THE MODEL OF CONCEPTUAL CHANGE IN LEARNING CHEMISTRY

Ni Kadek Ningsih Handayani, I Wayan Redhana, Ngadiran Kartowarsono

Jurusan Pendidikan Kimia
Universitas Pendidikan Ganesha
Singaraja, Indonesia

adek_isa@yahoo.com,redhana.undiksha@gmail.com,ngadiran@yahoo.com

Abstrak

Penelitian ini bertujuan untuk mendeskripsikan dan menjelaskan model perubahan konseptual pada pembelajaran kimia di SMA Negeri 1 Singaraja ditinjau dari karakteristik suatu konsepsi baru, yaitu *necessity, intelligibility, plausibility,* dan *fruitfulness*. Penelitian ini termasuk penelitian kualitatif tipe studi kasus. Subjek penelitan ini adalah guru kimia, siswa kelas XI IA, dan pembelajaran di kelas. Data dikumpulkan melalui observasi kelas dan tes pemahaman.Masalah-masalah mengajar guru berdasarkan transkripsi pembelajaran dikelompokkan ke dalam komponen model perubahan konseptual. Data dianalisis secara deskriptif interpretatif. Hasil penelitian menunjukkan bahwa masalah mengajar guru yang berkaitan dengan *necessity* adalah guru menyajikan materi tidak lengkap. Masalah mengajar guru yang berkaitan dengan *intelligibility* adalah guru sering mengajukan pertanyaan beruntun, memberikan pertanyaan dijawab oleh guru sendiri, memberikan informasi tidak lengkap, memberikan informasi salah, memberikan informasi tidak jelas, menyajikan soal yang salah ketik, membuat analogi tidak jelas, dan tidak meminta alasan siswa. Masalah mengajar guru yang berkaitan dengan *plausibility* adalah guru kurang menekankan pentingnya konteks dan mengabaikan konsepsi alternatif siswa. Masalah mengajar guru yang berkaitan dengan *fruitfulness* adalah guru kurang memberikan masalah-masalah kompleks yang berkaitan dengan aplikasi konsep larutan penyangga dalam kehidupan sehari-hari.

Kata kunci: model perubahan konseptual, miskonsepsi, larutan penyangga

Abstract

This study is aimed at describe and explain the model of conceptual change of learning chemistry at SMAN 1 Singaraja in terms of the characteristics of a new concept, namely necessity, intelligibility, plausibility, and fruitfulness. This study was a qualitative study in form of case study. The subjects of the study were chemistry teachers, students, and learning process in the classroom. Data were collected by doing classroom observation and giving comprehension test. The transcription data was created and ploblems were grouped into the conceptual change model. Data were analyzed descriptively. The result shows that the teachers' teaching problem related to the necessity is the incomplete subject information. The teaching problems related to the intelligibility include asking streak questions frequently, giving the question answered by the teachers themselves, giving some incomplete and false information, providing ambiguous information, presenting misspelled items, making vague analogy, and asking for no reason of students' answer. The teaching problems related to the plausibility are less emphasizing the importance of context and ignoring of students' alternative conceptions. The teachers problem related to the fruitfulness is not providing complex issues associated to the application of buffer solution concept in daily life.

Keyword: conceptual change, misconceptions, buffer solution

INTRODUCTION

One of changes in the paradigm of teaching and learning concept is a change from teaching to learning process. In this case, teaching is defined as the process of transfer of knowledge (knowledge transfer), whereas learning is defined as the process of constructing knowledge (knowledge construction) (Subagia, 2011). Conventional teaching process is carried out by the teachers has proven failed to increase students' understanding of the material being taught. In this teaching, the educators with knowledge necessarily move as many theories in the form of concrete and abstract into the student's head in a perfect round shape. Many educators believe that science can be transferred from the teacher to the student in accordance with the concept of "tabula rasa" expressed by John Locke (Dawkins, 2009). In that view, a child is like a blank slate that can be filled by any teacher. Teachers play an important role in the learning process and are assumed to be able to make the students in accordance with the desired. However, recently, many studies have shown that the concept of "tabula rasa" failed to develop students reasoning power. It can be seen from the students cannot solve problems rather complex and abstract, and they are not able to apply the concepts learned in everyday life (Redhana, 2008).

