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Submission date: 27-Mar-2022 09:44PM (UTC+0700)

Submission ID: 1793992773

File name: Artikel_Avianti-Suyatno-2018-Unesa.pdf (618.67K)

Word count: 3463

Character count: 17928

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To cite this article: R Avianti *et al* 2018 *J. Phys.: Conf. Ser.* **1006** 012012

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The development of learning materials based on core model to improve students' learning outcomes in topic of Chemical Bonding

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Abstract. This study aims to create an appropriate learning material based on CORE (Connecting, Organizing, Reflecting, Extending) model to improve students' learning achievement in Chemical Bonding Topic. This study used 4-D models as research design and one group pretest-posttest as design of the material treatment. The subject of the study was teaching materials based on CORE model, conducted on 30 students of Science class grade 10. The collecting data process involved some techniques such as validation, observation, test, and questionnaire. The findings were that: (1) all the contents were valid, (2) the practicality and the effectiveness of all the contents were good. The conclusion of this research was that the CORE model is appropriate to improve students' learning outcomes for studying Chemical Bonding.

1. Introduction

The 2013 curriculum of Indonesia is designed to realize educational objectives with the characteristics of developing attitudes, knowledge, and skills and applying them in a variety of situations in schools and communities [1]. Science learning including chemistry is learning by involving students directly in the learning process to solve problems based on scientific methods. Therefore, the assessment and learning of chemistry should consider the scientific characteristics of chemistry as a product and process.

One of the factors that influence success in learning is student activity. Student activity in learning is a very important element in determining the effectiveness of the teaching for developing students' potential. The learning process is effective when students are actively involved in the organization and discovery of information (knowledge) so that they do not only receive passively the knowledge provided by the teacher. Students' involvement in learning chemistry is necessary, so that what the students learned will be more memorable and meaningful in the minds of students. This is supported by research Soltanzadeh [2] which states that the use of active learning methods in the classroom has a very positive impact on the quality of student learning process and student learning motivation.

One way to involve active students in learning chemistry is by preparing teaching materials or learning media before teaching and learning activities. Based on Permendikbud No. 22 2016, lesson plan includes the preparation of learning implementation plans and media preparation as well as learning resources, learning package, and learning scenarios. The example of the learning resources is student book and student worksheet structured for the learning process and containing learning materials.

Preparation of the worksheet aims to present the materials that allow students to explore the material, to train students' self-reliance and to facilitate teachers in assigning tasks to the students.

Based on the results of observation, it was found that in SMA (*Senior High School*) Muhammadiyah 3, student textbooks and worksheet were not made by the teachers of the school but they were prepared by publishers so that they were not generally adjusted to the characteristics of students at the school. This causes a lack of motivation for the students to develop their thinking skills. In consequence, the students felt not to be encouraged in their learning. In addition, inadequate facilities owned by the school caused the teachers did not have an opportunity to prepare scientific works (experiments) for the students. Therefore, the students only memorized information and got difficulty to gain their potential of thinking skills.

Another fact mentioned the average result of learning chemistry of class X students of SMA Muhammadiyah 3 Surabaya in chemical bonding was 50.5 which means that almost some students get the value below minimum standard score determined by school that was 80. So it needs to be given remedial test for students who get the value under minimum standard score in order to achieve mastery. Another fact that supports Halim (2013) states that in the study of chemical bonding, students can not see how the atoms or elementary particles are put together, and how they interact and bind to form compounds [3]. In addition, research by Dhindsa (2014) suggests that the difficulty in studying the concept of chemical bonds is related to ionic bonding, covalent bonding and polar covalent bonding and non-polar covalent bonding [4].

From the above description, then the efforts made by teachers to condition learning activities in order to help students in learning and improve student learning outcomes is to design a model of learning. The learning model refers to the approach to be used, including learning objectives, stages in the learning activities, learning environment and classroom management [5]. The design of the learning model refers to the view of constructivism theory. The theory known as constructivist theories of learning implies that students have to build their own knowledge in their minds. In other words, one of the most important based on the constructivism theory principles is that the teachers are not just transferring knowledge to students.

