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Students' Views of Science

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ABSTRACT

This study was to investigate high students' conceptions of acids and bases, and their views on learning science. Multiple sources of data were collected over six months with a participation of sit tenth graders and their science teacher. The transcripts of interviews and other data were examined with an eye toward students' conceptions of acids and bases, and their views of learning science. Students' views of science are displayed the representative pattern. Each pattern is represented with an episode. Students' views of learning have been found to reflect the transmissive models of science educational practice. Students accept passive and difficult-to-modify views of the learner roles that they should play in the science classroom. Students identified science classes as conservative places, despite the introduction of science literacy as a goal of Korean science education since 1980. Behaviorism remains the major influence in their expectation, design, and practice in school science. Moreover, 'transmission' remains the persistent and dominant classroom cultural dynamic for both teaching and learning of science.

Key words: conceptions of acids and bases, conceptual change, views of learning science, conceptual ecology, episode

Ⅰ. Introduction

Chemistry is a microscopic science, and chemical processes are represented by molecules and experienced from a microscopic perspective. Various types of microscopic representations, such as structural formula and ball-and-stick models, are cultural tools for chemists to conduct inquiry(Nye, 1993). Chemists schematically choose appropriate symbols and signs to generate hypothesis, present data, make predictions, and convince other scientific community members(Kozma, Chin, Russell, & Marx, 2000).

Many studies, however, showed that students are not able to understand microscopic representations as chemists(e.g. Ben-Zvi, Eylon, & Silberstein, 1986, 1987, 1988; Kozma & Russell, 1997; Krajcik, 1991). Examining the evolution of the chemists' way of seeing and drawing, Hoffmann and Laszlo(1991) argued that microscopic representations currently used in chemistry have evolved from phenomenological analogies of sensory experiences at the macroscopic level. However, learning microscopic and symbolic representation is especially difficult for students, because these representations are invisible and abstract while students' understandings of chemistry heavily relies on sensory information(e.g., Ben-Zvi, Eylon, &

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Silberstein, 1986, 1987, 1988; Gabel, Samuel, & Hunn, 1987). In addition, students can produce correct answers to various kinds of problems in chemistry, including those involving chemical reactions, but their understanding of the underlying chemical concepts was lacking(Watson, 2001). They do not understand the chemical concepts behind their memorized (or algorithmic) solution. It appears that often students' school learning is like a veneer. That is, on the surface they are able to perform the required operations, but there is little depth of understanding of the scientific concepts(Krajcik, 1991). In order to go beyond cataloging the 10th graders' conceptions of acids and bases, I would like to investigate their views of learning science.

According to constructivist learning theory, students come to chemistry classes with their own conceptions as a result of their interactions with the real world. These conceptions influence how students interpret and construct new conceptions in chemistry. The theory of Conceptual change(Posner, Strike, Hewson, & Gertzog, 1982) is strengthened by the inclusion of Toulmin' s(1972) idea of a conceptual ecology(Strike & Posner, 1992). The notion of conceptual ecology provides a context for understanding individual's learning science(Park, 2000), as it is the intellectual environment in which all information or data is interpreted. Conceptual ecology helps individuals find the deeper structures and commonalities in the world, which then allows them to reason causally about the observations they make, and to create knowledge which incorporates and change conceptions.

The purpose of this study is to understand the high school students' conceptions of acids and bases and their views of learning science, as one aspects of their conceptual ecologies. Instead of applying quantitative methods to assess students' understanding of the concepts, I examine what conceptions they have and how their conceptions made of by qualitative approaches.

Ⅱ. Design and Procedure

The Students The participants in this study were six 10th graders. The students were purposefully selected from two science classes by their science teacher. They all have a good record(A) of chemistry at school, and express themselves well what they think. They have learned the concept of acids and bases three times in elementary, middle, and high school as a manner of highly discipline-centered contents prevail.

Data Collection. Data was collected by several sources for triangulation for six months.

Interviews. There were four interviews with six students, and each interview was succeeded by a follow-up interview to clarify concerns or questions that had arisen in the previous interview, or in students' science classroom observation reports. Our interviews builds on prior research using microscopic representations, to examine students' conceptual knowledge of acid strength and solution chemistry. All participants were tested individually by researchers. Students were asked to voice their thoughts and reasoning aloud.