Lately, many educational experts believe that knowledge is built by the students through the learning process, i.e the process of developing knowledge (knowledge construction). The learning process occurs continuously during the learning process takes place in accordance with the constructivism view (Subagia, 2011). Based on such view, knowledge cannot simply be transferred from the teacher to the students' minds thinking. The main role of the teacher is to facilitate the development process of knowledge on students. That is, students are expected to actively mentally construct their own knowledge based on cognitive maturity owned (Barlia, 2011). Teachers should be aware that knowledge cannot be transferred from the teacher to the students because the students have their own scheme of what he knows. According to constructivism view, an understanding of learning more emphasis on process rather than outcomes. Learning outcomes as goals considered important, but the process of how learning and strategies involved are also considered important. In the process of learning, learning outcomes, how to learn, and learning strategies influence the development of students' ways of thinking. Students construct or build their understanding of events / facts of nature are encountered with using experience, cognitive structure, and the belief held as an effort to obtain knowledge and foster understanding or reasoning power.

n an effort to foster student reasoning power, innovative learning began to be applied. The application of innovative learning can help students understand the concepts more easily. Innovative Learning is a creative learning activity of students who tend to engage in the learning process. In this lesson, students are expected to actively construct their knowledge with the help of a teacher. The learning process with emphasis on active learning students need to be developed for student activity can help them to stand alone in the cognitive life. They also helped to become critical in analyzing a case because they think and not imitate it.

Generally, students do not present to the class with an empty head, but they have brought a number of experiences or ideas that formed earlier when they interact with the environment (Pinker, 2003, in Redhana 2008). Paul Suparno (1997) argue that students should not be regarded as a blank sheet of paper that can be filled with knowledge, they have had the initial concept learned from experience and observation of the environment in their daily lives. The initial concept will be the basis to build their knowledge further. This means that, before learning activities take place, students already have ideas or notions about the events surrounding it. Ideas that have been previously owned by the

student are referred to the preconceptions or alternative conceptions. This preconception is often a misconception (Redhana, 2008). Students can experience cognitive conflict if a new conception obtained is not in line with the initial conception of the students beforehand.

Under conditions of cognitive conflict, students are faced with three choices: (1) maintain the preintuition (the ability to understand something without reasoning, rational and intellectual), (2) revise the most intuitively through the process of assimilation, and (3) change the view that intuition and accommodate new knowledge (Santyasa, 2008). In this condition, the initial conception held by students is very difficult to change by the new conception. Preconceptions are misconceptions that students will turn into a scientific conception of learning only if teachers become more necessary, intelligible, plausible, and fruitful for students (Posner et al, 1982, in Redhana 2008).

The model is a conceptual change model of learning that mostly used in science. This model was first introduced by Posner et al 1982 and already more than a decade this model has a lot of influence of study in the field of child conception. This model was first developed at Cornell University in the years 1978-1979(Barlia, 2009).

Application of the learning model cannot be separated from the role of the teacher in it. Teachers play important role in education. However, recently, study in the field of education began to focus on the problems of teaching and teachers. Orgill and Sutherland (2008) reported that teachers tend to focus more on the conceptual aspects of the calculation than in explaining chemical subject. This resulted in students experiencing difficulty understanding the concepts in chemistry correctly. This leads to students having difficulty understanding the concept of a variety of chemicals. Among this view, there is some views that does not conform to the views of the scientific community called misconceptions. Misconceptions in students is very difficult to repair and can occur in students who are good and who are less. Students who have misconceptions will have difficulty in connecting concepts owned by the concepts further. Therefore, the teacher must know the misconceptions that occur in students so that they can hold a learning process in accordance with the original concept of the students. Based on this background, it is needed to do study that describes the learning undertaken by teachers and students, especially in SMA 1 Singaraja.