One of the learning models that corresponds to the constructivism view is CORE learning model. Calfee (2010) who developed The CORE learning model reveals The CORE model incorporates four essential constructivist elements involving 1) it connects to student knowledge, 2) it organizes new content for the student, 3) it provides opportunity for students to reflect strategically, and 4) it gives students occasions to extend learning" [6].

The CORE learning model is appropriate to be applied in chemical bonding topic because the topic is abstract and contains from simple to higher level concept. Thus, to understand the higher level concepts, the students were required a correct understanding of the basic concepts that build the higher level concepts. This view is supported by a study conducted by Muizaddin [7] that perceives the use of CORE learning model has a positive and significant effect on students' cognitive learning outcomes. In addition, it is proved by the improvement of student learning outcomes, after the CORE learning model is implemented. The students' learning outcome is higher than the students' learning outcomes that apply the Think Pair Share learning model. Based on the above description, the researcher intends to conduct a research entitled Development of Learning Materials Based on CORE Model to Improve Students' Learning Outcomes in Topic of Chemical Bonding.

2. Research method

The participants of this research were 30 students in grade 10 of Muhammadiyah 3 Senior High School Surabaya in academic year 2017/2018. The research design used in this study was the one group pretest – posttest design. The collecting data process involved some techniques such as validation, observation, questionnaire, and test. Validation techniques were used to determine validity (validity) including lesson plan, Student Textbook, worksheet, and Test. The observation technique aimed to collect research data on the implementation of learning and student activity. Implementation of learning was observed to determine the consistency between what the teacher

teacher and the students' activities and the CORE model syntax at each meeting. The questionnaire technique was used to measure students' opinions or responses to learning materials. The test was used to determine the effect of learning on improving the mastery of student concepts. This test was given in two stages involving pre-test and post-test. The improvement of score was determined using a N-gain score.

3. Result and discussion

3.1. Validation

Learning packages developed using the 4D model were validated by three validators as experts. The learning packages consist of lesson plan, student textbook, worksheet, and concept mastery test. Based on the validation result, the four learning materials are valid with the result score presented in Table 1.

Table 1. Validation score.

No.	Learning packages	Average Score	Category
1.	Lesson Plan	3.50	Very Valid
2.	Students Textbook	3.57	Very Valid
3.	Worksheet	3.44	Valid
4.	Mastery Concept Test	3.93	Very Valid

Thus, they are valid and allowed to be implemented in the learning process for topic of chemical bonding.

3.2. Observation

3.2.1. Learning implementation

To evaluate the success of applying the learning model, the learning implementation was observed using observation sheet of lesson plan implementation, that was observed by three observers during three meetings. The result of observation of the implementation of lesson plan in the learning process can be seen in Table 2.

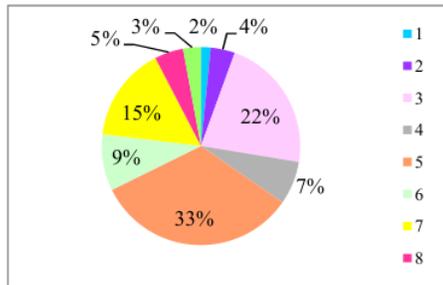
Table 2. Learning implementation.

Meeting	Aspect		Learning Implementation (%)
	Lesson Plan	Done	
1	21	21	100
2	21	21	100
3	21	21	100

These results indicate that all the steps listed in the syntax have been done by the teacher and the students have been active learners during the learning.

3.2.2. Students' activities

The students' activities during the learning process can be seen in Figure 1.



