Journal of Educational Sciences Vol. 6 No. 2 (April, 2022) 286-293

Journal of Educational Sciences
Journal homepage: https://jes.ejournal.unri.ac.id/index.php/JES

P-ISSN 2581-1657
E-ISSN 2581-2203

The Urgency of Implementation RADEC Learning Model to Understanding of Three Levels Representation in Chemistry Learning: Literature Review

Ismi Yohana*, Wahyu Sopandi, Wawan Wahyu
Chemistry Education Masters Study Program, Faculty of Mathematics and Natural Sciences Education, Indonesian education University, 40154, Bandung

ARTICLE INFO

Article history:

Received: 02 Sept 2021
Revised: 03 April 2022
Accepted: 05 April 2022
Published online: 24 April 2022

Keywords:

RADEC
Representation
Understanding

A B S T R A C T

The transition from face-to-face learning to distance learning has decreased student learning outcomes. Departing from this phenomenon, this research is presented as an effort to overcome various obstacles experienced by teachers and students during the COVID-19 pandemic. The researcher offers a model that can be used in virtual learning activities. Beginning with finding out the extent of the influence of the problem-based learning (PBL) model on accounting learning outcomes in class X Accounting 1 students at SMK YPKK Limbung. Research data obtained from the results of the test, observation, and documentation. Then analyzed using t-test which consists of simple linear regression analysis and product moment correlation. The findings in this experimental study resulted in a simple linear regression equation model with a value of Y=33,012+4.283X and a correlation coefficient value of 0.580. After students received learning using the PBL model through distance learning and were given a post-test, their learning outcomes also increased. In other words, the implementation of the PBL model has a significant and positive effect on accounting learning outcomes during the COVID-19 pandemic.

1. Introduction

Chemistry is a learning based on abstract concepts which are closely related to interpreting the three levels of representation in learning. These three levels of representative were first identified by Johnstone (1982) as an indication of student difficulties in learning chemistry (Ye et al., 2019). These three level representatives are: (1) macroscopic, which describes observable phenomena; (2) submicroscopic, which consists of atomic and molecular models; and (3) symbolic, in which submicroscopic models and observable data are expressed

* Corresponding author.
E-mail: ismiyohana1@gmail.com
Doi: https://doi.org/10.31258/jes.6.2.p.286-293

symbolic, for example through chemical equations and graphs (Gilbert & Treagust, 2009; Taber, 2013). Often referred to as the Johnstone triangle or the three levels of chemistry, this framework has been a powerful way of conceptualizing chemistry as a scientific discipline and guiding approaches to teaching and learning chemistry.

Chemistry abstract concepts are considered difficult by most students, especially when they are placed to believe in something they cannot perceive with the senses, as stated by Stojanovska (2013) (Milenković et al., 2016). Ayas et al., (2010) revealed that many researchers in science education stated that the transition between the levels of macroscopic, sub-microscopic, and symbolic knowledge is very important for learning chemistry, but this creates difficulties for students from school to university level (Derman & Ebenezer, 2018) . In addition, many high school teachers do not connect the three aspects of representation in classroom learning. Lack of fluency in implementing the three levels of representative has an impact on students' difficulties in developing conceptual understanding because of the teacher's dependence onlearning procedures structured and systematic (Irby et al., 2016).

Meanings or concepts that students construct often conflict with what scientists perceive as knowledge (Yan & Subramaniam, 2018). This is considered a barrier to conceptual understanding. Identification of students' understanding and conceptions is usually done by means of tests. The test that is usually done is multiple choice or multiple choice used in assessing students' understanding, but this test cannot provide sufficiently detailed information to determine student understanding, therefore a test tool or instrument is needed to express it, namely a diagnostic test (Kaltakci-Gurel et al., 2017; Taslidere, 2016; Yan & Subramaniam, 2018).

2. Methodology

Research methods

The method used in this research is pre-experiment. Pre-experiment method is a research method that observes a main group and intervenes throughout the study. In this research design there is no control group to compare with the experimental group which is called the pre-experimental design (Creswell, 2012). The research design used one group pretest-posttest. In a one-group pretest-posttest design, one group is measured or observed not only after being given a certain treatment, but also before. The group was treated with pretest and posttest to see changes in the understanding of the three levels of representation. Researchers at least know whether there are changes that occur (Fraenkel & Wallen, 2012).

Research Instruments

The test used is aimed at obtaining an overview of the students' understanding of the three levels of representation at the macroscopic, submicroscopic, and symbolic levels of electrolyte and nonelectrolyte solutions.