SMA Negeri 1 Singaraja as part of the educational institutions in charge of setting up an intelligent member of society, has the life skills, fear of God Almighty, noble character, and so on. To carry out duties as an educational institution, the vision of SMA Negeri 1 Singaraja is the "Excellence in Quality, Character, Global Perspective". SMA Negeri 1 Singaraja is the favorite school in Buleleng regency. Students' achievement in the arena of competitions such as the Olympics are quite encouraging. Likewise, the number of SMA Negeri 1 Singaraja graduates accepted in favorite college are pretty much. However, based on observations conducted by researchers when following PPL-Real (Real-Field Experience Program) at SMAN 1 Singaraja, it was found that the quality of learning in the classroom by teachers needs to be increased.

The results of observations of the teacher models indicated that teachers in teaching still apply the conventional teaching process in which teachers transfer as many theories in the form of concrete and abstract into the student's head in a perfect round shape. In thelessons, teachers use more chemistry lecture and question and answer and discussion groups for some of the subject that are parallel. The results of observation also showed some chemistry teachers give tasks to the students so that students actively learn and be able to solve the problem given by the teacher. With assignments, many teachers assume students will be actively working on the task in any way. This resulted in students experiencing difficulties due to the lack of

guidance from the teacher. To overcome the difficulties they face, many students end up following tutoring or private tutoring.

Following tutoring or private tutoring outside school hours is not able to guarantee students will come up with good concepts. In tutoring, educators (teacher in tutoring place) provide rapid steps in solving a problem and instant. Students are only focused on the final result regardles the process of how the results were obtained. This resulted in students do not have a solid foundation of the concepts they are learning. When learning takes place, students will become confused when confronted with a new concept that is related to the previous concept. The study findings also indicate that there were many students who have misconceptions (Redhana, 2008). The results of this study related to students misconceptions in SMA Negeri 1 Singaraja showed that the average student misconceptions on the concept of atomic structure in class X and XII, respectively 68.1% and 45.9% (Redhana & Kirna, 2004) This showed that student misconceptions are still very high. Further study, Redhana (2008) found that some of the misconceptions students come from the teacher. This means that teachers as a source of student misconceptions.

This study aimed to describe the changes of a conceptual model of learning chemistry teachers in the buffer material in SMA Negeri 1 Singaraja. Buffer solution material is one of subject that contains a lot of complex concepts. In order to understand the buffer solution, students are required to understand the concepts underlying the concept of acid-base and equilibrium. If students have misconceptions on the concept of acid-base equilibrium and then most likely the students will also had misconceptions on the concept of buffer solution. The results of the study by Orgill and Sutherland (2008) showed the presence of misconceptions on the concept of buffer solution, which students assume the stronger acid-base forming a buffer, the greater the capacity of the buffer. In addition, students are sure that the buffer can be made from a mixture of acid-base regardless of the strength of the acid or alkaline. Such understanding may also occured to students at SMAN Negeri 1 Singaraja. Teacher-centered learning and an emphasis on the aspect of a matter enable the emergence of misconceptions and lack of understanding in students. This showed that the teachers' teaching problem can lead to misconceptions to students. The results of the study by De Jong et al (1995; within Redhana, 2008) revealed that teachers who teach redox reactions face learning many problems associated with the changes of conceptual models in terms of the characteristics of a new concept, namely the necessity, intelligibility, plausibility , and fruitfulness. Learning problems include teacher presents irrelevant problems, present unnecessary explanations, explain conception prematurely, use ambiguous terms, put less emphasis on the importance of context, ignoring alternative conceptions of students, less discussion about the application of concepts (especially in industry), and too much explanation on the procedures of the experts.

The purpose of this study was to describe and explain the model of conceptual change in learning chemistry at SMAN 1 Singaraja in terms of the characteristics of a new concept, namely the necessity, intelligibility, plausibility, and fruitfulness.

The benefits of this study were to enrich the knowledge about conceptual change model in learning in terms of the chemical characteristics of a new concept, namely the necessity, intelligibility, plausibility, and fruitfulness in supporting the learning process in chemistry and can be used as reference on the theoretical model of conceptual change.

