

## **Demonstration Based Test to Assess Students' Understanding of Redox Reaction and Electrochemistry Concept**

### **Abstract**

This article is aimed to discuss the preparation, implementation, and evaluation of demonstration based test to assess student understanding of electrochemistry and redox reaction concept. Electrochemistry and redox reaction concepts have been reported as one of the most difficult concept for high school student. There are some misconceptions happen on this concept. Common assessment applied on this concept can not explore them because students had never been assessed on their concept and scientific process understanding. For that reason, it is needed to develop an assessment to dig student understanding level that not halted on a result that student had chosen a right answer without view if they used a right logical process. Demonstration assessment becomes an interesting choice. Demonstration gives student chance to observe the change on reaction, analyze data, make a conclusion to propose some hypothesis, and make a relationship between macroscopic, microscopic, and symbolic world. Two kind of demonstration based test for redox reaction and electrochemistry concepts have been developed, namely direct demonstration and multimedia based demonstration. Both have advantages and disadvantages on preparation and implementation phase. It still needs teacher analysis expertise to transfer student answers and comments into understandable data.

**Keywords:** demonstration based test, electrochemistry, redox reaction, student understanding of concept, assessment

### **Preface**

Research in science teaching has indicated misconception contribution on students learning outcome. Misconception is not a simple problem and cannot be taken for granted. Numerous studies have shown that misconceptions concerning many aspects of chemical phenomena are prevalent among students (Cole & Todd, 2003). Misconception can raise from text book, teacher, students' daily life, and students their selves (Kikas, 2004). Misconception can distract student concepts construction process in their cognitive structure. For that, it is so important for teachers to know their students misconception so they can carry out misconception remediation. It also can help to give a direction on from where, to where, and how learning process is.

Electrochemistry and redox reaction concepts have been reported as one of the most difficult concept for high school student. There are some misconceptions happen on this concept. Common assessment applied on this concept can not explore them because students had never been assessed on their concept and scientific process understanding. For that reason, it is needed to develop an assessment to dig student understanding level that not halted on a result that student had chosen a right answer without view if they used a right logical process.

There are some ways to identify student misconception of chemistry. To identify misconception, interview, paper and pencil based test such as multiple choice, concept map, word association test, or combination of these methods had been used (Schmidt, 1997). Chemistry concept inventory has been developed as a method to explore students understanding of concept (<http://jchemed.chem.wisc.edu/>). This is an interesting test because it is intended for basic concept understanding. But, again, this is a pencil and paper based test. It cannot cover chemistry characteristics, for example colour and state changes, moving, sound, and so on. Scientific process on getting the answer is not raised.

Using demonstration as an assessment tool is a useful technique on exploring students understanding of scientific process (Bowen & Phelps, 1997; Deese, Ramsey, Walczyk, & Eddy, 2000; ). Demonstration can be delivered as direct demonstration or multimedia packaged demonstration. Both has their advantage and disadvantage. This article will discuss the advantage and disadvantage of preparation, implementation, and evaluation of demonstration based test to assess student understanding of electrochemistry and redox reaction concept.

## **Theoretical Background**

### **1. Misconception and Its identification**

Students' misconceptions in science constitute a major problem of concern to science educators, teachers, and students (Ozmen, 2004). Questions concerning the nature of students' misconceptions, the source of these misconceptions, and the effects of instruction have been of interest to educators, researchers, and

teachers. Knowledge of common misconceptions (about scientific facts, models, laws, and theories) is particularly valuable to curriculum developers. Misconception research can aid them in designing instructional materials and activities that begin “where the student is” (Ozmen, 2004)..

Skelly and Hall (1993) defined a misconception as a mental representation of a concept that does not correspond to a currently held scientific theory. They divided misconceptions into two categories: experiential and instructional. Experiential misconceptions are also referred to as alternative, intuitive, or native conceptions. In experiential misconceptions, a concept has been understood, at least to some extent, through everyday experience and interaction with the phenomenon involved. Meanwhile instructional misconception is defined as misconceptions pertaining to these more abstract phenomena result from some instructional experience.