Data Analysis

The data analysis includes validity testing, reliability testing, after testing the five-level diagnostic test items, scoring and percentage calculations are carried out to be categorized. The N-Gain test is used to see the increase in students' mastery of concepts, in this study the n-gain value is used to see the increase in the understanding of three levels of representation after the application of the RADEC learning model. Improved understanding of the three levels of representation can be seen by using the n-gain test formula below.

$$N - gain = \frac{post\ score - pretest\ score}{maximum\ value\ -\ pretest\ score}$$

The grouping of students' increased mastery of concepts according to Hake's 1998 criteria (in Velanda, 2019) is as shown in Table 1 below.

Table 1. Improved Concept Mastery

N-gain Value	Category
g > 0,70	Height improvement
0,3 < g < 0,70	Moderate improvement
g ≤ 0,30	Low improvement

3. Results and Discussion

RADEC Learning Model to Understanding Three Levels Representation In Chemistry Learning

This research was conducted by applying the RADEC learning model to the students' ability to understand three levels of representation on electrolyte and nonelectrolyte solutions. The findings include: (1) students' understanding of macroscopic representations; (2) students' understanding of submicroscopic representations; (3) students' understanding of symbolic representation.

The implementation of RADEC learning on electrolyte and nonelectrolyte solutions is integrated with three levels of representation. The initial stage of *Read* provides opportunities for students to grow their knowledge independently by reading. This stage is carried out on the basis that each student has the same opportunity to develop his potential independently. The basic principle of the RADEC learning model is that each learner has the potential and ability to learn independently and study higher to be able to master knowledge and skills

(Sopandi, 2017). At first steps, students read information from various sources including books, other sources of printed information and electronic information sources such as the internet. In order to guide students in comprehending the information students are provided with the pre-teaching questions. The preteaching questions are questions related to teaching materials. The answers of the questions are essential cognitive aspects that must be mastered by students after they finish the teahing materials.

Learning independence also affects the increasing self-confidence of students (Pratiwi & Laksmiwati, 2016; Sadikin, 2020). When faced with questions or problems, students will have the confidence to be able to determine the solution because students have learned independently and this belief will increase when learning in the classroom takes place. The existence of feedback from students' reading results can be seen through the *Answer*. At this stage the teacher gives pre-learning questions before learning activities in class. Pre-learning questions are questions whose answers include essential cognitive aspects which are an important part for students to master after studying the material (Sopandi, 2017). So that the pre-learning questions are made with the same indicators as the pretest but the types of questions are different. This pre-learning question is also a guide for students in independent learning to stay focused according to the material to be studied. Independent learning students can train and develop several characters including a sense of responsibility, confidence, initiative, and self-motivation (Pratiwi & Laksmiwati, 2016). At this stage, students can find the basic knowledge they will learn. If there is information that is felt by the participants, students still do not understand and it is difficult, then it can be asked to other students (peer tutors) in Discuss steps.

At this step students learn in groups to discuss their answers of pre-teaching questions. Teachers motivate successful students in doing certain tasks to provide guidance to friends who have not mastered them. Teachers also motivated students who have not mastered to ask their friends. This step provides students with activities to discuss their answers with other members in one group. At this step the teacher should ensure that there is communication among students in each group in order to get right answers or jobs. In this way the teacher can also know which group or who have already had creative ideas as a form of application of concepts that have been mastered.

The fourth step is Explain, classical presentation is conducted. The teaching materials presented cover all the learning indicators of the cognitive aspects that have been formulated in the lesson plan. At this step, the students' representatives who have mastered learning indicators explain the essential concepts in front of the classroom. This step can also be used by a teacher to explain the essential concepts that can not be mastered by all students as observed at step discussion (D). When explaining, the teacher may provide explanations with demonstrations, video, PowerPoint, or other things that are expected to overcome the difficulties of students.

The last step of the RADEC learning model is Create, the teacher inspires the students to learn to use the knowledge he or she has mastered to generate creative ideas or thoughts. Creative thinking can be formulated as productive questions, problems, or thoughts of making other creative works. As mentioned earlier, the task of creating creative ideas or thoughts is already covered in the pre-teaching questions. Students also have discussed it in step D. So at this step just discuss it classically because students have previously been assigned to do it independently. And they have also discussed it at stage D. When teachers find all students have difficulty generating creative ideas, teachers need to inspire the students. The source of inspiration given by the teacher can be in the form of an example of research, problem-solving or other work that has been done by people. And then students classically discuss other creative ideas that can be planned and realized (Sopandi, 2017).

Analysis of Three Levels Representation with Diagnostic Tests

Diagnostic tools have been widely developed and used by researchers, ranging from interviews, open or free-response questionnaires, pictures, multiple-choice tests, and multi-tier tests. such as two-level, three-level, and four-level tests (Çil, 2015; Kaltakci-Gurel et al., 2017; Milenković et al., 2016; Sen & Yilmaz, 2017; Taslidere, 2016; Yan & Subramaniam, 2016). Judging from these several reasons, various studies more often use diagnostic tests in expressing students' understanding of concepts. This type of test not only provides information about the student's conceptions but also the reasons behind the answers. In addition, through this type of test, teachers can find out the level of student confidence in their understanding (Milenković et al., 2016).