METHOD

This study is a qualitative study in form of case study. The study was conducted at SMAN 1 Singaraja. The subjects were chemistry teachers, students, and learning in the classroom on buffer solution subject. This study focused on the teaching and learning process

conducted by the teacher. Data related to the above problems were collected by doing classroom observation. The transcription was created and then the problems are grouped in to the component model of conceptual change. Classroom observation techniques to study chemistry subject on buffer solution made by chemistry teacher were observed directly by the researcher and the learning that took place recorded using a video camera and voice recorder to facilitate researchers in creating learning transcription. Recordings from the voice recorder and a video camera on the learning that takes place, then, replayed by the researcher to make the transcript. Record results on the board were used to complete the manufacture of transcription of learning. Comprehension test were used to explore students' understanding of the buffer solution subject. Comprehension test was made based on the findings in learning problems as the results of transcription on buffer solution subject.

The steps in the data analysis are as follows. (1) Analysis of transcription of learning. Researcher collected data from the observation of the learning in the classroom, chemistry teacher and student notes on the board, the teachers' administration like lesson plans, teaching subject, and questions on buffer material test. Once the data were obtained, the researcher made the transcription of learning and further analyzed the transcription of learning to find the problems that arise during the learning process took place. Learning problems which arise, in turn, were grouped into the components of a conceptual change model of Posner et al (1982), which includes the necessity, intelligibility, plausibility, and fruitfulness.

RESULTS AND DISCUSSION

Based on the analysis of transcription of learning, conceptual change models of teaching of chemistry teacher at SMAN 1 Singaraja on buffer material are shown in Table 1 below.

Table 1. Conceptual change models of teaching of teacher in class XI IA 6

Characteristics of new conception	Description
Necessity	The material presented by the teacher is largely in accordance with the demands of the curriculum (content standards: standards of competence and basic competences), such as analyzing the buffer solution instead of buffer through the experiment, calculate the pH or pOH buffer solution, calculate the pH of the buffer solution with the addition of a little sour, a little bases, or by dilution, and explain the function of the buffer solution in the living body. However there are some issues that teachers teach successfully identified based on analysis of transcription of learning is as follows. 1. The teachers do not do lab work to explain the buffer solution 2. Did not give an example of the calculation of pH buffer solution formed from acidic or alkaline divalent or three 3. Incomplete discussion on buffer function in vivo 4. Did not discuss the nature of the buffer solution if dilution is done 5. Did not give an example of a buffer solution consisting of a weak base with its conjugate acid 6. Incomplete discussion on the buffer acid and alkaline buffer 7. Discuss the matter outside of the buffer material that is on the acid-base conjugate 8. Did not discuss the nature of the salt compound in buffer solution
Intelligibility	The information presented by teachers is largely in accordance with the

	conception of scientists, such as buffer solution and not the buffer, how to calculate the pH or pOH buffer solution, and how to calculate the pH of the buffer solution with the addition of a little acid or slightly alkaline. However there are some teachers' problems of teaching were identified are as follows. 1. Frequently asked questions in a row to students 2. Provide questions answered by the teacher themselves 3. Provide incomplete information 4. Giving wrong information 5. Provide information that is not clear 6. Presents a misspelled problem 7. Making analogies that are not clear. 8. Did not ask for students' reason
Plausibility	1. Less emphasis the importance of context 2. Ignore alternative conceptions students
Fruitfulness	Provide less complex problems related to the application of the concept of a buffer solution in everyday life

Based on data from the above results, conceptual change models of teaching of teacher respectively shown in Table 1, it appears that for the necessity of teachers begin lessons on the nature of the buffer solution and not a buffer solution through class discussion. Based on the demands of the curriculum, differentiating buffer solution and buffer solution are not expected through experiments that the students were able to discern the nature of the buffer solution and not the addition of buffer solution slightly acidic, slightly alkaline or dilution. The teachers' learning to determine the buffer solution instead of buffer solution through class discussions lead to less meaningful learning for students. Students do not do their own experiments to determine the nature of the buffer solution and not the addition of buffer solution slightly acidic, slightly alkaline or dilution. Teachers may think that students can distinguish buffer solution and buffer solution not only through class discussion. In fact, there are still some students who think that the buffer solution when added to strong acid or a strong base, will not experience a significant change in pH.

Students' understanding of the concept of a buffer solution is still lacking. Students do not understand the addition of acid or base in a buffer solution at a given volume or only a few can be added to the buffer solution.

