Integrated thinking ability and activities on eleventh grade students through learning cycle 7E

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Abstract. The study were aimed to compare the integrated thinking in the form of science process skills and analytical thinking ability; and student learning activities toward chemistry learning of eleventh grade who learned using the 7E learning cycle and expository model. The quasi experimental model with post-test only design was used as a research design. To achieve this goal, sixty students were randomly selected from one public senior high school in Bantul regency, Yogyakarta Province, Indonesia then divided into two groups- there are 28 students of the experimental group which was taught by using the 7E learning cycle and 32 students of the control group which was taught by the expository model. Data were collected using the following two instruments: 5-item integrated thinking ability test, and 29 questionnaire statements of students activity. To answer the questions, Multivariate Analysis of Variance (MANOVA) was used. The results showed that students who learned using 7E learning cycle and the expository model had statistical differences in integrated thinking ability and activities towards chemistry learning at 0.05 level of significance; the students who learned using the 7E learning cycle showed more integrated thinking ability than did the students who learned using the expository model; also the result and indicated than student activities higher than did the students who learned using the expository model. It can be concluded that 7E learning cycle model can be used to improve integrated thinking ability and students’ activities. The researcher recommends that more studies should be conducted about the effect of this model on other instructional variables.

1. Introduction
We not only help students improve understanding of content but the thinking skills as well, ie. science process skills. Science process skill are needed in chemistry learning in 21st century. Thus, we need to develop students’ thinking skills. Science process skills are considered to have a correlation with higher-order thinking skills [1] because they help students to develop higher-order thinking [2]. One of high-order thinking skill is analytical thinking. Science process skill and analytical thinking ability are needed in chemistry learning. Science process skills are important elements that must be possessed by students because they involve cognitive or intellectual, manual, and social skills used in problem solving [3]. Whereas, analytical thinking ability is the ability to analyze, access, evaluate, compare, and distinguish abstract concepts [4]. If science process skill is integrated with analytical thinking ability, it will have a positive impact on the students’ performance. But, the result showed that integrated thinking (the science
process skill and analytical thinking ability) was relatively low i.e. 30.67% [5]. This is what drives the empirical study in this paper.

Student activities are related to chemistry learning, one of which is a buffer solution material. If students are actively involved in the learning process, they can better understand the learning material. Furthermore, it can increases achievement [6]. Students learn science best when the learning model enables them to get involved actively in class activities. So, they should participate actively in doing experiments, carrying out demonstrations, class discussion and other relevant learning experience.

Therefore, we need learning model that will help our students to develop their integrated thinking and increase activity. However, this cannot be done without giving the students the opportunity to express, shape and test their ideas. The use of various teaching approaches in a single lesson can create more opportunities for inculcation and acquisition of science process skills [7] also analytical thinking ability in the classroom. There are many model that can used such as inquiry based. The 7E learning cycle model is inquiry based learning that developed a constructivist theory by intellectual development. The constructivist theory is an educational theory that arouses students' thinking and makes students active and interactive during the learning process. Consequently, it concentrates on the students activity during learning and emphasizes meaningful learning based on understanding through the students’ active role and effective participation in the activities they do, in order to build their concepts.

7E learning cycle model was divided into 7 phases as follows [8], (1) elicitation, the teacher asks students to express the knowledge they already have; (2) engagement, the teacher motivates students to be curious about learning that will take place; (3) exploration, students identify ways of exploring and checking, setting hypothesis, identifying the possible choices, practicing to collect some data to be a base for the next phase; (4) explanation, after students have got enough information, then bring it to analyze, summarize and present in various formats; (5) expansion/elaboration, students bring the knowledge that students built up to cooperate with their own knowledge, or it is to bring the model or even conclusion to explain another case; (6) evaluation, teachers evaluate students by any technique to find out what students know after learning; and (7) extension, teachers prepare students knowledge after learning for applying using in their daily life. Also, motivate students to use their knowledge so as to make a new one.