Diagnostic tests are preferred by researchers, this is because they are more economical, easy to apply, and allow greater generalization of findings by investigating student responses, while also effectively expressing students 'understanding of students' cognitive domains (Taslidere, 2016). Various multi-tier tests have been developed by previous researchers, ranging from two-tier, three-tier, and four-tier diagnostic tests. The weakness of various multi-tier tests, such as two-level, three-level, and four-level test diagnostic tests is that they cannot reveal and explain students' understanding of concepts at the submicroscopic level. At this level, students can represent the molecular level (Anam et al., 2019).

Therefore, on the advice of Anam, et al had research (2019), develop a five-level test by entering the fifth level to draw sub-microscopic representations. The five-level test format was selected which is an expansion of the four-level version by adding one level, namely at level five, drawing a sub-microscopic representation. The findings made by Anam et al., (2019), show that the five-level diagnostic test can reveal a deeper understanding of students, that most primary school students know the concept at the macroscopic level but have less at the sub-microscopic level. The five levels developed in the study of Anam et al., (2019), consisted of 1) main questions; 2) level of trust; 3) reasons for answers; 4) Level of trust, and 5) a picture or representation of a reasonable answer.

Based on the description above, the researcher is interested in implementing the RADEC learning model to help students understand the three levels of representation (macroscopic, submicroscopic, and symbolic). This learning model will be a learning model that is relevant to the Indonesian context. As a new alternative learning model that aims to help students gain many useful competencies (Sopandi, 2017).

Based on the results of the average pretest-posttest understanding of the three levels of student representation with the RADEC learning model, it has a positive effect on increasing the understanding of the three levels of student representation with an n-gain value of 0.52 so that it is included in the medium category. Thus, the understanding of the three levels of student representation on the electrolyte and nonelectrolyte solution material can be categorized as good after the application of the RADEC learning model. The following Figure 1. is the result of the pretest and posttest understanding of three levels of representation on electrolyte and nonelectrolyte solutions through RADEC learning.

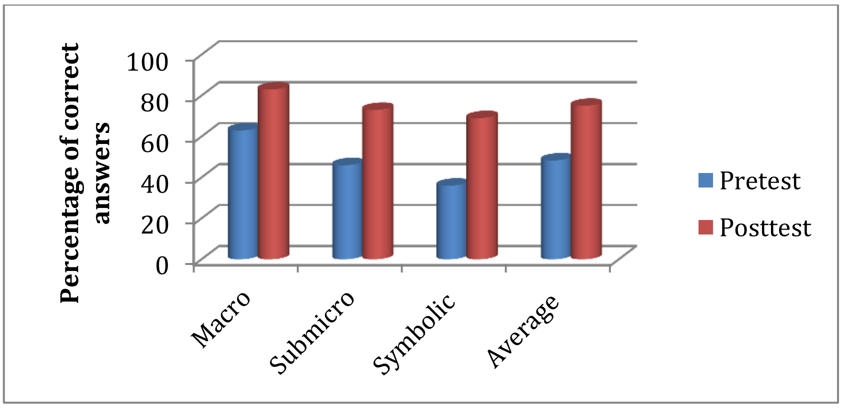

Figure 1. Pretest and Posttest The Understanding of Three Levels Representation

4. Conclusion

Based on the findings and discussion, it can be concluded that the implementation of the Read-Answer-Discuss-Explain-Create (RADEC) learning model has a positive effect on increasing students' understanding of the three levels of representation of students in the medium category (N-gain average 0.52). RADEC learning model is urgent to be implemented to improve students' understanding in the three-level representation of chemistry because, in addition to mastering concepts, the RADEC learning model can also develop character and skills students as provisions for the future.

References

Anam, R. S., Widodo, A., Sopandi, W., & Wu, H. K. (2019). Developing a five-tier diagnostic test to identify students' misconceptions in science: an example of the heat transfer concepts. *Elementary Education Online*, *18*(3), 1014–1029. https://doi.org/10.17051/ilkonline.2019.609690

Ayas, A., Özmen, H. & Çalik, M. (2010). Students' Conceptions of The Particulate Nature of Matter at Secondary and Tertiary Level. International Journal of Science and Mathematics Education, 8, 165-184. https://doi.org/10.1007/s10763-009-9167-x

Çil, E. (2015). Effect of Two-tier Diagnostic Tests on Promoting Learners' Conceptual Understanding of Variables in Conducting Scientific Experiments. *Applied Measurement in Education*, *28*(4), 253–273. https://doi.org/10.1080/08957347.2015.1064124