Note :
 Activity 1 : Pay attention to the explanation / analogy the teacher conveyed
 Activity 2 : Write down ideas / questions
 Activity 3 : Read the textbook
 Activity 4 : Experiment
 Activity 5 : Discuss and cooperate
 Activity 6 : Present the group work
 Activity 7 : Inquire / submit an opinion
 Activity 8 : Summing up learning materials
 Activity 9 : Irrelevant behavior

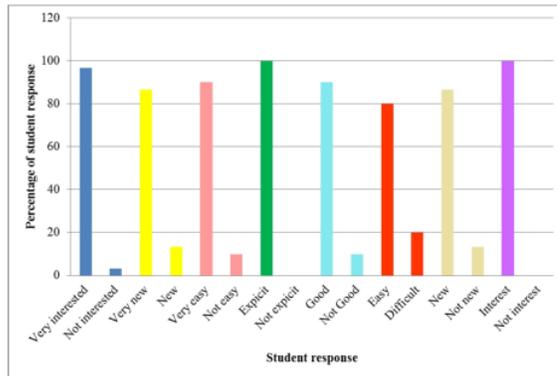
Figure 1. Students activity.

The dominance of student activities which include physical and mental activity at each meeting and active student involvement during the learning process, indicates that the implementation of the CORE learning model is more student centered.

3.3. Questionnaire

3.3.1. Student response

Spreading questionnaire is done after the learning process aims to determine the student's response to the learning that has been implemented. The result of percentage analysis of student response is presented in Figure 2.



Note :
 Opinion 1 : Student's attraction to the learning component
 Opinion 2 : The renewal of the learning component
 Opinion 3 : Students' ease in understanding the learning component
 Opinion 4 : Clarity of how to teach teachers in guiding students during learning
 Opinion 5 : How teachers use CORE model learning
 Opinion 6 : Student ease in answering items
 Opinion 7 : Students interest to follow CORE learning model

Figure 2. Student response to learning.

The overall result of the students' responses to the CORE learning model gave an average score of 91.25% so that the categorized student response was positive (≥ 81%) The positive response indicates that students can receive well all the learning components that cause the expectation to achieve success in teaching becomes higher.

3.4. Test

Individual mastery analysis after the implementation of the CORE learning model is shown in Table 3.

Table 3. Test score.

Student	Pretest			Posttest			N-Gain	Category
	Score	Predicate	Description	Score	Predicate	Description		
1	20	D	Not Passed	92	A	Passed	0,90	High
2	12	D	Not Passed	92	A	Passed	0,91	High
3	8	D	Not Passed	88	B	Passed	0,87	High
4	24	D	Not Passed	80	C	Passed	0,74	High
5	12	D	Not Passed	72	D	Passed	0,68	Middle
6	16	D	Not Passed	92	A	Passed	0,90	High
7	16	D	Not Passed	68	D	Passed	0,62	Middle
8	24	D	Not Passed	88	B	Passed	0,84	High
9	28	D	Not Passed	84	C	Passed	0,78	High
10	12	D	Not Passed	92	A	Passed	0,91	High
11	12	D	Not Passed	80	C	Passed	0,77	High
12	28	D	Not Passed	68	D	Passed	0,55	Middle
13	32	D	Not Passed	88	B	Passed	0,82	High
14	32	D	Not Passed	80	C	Passed	0,70	High
15	20	D	Not Passed	88	B	Passed	0,85	High
16	24	D	Not Passed	80	C	Passed	0,74	High
17	32	D	Not Passed	92	A	Passed	0,88	High
18	24	D	Not Passed	68	D	Passed	0,58	Middle
19	32	D	Not Passed	88	B	Passed	0,82	High
20	24	D	Not Passed	64	D	Passed	0,53	Middle
21	20	D	Not Passed	72	D	Passed	0,65	Middle
22	24	D	Not Passed	88	B	Passed	0,84	High
23	20	D	Not Passed	80	C	Passed	0,75	High
24	20	D	Not Passed	84	C	Passed	0,80	High
25	28	D	Not Passed	88	B	Passed	0,83	High
26	28	D	Not Passed	80	C	Passed	0,72	High
27	16	D	Not Passed	88	B	Passed	0,86	High
28	24	D	Not Passed	88	B	Passed	0,84	High
29	12	D	Not Passed	84	C	Passed	0,82	High
30	16	D	Not Passed	92	A	Passed	0,90	High
Average	21.33			82.93			0.78	High
Percentage		Passed	0%	Passed	80%			
		Not	100%	Not Passed	20%			
		Passed						

At the time of pretest, all students did not passed the test but at the time of posttest all students are passed the test thoroughly. The average pretest of students was 21.3 and the mean posttest score was 82.93. Percentage mastery learning achievement when pretest equal to 0%, meaning that all students at the time of pretest at the beginning of learning did not reach the value of at least 80. After students are given learning using CORE learning model and conducted posttest, the percentage of learning result is 80%, meaning that most of the students achieved the result of learning.