Consequently, we can say that the 7E learning cycle model makes meaningful learning so that it can improve integrated thinking ability and student activities of the eleventh grade toward chemistry learning using the 7-E learning cycle model and expository model. Thus, the study’s problem is represented by the following main question: Are there differences in integrated thinking ability and student activities from the eleventh grade in Bantul District, Yogyakarta Province, Indonesia to chemistry learning using the 7-E learning cycle model and the expository model?

2. Methodology

The quasi experimental model with post-test only design was used as an research design. The sample consisted of sixty students were randomly selected from one public senior high school in Bantul regency, Yogyakarta Province, Indonesia then distributed in two groups: (1) an experimental group which was selected randomly and studied using the 7-E learning cycle model, and (2) a control group studied using the expository model. The sample size of the study shown in the Table 1.

| Table 1. Sample size of the study |     |
|----------------------------------|-----|
| Groups                           |     |
| Eksperimen                       | 28  |
| Control                          | 32  |
| Total                            | 60  |
2.1. **Research tools**
The study implemented the following instruments:

2.1.1. Five items of integrated thinking test on Buffer. Its type was a essay question test. The test’s difficulty index ranged from -2.90-4.26 and its reliability was 0.87. The reliability coefficient level is above 0.7, hence acceptable. This implied that there was a good internal constituency of items [9].

2.1.2. Questionnaire on students’ activities toward chemistry learning, including 4 levels, 29 items.

2.2. **Procedure**
Teach students by Buffer lesson plans. The experimental group, learned by 7E learning cycle plans and the controlled group, learned with the expository plans. Each group was to spend 8 h to learn and also 2 h to posttest. Test of students after studying by integrated thinking test on Buffer and questionnaire on students’ activities toward chemistry learning.

2.3. **Data analysis**
In order to compare the students’ integrated thinking scores and students’ activities toward chemistry learning, one-way MANOVA was used.

3. **Results and discussion**
Since the researchers had studied and compared the students’ integrated thinking ability and students activities toward chemistry learning entitled Buffer who learned with 7E learning cycle and expository, we got the conclusions as follows: the students learnt by using the 7E learning cycle model and the expository model shows differences in integrated thinking ability and students activities on Buffer toward chemistry learning at the 0.05 level of significance. In order to check this difference, one-way MANOVA was used. Table 2 shows the result of one-way MANOVA.

| Table 2. Analysis of MANOVA of integrated thinking skill and students’ activities | F    | DF  | Sig. | Partial eta squared |
|----------------------------------|------|-----|------|---------------------|
| Model                            | 13.974 | b 2.000 | .000 | .329                |

b Exact statistic.

It followed the hypothesis that the students learnt by using 7E learning cycle model and expository model had different integrated thinking ability and students activities at 0.05 level of significance. The different learning model would be an important variable for the students to have statistical differences of an integrated thinking ability and students’ activities.

Student who learned with 7E learning cycle model got higher integrated thinking on Buffer than the model. This can be facilitated with 7-E learning cycle because the 7-E learning cycle can help students to understand the relationship of a concept [6]. Also added that inquiry-based learning can improve students' analytical thinking by involving students in science and laboratory classes [10]. Learning with the 7E learning cycle model causes students to have analytical thinking skills and attitudes towards chemistry learning rather than expository classes because these models provide students to build their own knowledge, especially in the exploration and elaboration phase [11]. Table 3 shows the means and standard deviation.

In addition to analytical thinking ability, in integrated thinking there are science process skills. Science process skills are very important for students in solving a problem. It is also facilitated by 7E learning cycle because the learning 7E learning cycle model is one of inquiry-based learning. Inquiry learning gives students thinking, communication, problem solving skills [12]. These three things are obtained from the stage of inquiry, namely asking, making hypotheses, investigating, and making conclusions. The results of several studies also show that science process skills can be developed using inquiry or investigative approaches to learning and learning science that give them the opportunity to practice their skills [13-16]. Inquiry-based instruction is a teaching strategy that aims to develop
students' skills in dealing with problems by using methods used by scientists through research, inquiry, analysis and investigation in the classroom [17]. Inquiry-based learning has a positive influence on science process skills [18]. Consequently, the 7E learning cycle can improve students' integrated thinking skills.