Tests of acids and bases. This involves atoms, molecules, elements, and compounds and severed as an introduction to microscopic representation. All participants were tested individually and were asked to voice their thoughts and reasoning aloud. Participants were not given time restraints. I did not help the participants but periodic tables and chemistry textbooks were available, although rarely utilized.

Document collection. The documents for this research included participants' quizzes, exams, journals, participants' profiles written by their science teacher.

Data Analysis. This study is primarily descriptive in nature. I took several analytical steps. First, the audio recording of interviews and class activities were transcribed. The level of transcription provided an overview of the cycle of activity and made a range of conceptual ecologies visible. Second, the transcripts of interviews and other data were examined with an eye toward students' conceptions of acids and bases, and their conceptual ecologies. The preliminary analyses are represented by the three strands of data; excerpts from interview, categories identified components of conceptual ecology, and explanations. Third, I generated assertions from the transcripts of segments by searching the data corpus. Then I established an evidentiary warrant for the assertions and verified them by confirming and disconfirming evidence provided by data corpus(Erickson, 1986; Lincoln & Guba, 1985).

A key features of this analytical procedures was constant comparative analysis(Strauss, 1987) by two types of triangulation(Denzin, 1978; Mathison, 1988): Data triangulation and investigator triangulation. For data triangulation, both data collections and analyzing were from the various sources of interviews, teaching observations, journals, and information and profiles by the participants' supervisor, and different methods were also deployed to validate findings. As investigator triangulations, three colleagues were asked to analyze and to interpret the data. Each one was to read and to analyze transcripts of the participants. They were also asked to read interpretation of the data, and later to discuss with me whether they agreed with this analysis. In addition, once the data analysis was done, I checked with the participants and their science teacher whether they agreed about our interpretations on them.

Ⅲ. Results

The analysis presented will include only those common views that were represented in the discourse of the six high school students who participated in the study. I have assumed that all aspects of views might not be present in the discourse of every student, and that different students would manifest different aspects of views to varying degrees.

The Itallic transcript excerpts from the interviews which appear below were chosen because they were typical of the students being interviewed. The excerpts are unaltered, with the exception of name changes.

Conceptions of acids and bases, and as microscopic perspective

All successfully defined a strong acid as being totally ionized or dissociated yet could not relate this memorized information to true comprehension. Some students remembered how to distinguish between acids and based by using an indicator. They didn't have conceptual knowledge of acid strength. In the case of acid, for example, acid has hydrogen ion [H+] in hydrogen bonding. *"By checking a boiling point, I can know acid strength... the higher boiling point the stronger acid... to make hydrogen bonding..."* One student of particular interest tried to employ mathematical knowledge to solve the test. He shows how it is possible to apply algorithms without conceptual knowledge.

In general, stuents showed the confusions about the conceptual understanding of acids and bases. They drew a strong acid, HCl and a weak acid, HF as microscopic perspective. They complained about the difficulty of the test because they have never had this kind of questions before. The participants' conceptions of acids and bases are follows:

First, if HCl have an acidity, there must be HCl, not either H^+ or Cl^- because hydrochloric acid(aq) is a mixture of water and hydrochloric acid.

Second, a strong acid has a strong bond. For example, students stated that strong acids *"won't separate"* and are "hard to dissociate." Students believe that *acids accept hydrogen from bases, and strong acids are not soluble.*

Third, the oppositely charged ions attract strongly to each other in a strong acid. Therefore, *in hydrochloric acid(aq), there are HCls, not hydrogen ion(H^+) and chloride(Cl^-), because these ions are easily bonded each other.*

Fourth, more hydrogen gas is displaced from a strong acid because a strong acid contains more hydrogen bonds than a weak acid. For example, *acetate acid(CH_3COOH) is a strong acid, because there are two hydrogen.*

Fifth, a weak acid is easily pulled apart *due to weak bonds* or weak attractions between the charged species.

There are more conceptions of acids and bases in the students: Even in same solution, more concentrated one is a strong acid; A weak acid cannot perform as well as a strong acid; pH is a measure of acidity but not basicity; and a acid has hydrogen ion [H+] in hydrogen bonding.