Teachers are still teaching problems associated with the necessity that the teacher does not complete discussed buffer acidic and alkaline buffers. This causes some students to confuse both the nature of the buffer. Students assume that the nature of the buffer species determined by acid / strong base remaining. If a strong acid remaining species, the acidic buffer solution and vice versa, if the species remains strong base the alkaline buffer solution. Acidic buffer solution contains a weak acid and its conjugate base.

In addition, another problem is related to the necessity of teachers did not discuss the nature of the salt compound in buffer solution. This causes some students mistakenly describes the nature of the salt formed is acidic or alkaline. Students assume that CH_3COONa is acidic salt. In fact, salt is salt alkaline CH_3COONa formed from a mixture of a weak acid CH_3COOH solution with strong alkaline solution of NaOH.

Another problem is incomplete teacher discussion on buffer function in vivo. Teachers should discuss that in the human body there is a buffer system that plays a role in maintaining pH, such as: (1) buffer the blood is carbonic acid-bicarbonate pair (HCO_3^--H_2CO_3). This system reacts with acids and bases metabolism results received blood to maintain blood pH is almost constant, which is about 7.4, and (2) buffer body

fluids are a couple dihidrogenfosfat-monohidrogenfosfat ($H_2PO_4^-$-HPO_4^{2-}) so that the students' understanding material support system not only theories and count but can be applied to everyday life.

A further problem is related to the necessity of teachers do not discuss the nature of the buffer solution if dilution happened. Teachers discuss more the nature of the buffer solution when added slightly acid or slightly alkaline. In general, for this necessity, the teacher presentation on the material with a buffer solution is incomplete.

In the learning process the teacher did not emphasize the important concepts in the material buffer solution. This can be seen in the learning of teachers who are less stressed overall context being studied.

In the learning process, often a concept that would be submitted by the teacher to the students as knowledge experienced misconception. This error may occur in the delivery and acceptance by the student teacher (Suparno, 2005). This is likely to be one of the factors that lead students to understand the concept of partial or incomplete.

The results showed that most students can grasp the concepts in the buffer solution with good material. However, most students understand difficult concepts in this matter. The difficulty students understand some of the concepts in the buffer solution in line with the teachers' problems were found in this study, such as frequently asked questions in a row to students, provide questions answered by the teachers themselves, give incomplete information, false information, providing information which are not clear, the false writing, making analogies that are not clear, do not emphasize the importance of context, and ignore alternative conceptions students. The problems cause confusion teachers teach the students so that the students understand the difficulty of this material well.

Teachers teaching problems were identified suspected adverse effect on students' understanding of the topics being studied. On the topic of buffer solution, student understanding can be said to be still lacking. Students had difficulty in applying the concepts in buffer solution. This is because teachers provide less complex problems related to the application of the concept of a buffer solution in everyday life, such as the usefulness of the buffer solution in a living body, such as blood buffer and buffer body fluids, and usefulness of the buffer solution in the pharmaceutical industry, for example in manufacture of drugs.

The material presented by the teacher there are intelligible to students and there is not intelligible to students. The material intelligible to students is the definition of the concept of buffer solution. Definition of buffer solution cab easily be remembered by students. However, there are still some students who have an incorrect understanding of the definition of this concept, the buffer solution is a solution that will not experience a significant change in pH when added strong acid or a strong base. Students still do not understand about this concept because of the addition of strong acids or strong bases only on a particular volume or only a few can be added to the buffer solution.

Meanwhile, other material for students is not intelligible components of the formation of a buffer solution. Many students who do not understand that the buffer solution formed from a weak acid with its conjugate base or a weak base with its conjugate acid. Buffer solution can also be called a solution formed from a mixture of acid or alkaline salts. The suffix in the word salt means of acid / conjugate base of the acid / weak base. Many students who do not understand distinguish acid / conjugate base of a weak acid or weak base. Some students had an understanding that the buffer solution is a mixture of a weak acid or weak base with salt. Any mixture of a weak acid or weak base with salt will produce a buffer solution. There are also students who stated that to make the necessary buffers weak base with its conjugate base.