Misconceptions may also be categorized into these five groups: preconceived notions, nonscientific beliefs, conceptual misunderstandings, vernacular misconceptions, and factual misconceptions (Committee on Undergraduate Science Education 1997). Preconceived notions are popular conceptions rooted in everyday experiences. Non scientific beliefs include views learned by students from sources other than scientific education, such as religious or mythical teaching. Conceptual misunderstandings develop when students are taught scientific information in a way that does not challenge them to confront paradoxes and conflicts resulting from their own preconceived notions and non scientific beliefs. Vernacular misconceptions arise from the use of words that mean one thing in everyday life and something else in scientific contexts. Factual misconceptions are falsities often learned at an early age that remain unchallenged into adulthood (Committee on Undergraduate Science Education, 1997).

Kikas (2004), Sanger& Greenbowe (1999), and Zavitsas (2001) viewed that the printed material and textbooks that students are exposed to can also be sources of misconceptions within or outside of the classroom. Conpolat, Pinarbasi, and Sozbilit (2006) prove that teachers can also be a source of misconceptions. Some teachers fail to provide accurate information to students.

Because teachers are considered to be experts, most students will accept that what teachers say to them is true.

The science education literature contains a number of studies about students' misconceptions in high school science courses. Many chemistry studies have dealt with students' comprehension of atom and atomic structure, the particulate nature of matter, bonding, stoichiometry, chemical equilibrium (Azizog˘lu, Alkan, Geban, 2006), and electrochemistry (Sanger & Greenbowe, 1997).

To identify misconception, interview, paper and pencil based test such as multiple choice, concept map, word association test, or combination of these methods had been used. Oral and written test have different advantages. So, many researchers used both of them to gain the meaningful result. (Schmidt, 1997). Ross dan Munby (1991) used clinical interview to study student understanding of acid-base concept. Student was given a written test and asked to answer the question orally. (Schmidt, 1997).

Experienced has been reported as giving some contribution on misconception retention and elimination (Birk & Kurtz, 1999). Huddle, White, & Rogers, (2000) used teaching model to correct misconception in electrochemistry. An interesting suggestion to use demonstration on challenging misconception was submitted by Whitfield (2006). Meanwhile, Yeziarski & Birk (2006) used computer animation to reduce misconception on nature matter and reduce the gender gap and Yang, Greenbowe, & Andre (2004) used interactive software program to reduce misconception on electrochemistry.

## **2. Multimedia**

Multimedia can be defined in so many way, depend on someone perspective (Doolittle, 2002:1). Generally, Doolittle (2002:1) defines multimedia as integration of more than one medium on communication or combining number of media such as text, sound, graphics, spatial model, and picture on computer system.

Meyer as cited by Robinson (2004:10) used eight principles to analyse multimedia for instructional purposes. Those principles are multimedia, contiguity, coherence, modality, redundancy, interactivity, signal and personalization.

Sanger, Phelps & Fienhold (2000) used computer animation to improve students' conceptual understanding of a can-crushing demonstration. This study proves that multimedia using improved students' conceptual understanding effectively.

### **3. Chemistry Concepts Inventory**

Generally, concept inventory is a name given to a test that used to explore students mental model and qualitative image of science (Savinainen & Scott, 2002). Chemistry Concepts Inventory is a multiple choice test designed to monitor student understanding of chemistry concept. This test is based Force Concept Inventory (FCI) developed by Hestenes (1992). FCI is used as physics learning diagnostic measurement in all level. An example of chemistry concept inventory can be seen on <http://jchemed.chem.wisc.edu/>. This test explored student understanding of chemistry base concepts and avoided memorizing process.

Research proves that commonly, students can solve mathematics problem but show a weak or fault mental model. As shown on Pavelich, Jenkins, Birk, Bauer, & Krause (2004) study, students can apply an equation they know on solving calculation problem but they cannot give the right answer on concept problem. Hopefully, student can give the right answer on both. Yet, our traditional curriculum gives great pressure on the first type, more qualitative and assume that if students can give the right answer on mathematics problem this means that they have an adequate conceptual mental model and can do the second type, the one that more, correctly.

### **The Preparation**

On preparing direct demonstration, we have some steps as follow

1. Identifying and analysing the demonstration that will be implemented to assess student understanding of chemistry concept.

2. Make demonstration worksheet and assessment guide. Score range of every understanding degree on each demonstration is different. It fits to number of requirements and explanation.

3. Make two student worksheets.

First worksheet, this worksheet is filled after they observe on the first stage demonstration but before they know the result of the last stage.

