The improvement of students' conceptual understandings through the PQ4R aided the 5E learning cycle model on the topic of salts hydrolysis

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Abstract. Conceptual understanding is essential for students to be gained during classroom activities. There are various methods to achieve it. This study was conducted to describe the improvement of students' conceptual understanding of the topic of salt hydrolysis after being taught with the PQ4R aided 5E learning cycle model. To achieve the goal, one shot study was implemented as a study design. As participants, first semester students of the chemistry education department of Tanjungpura University were selected. Data were collected through an achievement test, which comprised two indicators. The indicators used were identifying acid-base properties of salts and determining the pH of salts solutions. The results showed that the improvements were 3.23%, 77.42%, and 19.35%, which was categorized as excellent, average, and poor, respectively. In conclusion, PQ4R aided the 5E learning cycle model successfully improved students' conceptual understandings.

1. Introduction

Every student has to understand the concepts of chemistry. The correct understanding of concepts will allow us to understand the related or complex ideas, facts, laws, principles, and theories of chemistry [1]. The understanding of concepts is more important than remembering. Thus, teachers should teach their students correctly [2].

One of the essential concepts for chemistry students is salts hydrolysis. This concept is necessary for students to determine the pH of solutions during acid-base titrations. Salts hydrolysis is a difficult concept for students [1], especially that is related to solvation and ionic reactions with water, including writing chemistry equations [2].

The difficulties on salts hydrolysis concepts also emerge among students of the chemistry education program of Tanjungpura University. According to surveys towards 29 students, the difficulties are as follows: The difficulty in determining acids and bases that compose salts (21.4%); the difficulty in determining species which react during hydrolysis (10.3%); the difficulty in determining pH of salts (51.7%). These difficulties will inhibit students in understanding concepts completely and affect their learning achievements [3].

The effort of improving students’ conceptual understanding can be made through constructivism. This theory explains that knowledge is constructed by students [6]. Students gain their knowledge through investigations, inquiries, and problems solving [7]. Students can actively follow classroom activities if they learn them beforehand.
A learning model that represents constructivism is the 5E learning cycle. It engages students in hands-on activities as a basis for constructing knowledge [8]. The phases of this model are engagement, exploration, explanation, elaboration, and evaluation [9].

The 5E learning cycle model is student-centered learning. Its activities imply a direct and practical way to understand concepts [10]. The activities give students opportunities to construct their knowledge [11] through either individual or cooperative learning [6]. Some researches show that the 5E learning cycle model successfully improves students’ conceptual understanding [12, 13].

In this study, the 5E learning cycle model has collaborated with PQ3R in order to ease students grasping information. Surveys towards 29 students show results as follows: 62% of students like reading their materials; 69% of students reading their materials several times; 75.9% of students read their materials before the course; 62% of students reading their materials again after the course; 58.6% of students bookmark their reading materials; 69% of students take notes on their reading materials; 41.4% of students make a summary of their reading materials. Those results show that most students have already had an interest in reading and applied strategies to ease themselves to understand concepts.

The use of the PQ4R strategy is expected to help students to understand reading materials and to make the course more meaningful. This strategy is a method of reading which aims to help the reader to easily memorize and understand the core of reading materials better [14]. One of the advantages of PQ4R strategy is to make learning meaningful by allowing students to memorize and understand reading materials [17]. PQ4R strategy is used to help students memorizing what they read and help to learn with books [15]. The steps of PQ4R are as follows: Preview; question; read; reflect; recite; review [16]. The use of the PQ4R strategy confirms the effectiveness of reading skills [16] and improving students learning achievements [17].

2. Method

One-shot case study type of pre-experiment design was chosen as a research method. The Subjects of this study were students of chemistry education program who are taking Chemistry of Aqueous Solutions course. Data were collected through achievement tests. The objectives of tests were: Identifying acid-base properties of salts and determining the pH of salt solutions. The steps of the study included: Identifying problems; giving tests before and after learning PQ4R aided 5E learning cycle model; conducting an analysis of data, writing discussion, formulating conclusions. 5E-learning cycle model consists of 5 phases: engagement, exploration, explanation, Elaboration, and evaluation. PQ4R (preview, question, read, reflect, recite, review) was given during the exploration phase of the 5E learning cycle.

The improvements of conceptual understanding are calculated by normalized gain equation [18]:

\[ g = \frac{(\bar{x}_{post} - \bar{x}_{pre})}{100\% - \bar{x}_{pre}} \]  (1)

\( g \) = normalized gain.
\( \bar{x}_{post} \) = mean of post test
\( \bar{x}_{pre} \) = mean of pre test

Classification of improvements of student understandings was in Table 1.

| Value of g  | Classification |
|------------|----------------|
| \( g < 0.3 \) | Poor           |
| \( 0.3 \leq g < 0.7 \) | Good          |
| \( g \geq 0.7 \) | Excellent      |

3. Results and Discussion

Improvements of student conceptual understandings before and after being taught using PQ4R aided 5E learning cycle model on the topic of salts hydrolysis is shown in Table 2. The implementation of the
PQ4R causes the improvements of student conceptual understandings aided the 5E learning cycle model. This treatment helps students to find concepts of salts hydrolysis individually and cooperatively [19]. This model aims to give students opportunities to construct their knowledge by actively learning individually and cooperatively [6]. This model can enliven the class because it helps students to construct their knowledge and help teachers to be facilitator [10].