From the responses of the students seemed that students' understanding of

the concept of conjugate acid-base is still lacking. Students pay less attention to the term used to denote the conjugate acid-base pair. This finding is consistent with the results of the study Kurniawan (2012) which states that students declare a buffer solution can be prepared by mixing the acid / weak base with any salt. These findings are also consistent with less Arofah (2012) which states that the students have understood the manufacture of the buffer solution by mixing a weak acid and its salts. However, students are not able to define precisely the meaning of salt. This shows the students' understanding of the concept of making a buffer solution is still lacking. There are still some students who confuse conjugate acid-base pairs. There are students who think that NaCl is a salt that will form a buffer with HCN. It is the students do not understand what is meant by "salt". Students assume the word "salt" has the same meaning as "salt" alone. As a result when acid or weak base mixed with salt students will answer any buffer solution formed.

Some students also have difficulty in distinguishing weakly acidic compounds, weak bases, or salts. There are students who stated that CH_3COONa is a weak acid compounds and there are students who stated that CH_3COONa an acid salt. Some of the students' answers showed that the students are not able to apply the concepts previously learned to new situations.

In addition, the material is not intelligible to students or how the buffer mechanism in maintaining the pH of the solution. The workings or mechanisms of the buffer solution in maintaining the pH of the solution has been described at length by the teacher. However, only a few students were able to answer correctly. There are students who think that if the system into a slightly alkaline buffer strong base is added, then the solution to maintain the pH gradually reducing the concentration of a weak base. Khordaryah study results (2010) found that the addition of a small base in alkaline buffer solution will increase the concentration of OH-ions without reacting to anything, so the concentration of a weak base and its conjugate acid remained.

Difficulties are found not only in the addition of a strong base slightly alkaline buffer system. The same thing happened to the addition of a strong acid to slightly acid buffer system. There are students who think that to maintain the pH of the acidic buffer solution with gradually reducing the concentration of weak acid.

Students have misconceptions or do not understand the concepts can be distinguished by looking at whether or not an item is about the answer and the reasons given in support of the answer selected so as to produce the data the percentage of students based answers and reasons according to Table 3.1. The percentage of students who understand concepts, misconceptions, and do not fully understand the concept at each items were tested in Table 4.3 shows that out of 15 questions each concept is still much to be misconcepted by students and also many students understand, while students who do not fully understand this concept are few. In this study generally students who have misconceptions may be caused by, associative thinking, reasoning which is incomplete or incorrect, using the wrong student experience as conception, and make conclusions based on what appear to be (Mahardika, 2014). It can be said that the students still do not fully understand the concept or incomplete.

Misconceptions in students led students to answer one of the questions given. Students answer questions based on a false concept mastery. Mastery of the misconceptions which will lead to further inter-related concepts as well be wrong. This is shown in the concept of buffer solution composition. Student mastery of the conjugate acid-base concept is still not well understood in the material before making an impact on the material that is still associated buffers. Each student experienced a misconception caused by different things. Students most experienced misconceptions caused by incorrect preconceptions. Preconception that one will affect the subsequent formation of concepts (Suparno, 2005). So

that the concepts students have learned further will be misconceptions.

Piaget in cognitive theory stated that students who are still in the stage of concrete will still be limited in constructing knowledge, especially in abstract concepts. Students cannot easily generalize, abstract, logical and systematic thinking. In this stage, students' conceptions are incomplete or even incorrect concepts (Suparno, 2005). Reasoning of students who did not complete due to the information or data obtained is not complete, the result is one of the students draw conclusions and this can cause misconceptions in students (Mahardika, 2014).

CONCLUSIONS AND SUGGESTIONS

Based on the study and discussion that has been described above, it can be concluded few things are as follows. The teaching problems related to intelligibility was asking streak questions frequently, giving the question answered by the teachers themselves, giving incomplete and false information, providing ambiguous information, presenting misspelled item, making vague analogy, and not asking for the students' reason. Problems related to plausibility were less emphasizing the importance of context and ignoring alternative conceptions from students. Teachers' teaching problem related to fruitfulness was not providing complex issues associated to the application of buffer solution concept in everyday life.

Through the results of this study it is expected that teacher teacher choose student'centered learning methods where the teacher is only a facilitator, one of which is using the inquiry approach. To overcome the misconceptions that occur in students', cognitive conflict strategy can be used.

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