Except one, five participants were fond of acids. They stated that they like acids better than bases because acids have cation, H+. They seemed to regard cation as affirmative. They felt that the symbol of [+] represents positive and more. The students have a mixed conception with mathematic aspect of the symbol, [+].

Views of Science

Students expressing views that science is boring, complicated, and/or difficult had a much more difficult time at learning chemistry. In addition, I found that students seemed not much care about developing accurate scientific conceptions as far as they got a good grade. All participants simply memorize definitions regarding acids and bases without being able to visualize and truly comprehend the concepts.

By analyzing data, views of students were coded and classified. I display the representative pattern. Each pattern is represented with an episode. An episode, as one separate event, what students display as their views under a certain pattern.

A science teacher is the leading actor, and students are the crowd.

Episode 1) Students listen to their teacher.

One student states the idea that thinking about acids and bases, content themselves, helps learning science. However, in a real science class, it is almost impossible that he thinks deeply on the theory he learned, or tries to understand it, or wonders about the trueness of the theory because there are too many theories to learn in science class within a certain period. Therefore, students just listen to their teacher, as if listen to the sound of TV.

Episode 2) Feel pity for a science teacher.

Sometimes, a teacher ask students, *"Do you understand?.. really understand?.. Sure?"* and even if they don't and can't understand, they say *"Yes, I understand because I feel sorry for the teacher"*.

Episode 3) Try not to ask a question even if I have one.

The students all agree that students do not want to interrupt their teacher's teaching [talking] because there are too many things to study: "*... we don't like to ask a question during the science class.. even I don't think it is needed... We don't have enough time to asking and answering questions....*"

Science is changing

Episode 4) Science and history are alike because the science textbook shows the historic sequence of science theories.

Science and history are alike because the sequence of presenting scientific theory in a science textbook is how the theory progresses over the time, example of atom, "*... the atomic theory first... Rutherford.... it's (the) history of (the) atom.*"

Episode 5) The science textbook doesn't show properly the dynamic of theory changing.

The science textbook seems to display the historic sequence of science theories without showing enough of the context of the changing theories. There are few student who experience '*changing theories*', because *we are not smart enough to do that.*

Episode 6) Science is changing but not for science exams.

One student said, "*The science teacher states that there is no truth in the field of science because science is changing*", however "*we study science as the absolute truth otherwise we can't get a correct answer in an exam*".

The nature of science is the same as scientific facts

Episode 7) Reading the science textbook can't give a clear picture of what the nature of science is.

Because the nature of science and scientific content is brought in separately in science classes, "*I memorize the nature of science as written in the science textbook*".

'Science' is only school subject to study in school.

Episode 8) Science means general science, physics, chemistry, biology, or earth science.

Therefore, "*my science grade indicates both how well I have done well and how good I will be in science*". Being good or bad in science is not regulated by scientific thinking or action but entirely by the grade.

Understanding a scientific term does not mean 'really' understanding it.

Episode 9) Saying a scientific term does not mean 'really' understanding it.

The grade shows nothing regarding how much the student understands about science: *I can provide scientific terms and repeat what a teacher said, but I can hardly see it in our lives.*

One of participants said, "*The more we understand it, the more interested we are in it.*"

Getting interested by experience.

Episode 10) It's hard to be motivated to study a science concept if I can't experience it.

The areas of science one of participants likes biology and physics. One student likes biology not because it is a kind of subject for memorization, but because it is fun and interesting for her. With regard to physics, she said, "*... when I pull the table, it is pulled.. I can see it with my eyes..*" she can feel enough of it through experience. She knows everything near her is science, but she can't have any interest because she can't experience it, "*.. Dalton's atom, we* *reason, reason even though we can't see... and it's not sure, yet..."*

Conceptual Ecologies

When the participants took the tests and answered questions, they showed their conceptions of acids and bases and displayed a tendency to engage the various components of conceptual ecologies, manifesting such things as the students' epistemological commitments, the nature of scientific knowledge, and so on. To justify their reasoning or their answers, for example, the students made reference to the consistency their explanations had with other knowledge, past experiences, beliefs rooted in theology, the positions taken by authorities, and/or their subjective evaluations. Among the various components of conceptual ecologies, the students" socio-cultural value is a potent influence to their learning chemistry: *New concepts don't need to be intelligible, nor initially plausible.*