Also, the students learned by the learning cycle model has higher learning activities on chemistry than the expository model. It was because the model was new, so the students would be enthusiastic to learn. Moreover, the LC 7E learning model is based on constructivism theory [6]. Constructivism theory assumes that students are active thinkers who build concepts and regard knowledge as a result of their thoughts and activity [19], it was concentrates on the learner and his/her activity. Thus, the 7E learning cycle can increase student activity, such as demonstrations, reading, experimenting, discussion, problem solving and problem solving, where this is done through seven stages. Table 3 shows the means and standard deviation.

| Table 3. Comparison of means and standard deviation at two group. |
|------------------|--------|--------|--------|
| Model           | Mean   | SD     | N      |
| Integrated thinking | 42.4812| 19.81905| 28     |
| Eksperiment     | 22.1217| 10.02319| 32     |
| Control         | 31.6228| 18.36995| 60     |
| Activity        | 82.7665| 10.69940| 28     |
| Eksperiment     | 82.0502| 13.94386| 32     |
| Control         | 82.3844| 12.43690| 60     |

The students who learned using the 7E learning cycle model have statistical differences in integrated thinking toward chemistry learning at the 0.05 level of significance. Tests of between-subject effects in one-way MANOVA was used. The result can be seen on table 4.

| Table 4. Tests of between-subject effects of integrated thinking. |
|------------------|--------|--------|--------|
| Dependent variable | DF    | SS     | Mean square | F      | Sig.   |
| Integrated thinking | 1     | 6190.000 | 6190.000 | 6190.000 | 26.168 | .000 |

But, the students who learned using the 7E learning cycle and the expository model were no statistical difference in students activities toward chemistry learning at the 0.05 level of significance. Tests of between-subject effects in one-way MANOVA was used. The result can be seen on table 5.

| Table 5. Tests of between-subject effects of activities. |
|------------------|--------|--------|--------|
| Dependent variable | DF    | SS     | Mean square | F      | Sig.   |
| Activity         | 1     | 7.662  | 7.662 | .049 | .826 |

Table 5 showed that the students who learned using the 7E learning cycle and the expository model were no difference in activities, but eksperimen group scored higher mean (82.7665) than control group. This is because students are not familiar with the 7E learning cycle model so students are still rigid and confused with the stages in learning. Consequently, the difference in average scores from the experimental class and controls is only a little. It can be seen on table 3.

The expository were model which deals with the teaching and learning process where the teacher plays a fundamental role and lead to a memorizing without observing, while 7E learning cycle were supported by the learner. 7E learning cycle was an active cognitive process, which the students explore their knowledge through various educational experience. Moreover, it was indeed a meaningful learning which is the opposite of the expository, which does not lead to meaningful learning and does not improve integrated thinking ability and activities of students. Finally, more researches should be conducted to test further effects of learning cycle as learning model with a larger number of students and the effect of this model on other instructional variables.
4. Conclusion

The students learnt by using the 7E learning cycle model and the expository model shows differences in integrated thinking ability and students activities toward chemistry learning on Buffer. The students who learned with 7E learning cycle had higher integrated thinking ability and activities than students who studied by using expository model. The reasons were that 7E learning cycle make meaningful learning. The students themselves were to arrange knowledge to learn and evaluate it. After that, they are continuously building and rebuilding understanding. Consequently, every phase at learning cycle encouraged students to develop their integrated thinking and activities. Thus, 7E learning cycle model can be used to improve integrated thinking ability and students’ activities.

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