Second worksheet, this worksheet is filled after they know the result and they have to explain the similarities and differences between their prediction and demonstration result.

4. Try the demonstration chosen to make sure that the demonstration can run well. It is needed to make note on the demonstration step to minimize mistake when it deliver to students directly

We do most of the steps above (1 – 3) on preparing multimedia based demonstration and of course we have to try the demonstration before it be videoed. We still have some steps to be done. It was started from demonstration movie making, video transferring into *Macromedia Flash Professional 8*, and compiling with letter (sentences), picture, and animation. This multimedia based ChCI test transferred into CD and certified by experts and students through concepts faultlessness, language, feasibility and multimedia requirements aspect. All the data gathered analysed to revise the media developed.

The fifth step is researching. In this step, we applied the multimedia based ChCI test into high school students for each concept to know their respond. Their answers were analysed, and there were 5 – 10 students for each concept to be explored further on their answer choosing reason and misconception experienced. The misconceptions are classified into five group: preconceived notions, non scientific beliefs, conceptual misunderstandings, vernacular misconceptions, and factual misconceptions.

The sixth step was verifying. In this step, researcher proposed a verified multimedia based ChCI test from experts, reviewer students, and sample students

comments and responds in concepts faultlessness, multimedia requirements, and operation and reading easiness.

It can be seen that to prepare the multimedia based demonstration is more complex than those of direct demonstration.

### **The Implementation**

The implementation of direct demonstration to assess student understanding can be done with the following steps:

1. Prepare the chemicals and equipments in the classroom and make sure that there is no one of them forgotten.
2. Do demonstration to assess student understanding. Structured demonstration was divided into two stage. First, observation stage. This stage led student attention to the concept will be assessed. They make an observation note, integrate their observation to the theory they get in the class. It will be used to make a prediction on the next stage. Demonstration was done with the following steps:
  - a. Give students direction and worksheets.
  - b. Introduce all equipments used on the demonstration.
  - c. Do SCRD for observation stage.
  - d. Give student time to make a note on their observation.
  - e. Do the beggining of the main assessment demonstration
  - f. Ask a question as written on the worksheet and demonstration guide.
  - g. Give student time to write down the answer of question and make a prediction what going to happen, on worksheet (max 5 minutes)
  - h. Collect students answer sheet.
  - i. Continue the main demonstration to show the fact.
  - j. Give students time to explain if their prediction fit to the fact or their explanation of the fact, compare with their prediction.
  - k. Collect their explanation.
3. Prepare the next demonstration
4. Score student answer and clasify them into degree of understanding.

#### 5. Analyze students answer to find some misconception

The implementation of multimedia based demonstration to assess student understanding is done with the similar steps. We do not have to prepare the chemicals and equipments in the front of the class, only computers and the connections. We play the multimedia and student will do the tasks inside.

Multimedia based demonstration can avoid us with mistakes on doing demonstration in the front of the class that will lead to fail of the assessment. Every chemistry teachers can do this type of assessment meanwhile, direct demonstrations need teacher expertise. Not all teachers will choose this type.

### **The Evaluation**

All of student answers have to be analyzed, especially on their concept understanding level. It needs teacher analysis competences. First, student answers are marked based on the benchmark we made before. Based on the student mark, we can classify student into six level of understanding. Students' worksheets were analyzed further to find any sentences that had possibility to lead to misconception. We began with student answer sheet that had been categorized into misconception level. From this It will take time to present all of student misconception sentences.

Both of demonstration type is done on the same work on this evaluation step. Except, on multimedia based demonstration we have a help to make a judgement. Multimedia based demonstration is completed with some note of misconception student may have according to their answer.

### **Conclusion**

Demonstration gives student chance to observe, obtain data, and conclude. In this technique, concept understanding is not only viewed as students ability to choose the right answer, but the way they use phenomena observed, data obtained, and process the data into a right conclusion. However, this will not be a popular technique on assessing student understanding in Indonesia, because it is time and



chemical consuming activity on preparation and presentation and cannot be handle easily.

Based on this condition, development of multimedia based *chemistry concepts inventory* will give a solution of the problem. This test will not only display written problem or question but the problem will be delivered on short movie of chemistry demonstration, field fact, or animation. This approach will bring student to real situation, where they can observe and obtain data before draw a conclusion.

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