learners to construct chemical concepts more easily and to gain a complete understanding [9]. In addition, animation helps learners visually to understand difficult concepts about complex chemical systems such as molecules and reactions [10].

In the symbolic level connectedness indicator, there are some students who are still making mistakes in answering questions related to symbolic representation, such as writing the cell notation incorrectly and not writing the phase signature of the reaction. Students assume that writing a phase sign of a reaction is not a must. In fact, writing phase signs is important because symbolic

representation is a chemical term that has certain rules [4]. The symbolic representation level includes all the qualitative abstractions used to present every item at submicroscopic level, writing errors will lead to wrong interpretations, doubt and incomprehension [4]. Therefore, it is important for student teachers to comprehend the rules of writing the equation of the reaction thoroughly [4].

That students can integrate the three levels of representation (macroscopic-submicroscopic-symbolic) is considered as a result of their ability to integrate these three levels Systematically with the aid of multiple chemical representation-based material. This idea is supported by the results of student responses that show that 91.5% of students said the existence of teaching materials helps them to think systematically. In addition, 85% of them said that multiple representation-based teaching materials help them to get easy in integrating all of the three levels of representation. It is because the materials contain knowledge of the three levels of representation (macroscopic, submicroscopic, and symbolic) that combine text, images, animated video and tables to facilitate the study of chemical concepts and phenomena completely [5].

The use of representational modes by using practicum, teaching materials and animated videos in studying the Volta cell material is also a factor making students success in enhancing the ability to link the macroscopic, submicroscopic and symbolic level. The success of learners to solve chemical problems involves the construction of mental associations between macroscopic-submicroscopic-level of representations to the symbolic one by using different representations [11]. The use of animation can help students understand the submicroscopic representation. It is known based on student questionnaire answers showing that 96% of students agree and strongly agree that the teaching materials containing pictures and animations submicroscopically can facilitate them to understand submicroscopic representation.

4. Conclusion

The application of Volta-cell materials based on multiple chemical representations in enhancing the ability to integrate the three levels of representation is very well applied (88%). The improvement of students' ability to integrate the three levels of representation as a whole is in medium criterion with N-gain 0.6. Students' response to the application of Volta-cell materials based on multiple chemical representations shows a positive response. Students agree to use the teaching material in chemistry learning and said that it can provide ease in integrating the three levels of representation (macroscopic, sub microscopic, and symbolic). Suggestions that can be given based on these results of the study are that learning by involving the three levels of representation should be also implemented for other concepts whose explanations require the three levels of representation such as the concept of electrolysis, chemical equilibrium, and the colligative system of solutions.

References

- [1] Y. L. Sunyono and M. I. Ibrahim, "Efektivitas Model Pembelajaran Berbasis Multipel Representasi dalam Membangun Model Mental Mahasiswa Topik Stoikiometri Reaksi," *Journal Pendidikan Progresif*, vol. 3, no. 1, pp. 65-79, 2013.
- [2] S. Haryani, A. T. Prasetya and Saptarini, "Identifikasi Materi Kimia SMA Sulit Menurut Pandangan Guru Dan Calon Guru Kimia," in *Seminar Kimia dan Pendidikan Kimia*, Semarang, 2014.
- [3] E. Heriyana, S. Rahayu and Prayitno, "Menggali Pemahaman Mahasiswa Kimia Angkatan Tahun Pertama FMIPA Universitas Negeri Malang Dalam Pokok Bahasan Elektrokimia Menggunakan Instrumen Diagnostik Two- Tier," Universitas Negeri Malang, Malang, 2013.
- [4] I. Farida, Liliarsari and W. Sopandi, "Pembelajaran Berbasis Web untuk meningkatkan Kemampuan Interkoneksi Multiplelev Representasi Mahasiswa Calon Guru Pada Topik Kesetimbangan Larutan Asam-Basa," *Journal Chemica*, vol. 12, no. 1, pp. 14-24, 2013.
- [5] M. Cheng and J. K. Gilbert, Towards a Better Utilization of Diagrams in Research into the Use of Representative Levels in Gilbert J. K. & D. F. Treagust (eds.) Multiple Representation of Chemical Education, Boston: Springer, 2009, p. 0.

- [6] I. Farida, "The Importance of Development of Representational Competence in Chemical Problem Solving Using Interactive Multimedia," in *International Seminar on Science Education*, Bandung, 2009.
- [7] M. A. Ramdhani and E. R. Wulan, "The Analysis of Determinant Factors in Software Design for Computer Assisted Instruction," *International Journal of Scientific & Technology Research*, vol. 1, no. 8, pp. 69-73, 2012.
- [8] M. A. Ramdhani and H. Muhammadiyah, "The Criteria of Learning Media Selection for Character Education in Higher Education," in *International Conference of Islamic Education in Southeast Asia*, Malang, 2015.
- [9] I. Langitasari, "Analisis Kemampuan Awal Multi Level Representasi Mahasiswa Tingkat I Pada Konsep Reaksi Redoks," *Edu Chemia (Jurnal Kimia dan Pendidikan)*, vol. 1, no. 1, pp. 14-24, 2016.
- [10] Russell, R. Kozma and Joel, "Modeling Students becoming chemist: developing representational competence," in *Visualization in science education*, Dordrecht, Spinger, 2005, pp. 121-145.
- [11] D. F. Treagust and Chandrasegaran, The efficacy of an alternative instructional programme design to enhance secondary students competence in the triplet relationship. In: Gilbert, J.K & D.Treagust (Eds). *Multipel representation in Chemical education. Model & Modelling in science education.*, Dordrecht: Spinger, 2009, pp. 151-164.