Creswell, J.,W. (2012). Educational Reasearch: Planning, Conducting, and Evaluting Quantitative and Qualitive Research 4th Edition. Boston: Pearson

Fraenkel, J. R., & Wallen, N. E. (2012). How to Design and Evaluate Research in Education (8th Ed.). New York: McGraw-Hill

Derman, A., & Ebenezer, J. (2018). The Effect of Multiple Representations of Physical and Chemical Changes on the Development of Primary Pre-service Teachers Cognitive Structures. *Research in Science Education*, 1–27. https://doi.org/10.1007/s11165-018-9744-5

Gilbert & Treagust. (2009). Multiple Representation In Chemical Education: Models And Modeling In Science Education. Springer.pp.251-283. https://doi.org/10.1007/978-1-4020-8872-8_1

Irby, S. M., Phu, A. L., Borda, E. J., Haskell, T. R., & Meyer, Z. (2016). Research and Practice Use of a card sort task to assess students ' ability to coordinate three levels of representation in chemistry. *Chemistry Education Research and Practice*. https://doi.org/10.1039/C5RP00150A

Kaltakci-Gurel, D., Eryilmaz, A., & McDermott, L. C. (2017). Development and application of a four-tier test to assess pre-service physics teachers' misconceptions about geometrical optics. *Research in Science and Technological Education*, *35*(2), 238–260. https://doi.org/10.1080/02635143.2017.1310094

Milenković, D. D., Hrin, T. N., Segedinac, M. D., & Horvat, S. (2016). Development of a Three-Tier Test as a Valid Diagnostic Tool for Identification of Misconceptions Related to Carbohydrates. *Journal of Chemical Education*, *93*(9), *1514–1520.* https://doi.org/10.1021/acs.jchemed.6b00261

Pratiwi, I., D. & Laksmiwati, H. (2016). Kepercayaan Diri dan Kemandirian Belajar Pada Peserta didik SMA Negeri "X". Jurnal Psikologi Teori dan Terapan, 7(1), 43-49 ISSN: 2087-1708.

Sadikin, A., A.Hamida. (2020). Pembelajaran Daring di Tengah Wabah Covid-19 (Online Learning in the Middle of the Covid-19 Pandemic). Jurnal Ilmiah Pendidikan Biologi, 6(2), 214 – 224.

Sen, S., & Yilmaz, A. (2017). The development of a three-tier chemical bonding concept test. *Journal of Turkish Science Education*, *14*(1), 110–126. https://doi.org/10.12973/tused.10193a

Sopandi, W. (2017). The Quality Improvement of Learning Processes and Achievements Through the Read-Answer-Discuss-Explain-and Create

Learning Model Implementation. Dalam. *In Proceeding 8th Pedagogy International Seminar. 8, 132–139.*

Taber, K. S. (2013). Revisiting The Chemistry Triplet: Drawing Upon The Nature Of Chemical Knowledge And The Psychology Of Learning To Inform Chemistry Education. Chemistry Education Research and Practice, 14(2), 156–168. https://doi.org/10.1039/C3RP00012E.

Taslidere, E. (2016). *Development and use of a three-tier diagnostic test to assess high school students ' misconceptions about the photoelectric effect*. *5143*(February). https://doi.org/10.1080/02635143.2015.1124409

Velanda, Stella. (2019). Penguasaan konsep kesetimbangan kimia melalui implementasi model pembelajaran Read-answer-Discuss-Explain and create (RADEC). (Skripsi). Fakultas Pendidikan Matematika dan Ilmu Pengetahuan Alam. Universitas Pendidikan Indonesia, Bandung

Yan, Y. K., & Subramaniam, R. (2016). Research and Practice understanding of reaction kinetics. *Chemistry Education Research and Practice*. https://doi.org/10.1039/C6RP00168H

Yan, Y. K., & Subramaniam, R. (2018). Using a multi-tier diagnostic test to explore the nature of students' alternative conceptions on reaction kinetics. *Chemistry Education Research and Practice*, *19*(1), 213–226. https://doi.org/10.1039/C7RP00143F

Ye, J., Lu, S., & Bi, H. (2019). The effects of microcomputer-based laboratories on students'of macro, micro, and symbolic representations when learning about net ionic reactions. *Chemistry Education Research and Practice, 20(1), 288–301.* https://doi.org/10.1039/c8rp00165k

How to cite this article:

Yohana, I., Sopandi, W., & Wahyu, W. (2022). The Urgency of Implementation RADEC Learning Model to Understanding of Three Levels Representation in Chemistry Learning: Literature Review. *Journal of Educational Sciences*, *6(2)*, 286-293.