The course starts with the engagement phase by giving motivation [11]. This phase attracts students to join the course [20]. In this phase, teachers are instructed to awaken student curiosity through questions [9]. The course starts by making connections between salts hydrolysis to the acid-base topic, which is previously taught. This activity is done to examine prerequisite concepts. A simple example of engaging students is exploring the use of [(NH₄)₂SO₄] as fertilizer to decrease the pH of soil. The learning through constructivism allows students to follow classroom activities actively and well prepared to learn various concepts [20].

| Code | Pre test Score | Post test Score | N-Gain | Criteria |
|------|----------------|----------------|--------|----------|
| UL1  | 57.14          | 85.71          | 0.66   | Good     |
| UL2  | 42.85          | 85.71          | 0.5    | Good     |
| UL3  | 57.14          | 85.71          | 0.66   | Good     |
| UL4  | 42.85          | 85.71          | 0.5    | Good     |
| UL5  | 28.75          | 42.85          | 0.19   | Poor     |
| UL6  | 28.75          | 42.85          | 0.19   | Poor     |
| UL7  | 28.75          | 42.85          | 0.19   | Poor     |
| UL8  | 28.75          | 42.85          | 0.19   | Poor     |
| UL9  | 28.75          | 42.85          | 0.19   | Poor     |
| UL10 | 42.85          | 85.71          | 0.5    | Good     |
| UL11 | 57.14          | 85.71          | 0.66   | Good     |
| UL12 | 28.75          | 57.14          | 0.39   | Good     |
| UL13 | 57.14          | 85.71          | 0.66   | Good     |
| UL14 | 28.75          | 57.14          | 0.39   | Good     |
| UL15 | 28.75          | 57.14          | 0.39   | Good     |
| UL16 | 28.75          | 57.14          | 0.39   | Good     |
| UL17 | 28.75          | 57.14          | 0.39   | Good     |
| UL18 | 28.75          | 42.85          | 0.19   | Poor     |
| UL19 | 57.14          | 100            | 1      | Excellent|
| UL20 | 57.14          | 100            | 1      | Excellent|
| UL21 | 57.14          | 100            | 1      | excellent|
| UA22 | 28.75          | 57.14          | 0.39   | Good     |
| UA23 | 14.28          | 57.14          | 0.5    | Good     |
| UA24 | 28.75          | 57.14          | 0.39   | Good     |
| UA25 | 28.75          | 57.14          | 0.39   | Good     |
| UA26 | 28.75          | 57.14          | 0.39   | Good     |
| UA27 | 28.75          | 57.14          | 0.39   | Good     |
| UA28 | 42.85          | 57.14          | 0.39   | Good     |
| UA29 | 28.75          | 57.14          | 0.26   | Poor     |
| UA30 | 28.75          | 57.14          | 0.39   | Good     |
| UA31 | 28.75          | 57.14          | 0.39   | Good     |

On the next activity, students construct their knowledge of salts hydrolysis through PQ4R. Students are given opportunities to share their ideas to solve problems [11]. In this phase, students are divided into groups and given learning sources and worksheets. Students have to think actively, and teachers have to facilitate them in a convenient learning atmosphere. Therefore, students build their knowledge [10].
The activity in this phase is about reading (preview). Students are asked to read their reading materials to solve problems on the worksheet. Students are asked to post questions about unknown concepts (question) while teachers guide them to find the answers. In the read phase, students are asked to reread their reading materials thoroughly to answer the problems. The reflected phase is related to the read phase. During this phase, students are given problems with related topics. Students will develop their building of knowledge by connecting information to solve problems.

In the recite phase, students are asked to write down the answers during the reflection phase. Students are asked to recall the information in the previous phase. Students are asked to actively examine every step of the review phase by rereading answers and reading materials. Students are asked to explore reading materials by rereading them repeatedly to gain complete understanding through the PQ4R strategy. By this PQ4R, teachers can create active, creative, and innovative learning [21]. Reading in PQ4R is an activity to understand concepts altogether [10]. Active, excited, and motivated students will gain complete concepts that ease them from understanding learning materials [15].

5E learning cycle model can improve student conceptual understanding through active participation in a course. The 5E learning cycle can accommodate any discussion and experiment activities by which it makes students active [25]. 5E learning cycle suits students' needs, by which students become active through exploration, construction of their body of knowledge, implementation of concepts to solve problems, and evaluation of their learning [10]. Furthermore, the PQ4R strategy invites students to elaborate on the subject matter and construct their knowledge [24]. PQ4R strategy leads to deep conceptual understanding [23].

4. Conclusion
The improvements of student conceptual understandings are 0.46, which is categorized as good. There are difficulties that students face during the elaboration phase. Time management and adaptation of the model are necessary for better results.

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