Based on pretest and posttest result, it can be concluded that the use of CORE learning model can improve students' mastery of the concept taught by the teacher, it is indicated by the gain-score on all students who follow the learning process with an average of 0.78 or categorized high.

In order for students to be motivated to learn, teachers play a role to create interesting learning, one of them is as mention above that is by applying motivation learning model that is learning model of CORE in chemistry. CORE is one of the learning models based on constructivism theory that students must be able to construct their own knowledge, through self-interaction with their environment [8]. The syntax of learning with the CORE model is as follows: (C) interdisciplinary information, (O) organizational ideas for understanding material, (R) rethinking and exploring; (E) developing, expanding, using, and find [8].

The Connecting stage is an early stage in which students are linked to the daily life of students relating to the material to be studied as well as the relationship between the chemical bonding with the previous topic. It is intended that students feel the need to learn new material or commonly called by David Ausubel as meaningful learning. Ausubel finds that learning is said to be meaningful if the information to be learned by students is structured by the cognitive structure that students have so that students can associate their new information with their cognitive structure [9].

The next stage is Organizing stage. This stage is an important stage because at this stage students begin to enter into the subject matter. In practice, students are given an analogy in which students are given the opportunity to ask questions of the analogy, and then conduct discussions to answer the questions that have been provided on the student activity sheet and to do experiment to seek information from various sources in order to answer questions from the analogy which students have observed. Vygotsky introduced a learning theory called social learning theory. Vygotsky believes that social interaction with others spurs the construction of new ideas and improves the intellectual development of learners [5]. Vygotsky also introduced the term scaffolding. This is the basis for the researchers to divide the students into heterogeneous learning groups, which means that within the study group each student has a variety of abilities. It is intended that students who have more ability to provide assistance to friends of his group who find it difficult to understand the concept.

The next stage of the CORE learning model is Reflecting. This stage provides an opportunity for students to express the results of discussions that have been done with members of the group, ask friends, and refute the argument of friends if it is not in accordance with what they learn. The inclusion of information learned by students from short-term memory to term memory takes time, so this stage is required so that students have time to organize the information received into their long-term memory. This is in accordance with information processing theory which states that information stored in short-term memory will be lost in a short time if not repeated [6].

The next stage is the Extending stage. In the extending stage, students are given the opportunity to expand their understanding by using concepts acquired into new situations or different contexts as the application of learned concepts. This is supported by Thorndike's theory of connectionism learning which proposes a law called the Law of Exercise. The Law of Exercise principle states the connection between the condition (which is the incentive) and the action will become stronger because of the exercises, but will weaken if the connection between the two is not continued or stopped, in other words the more repeated the lesson will be mastered [9].

Increased aspects of knowledge is also closely related to student activity and the response shown by students. Positive responses from students during the learning activities can also motivate students to achieve success. The positive response is one proof that the learning process that takes place in the classroom is fun and interesting. A fun learning method, will motivate students to want to learn so that will improve their learning outcomes.

4. Conclusion

The conclusion of this research is that the CORE model is appropriate to improve students' learning outcomes for studying Chemical Bonding.

Acknowledgement

The authors thank Prof. Suyatno.M.Si and Dr. Bambang Sugiarto, M.Pd as supervisor. The authors also thank Dr. Utiya Azizah M.Pd., Bertha Yonata, S.Pd., M.Pd and Heriyatini, S.Pd as validators and Muhammadiyah 3 High School that has facilitated this research.

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