The participants hardly expressed and presented their thoughts and knowledge at the beginning of this research. Because they regarded this research as a kind of test for grading, even if both their science teacher and the researcher informed that that was not a test. The participants believed that scientific knowledge should be accurate and true. They, however, were not positive on their conceptions of scientific phenomena. They held beliefs that their scientific conceptions were usually inaccurate and incorrect comparing to that of the science teacher. Students considered the teacher to be competently versed in science knowledge and expected the teacher to give them the right answers.

The participants asserted that education has been the greatest influence for social mobility. Education in their conceptions of society seems to represent a very productive synthesis of traditional Confucianism and characteristically modern attitude toward the successful development of people. The motivation for education could be translated into a desire for upward mobility in the national stratification system. Education seemed be a universal avenue for social mobility. There were few doubts that economic growth should stem from education which would provide a trained labor force. To fulfill people's needs, education turned to how people prepare for examinations, so that people can move upward. The participants believed higher education guaranteed money, and education was restructured to a merit or contest system, including national examinations with visible results. Therefore, they believe education a tool for social change or a tool for social success.

The participants came to believe that they could change their social classes through contest. Most possibilities were related to examinations, like the national entrance examination for university. The participants told that education is the best way to upward social mobility, and education helps to determine qualifications for entry into higher education. They also believe that they can get an equal chance to gain upward social status by contest if they study enough to do well, and try to do well on examinations.

The obvious example of this is the participants states that science laboratory work was mainly used for grading, and to verify the truths and validate the correctness of scientific laws, or rediscover the facts provides by their teacher or textbooks. They said:

The lab activities in science classes would help us understand the processes of science.
I think the main purpose of lab activities is to "check [confirm]" the facts or conclusions presented in science texts. Therefore, I can get an right answer on exams.

Lab activities are for teachers to make grading students... especially, performance assessment?

...

I don't know why science classes need laboratory activities.. sometime that activities make me confused when I choose a right answer on exams. ... I have to memorize whole sequence of lab activities for exams.

Ⅳ. Conclusions and Implications

This study was to investigate high students' conceptions of acids and bases, and their views on learning science. The picture of a science class I draw from analyzing data is a play on stage and there is little interaction. Students' views of learning have been found to reflect the transmissive models of science educational practice. Students accept passive and difficult-to-modify views of the learner roles that they should play in the science classroom. Students identified science classes as conservative places, despite the introduction of science literacy as a goal of Korean science education since 1980. Behaviorism remains the major influence in their expectation, design, and practice in school science. Moreover, 'transmission' remains the persistent and dominant classroom cultural dynamic for both teaching and learning of science.

Moreover, participants' socio-cultural value were so strong that limit or empower their conceptions of acids and bases. The participants seems to be not much care about constructing scientific conceptions of acids and bases. Rather, care about getting good grades. They asserted that they must have good grade in school because education has been the greatest influence for social mobility.

Students should understand about learning processes, and how to play, monitor, evaluate and regulate them. Students should experience the plausibility and fruitfulness of learning science, and it will help students to feel a "love of learning science." I believe as students change their views of learning science that it will help to improve their learning of scientific concepts.

The findings of this study present some educational implications in science classes. First, the teacher needs be able to demonstrate that different processes can indeed lead to different interpretations of the same phenomenon, and that the consequences of a scientific phenomenon can also be different depending on the interpretations. By doing so, the teacher can encourage the students to explore different possibilities, without worrying about the truth value of the interpretation. They will also see the importance of the thinking process itself.

Second, the teacher needs to prepare good teaching aids that can help attract the students attention to the content of the lesson. If students see the topic of question is comprehensible and solvable with the help of the teaching aids, and if students perceive the topic interestingly presented, they will be stimulated to give a try.

Finally, the teacher needs to enhance the students self-confidence by giving positive feedbacks and praises generously. In too many classes, the students are punished more often than they are praised, although the punishment may be very subtle and sometimes unnoticed. The students, especially during the adolescent period, need constant assurance from their teacher.

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