

CHAPTER IV

EXISTING SITUATION OF TEACHING AND LEARNING ABOUT MATTER

Introduction

This chapter details findings from the exploration phase of this study about teaching and learning about matter and its properties in Thailand (academic year 2004) and concentrates on research question 1. There are two sections in this chapter. In the first section student conceptions about matter are presented. The second section is about teacher perceptions of teaching and learning of matter. The results for this chapter were used as foundational information to develop a conceptual change based instructional unit.

Student Conceptions about Matter

The students' conceptions were surveyed using the concept survey about matter. It consisted of 15 items which covered the concept of structure and properties of matter in Grade 6 (11-12 years). There were topics about change in state of matter; solution processes; chemical change and separation of mixtures. The participants were 50 Grade 6 students, sampling from 157 students from six primary schools in Saraburi province, Thailand. All of them took this survey in March 2004. The data analysed followed the categorization of the matter concept based on seven categories which were adapted from the categorization of concepts of Andersson (1990), Tytler and Peterson (2000) and Tytler (2003).

Table 4.1 Students' Categories of Responses.

| Category | Descriptions | Examples |
|-----------------------|--|---|
| Perceptual (P) | Responses that included the explanation on what is happening only. | Water disappears |
| Association (A) | Responses that included the associative thinking or incorrect use of terms. | Ice evaporates into water, or wind causes ice change into water |
| Displacement (D) | Responses that included the substances have been displaced. | Sun sucks the water into the cloud. |
| Modification 1 (M 1) | Responses that included the substances continue to be the same substances but the appearances have been changed. (scientific conception for solution process and separation of mixtures) | Small pieces of sugar spreading out in water. Filter is used to separate sand from water. |
| Modification 2 (M 2) | Responses that included referring the effect of heat differences in modification. (scientific conception for changes of state) | Water absorbs heat and change into gas, water particles get move quickly. |
| Transmutation (T) | Responses that included the substances change into others. | Heat changes into bubbles. |
| Chemical reaction (C) | Responses that included the new substances were form from the irreversible reaction. (scientific conception for chemical change) | Rust is formed because water reacts with oxygen, and iron nail. |

The results from this exploration phase are presented in four topics namely changes in state of matter, solution process, separation of mixtures and chemical reactions.

1. Changes in State of Matter

For the changes in state of matter, a category M2 which explained about the effect of heat differences in modification or change in form of substances was accepted as a scientific conception. The categories of students' responses were presented below.

Table 4.2 Number of the Students' Categories of Responses Concerning Change in State of Matter

(n= 50)

| The changes in state | Category | | | | | | | No response |
|-------------------------|----------|----|---|-----|----------|---|---|----------------|
| | P | A | D | M 1 | M 2* | T | C | |
| Melting | - | 22 | - | 21 | 7 | - | - | - |
| Freezing | - | 44 | - | - | 4 | - | - | 2 |
| Evaporation | 13 | 30 | 5 | 1 | - | - | - | 1 |
| Boiling | - | 46 | - | - | 4 | - | - | - |

* Scientific conception

From this table, most students fell into category A which is about using of associative thinking or incorrect use of terms. Most student alternative conceptions is about boiling, freezing, evaporation and melting respectively. For boiling process, the students were asked to explain the level of water going down during boiling and the appearances of bubbles in boiling water. Most students thought that 'water boils and changes into steam so the level of water goes down'. They made reference to heat as the cause of boiling. However, the students had difficulty explaining the forming of bubbles. Forty six students' responses showed that they had some misleading associative thinking about formation of bubbles. The students thought the bubbles were made of water which was heated or boiling water. Although some students referred to particles, they did not have any explanations about it. They still used their experiences in macroscopic level to explain particles, for example, "Water evaporates and particles of water expand or get bigger."

The students who used a category A to explain a situation of freezing water said water was mixed with air and some had changed into ice in the bottle and some had changed into ice on the wall of the freezer. Most of them regarded cooling in the freezer as air which made water harder or changed into solid matter or ice. Only four students chose a category M2 (scientific conception) to explain how water had changed into ice in the bottle.

The question “What happened to the water in dried clothes?” was used to elicit students’ ideas about evaporation. From the table 4.2, no students used M2 category (scientific category) to explain evaporation process. Most students (thirty students) used a category A and mentioned sunlight as the cause of evaporation but they had different explanations about what the sunlight did to the water. Most students made reference in their explanations to heat from the sun making the clothes dry. Some of them used many scientific words to explain how heat transferred from sun to clothes, for example, reflection of heat, radiation of heat, convection of heat. Some students explained that the sun sucked water from the clothes. Thirteen students replied that ‘water evaporates,’ but they did not give more explanation about evaporation so their responses were categorized into a category P which explained only what the students perceived. A student used a category M1 to explain evaporation which referred the change of state without the relation to heat.

Some students used a category A to explain melting process of ice. They said ice had changed into water and gone outside the bottle. They explained that water evaporates into gas or steam in closed bottle, so gas or steam goes through the bottle. This answer is also showed that the students did not think about condensation. Melting is a concept for which 7 students chose a category M2 to explain ice melting and changing into water and referring to heat as cause of melting.

The survey of students’ conceptions about changes in state of matter provided many ideas namely,

- 1) The students had difficulties in using scientific terms such as melting, freezing. They could not use scientific terms to refer to the process of changes.

2) The students had difficulties to explain the changes of state related to gas; for example, regarding the forming of bubbles in boiling process, the students said water evaporated but they could not explain the change of water into water vapour. The results from the melting process also showed that the students also had alternative conceptions about it. They paid attention formation of water outside container rather than the process of condensation.

2. Solution Process

There are three ideas for eliciting students' ideas about the solution process included; process of dissolving, the changes of solute in solvent, and conservation of matter. The results are showed in the table below.

Table 4.3 Number Of The Students' Categories Of Responses Concerning Solution Process

(n = 50)

| Solution process | Category | | | | | | | No response |
|------------------------|----------|----|---|----------|-----|---|---|-------------|
| | P | A | D | M 1* | M 2 | T | C | |
| Process of dissolving | 26 | - | - | 4 | 10 | - | - | - |
| Solute in solvent | 49 | - | - | 1 | - | - | - | - |
| Conservation of matter | - | 38 | - | 8 | - | - | - | 4 |

* Scientific conception

Most students used alternative conception to explain solution process. For the process of dissolving, the students perceived only what they saw, for example, "dissolving is the process in which solid matter or lumps change into liquid or

water”, and “dissolving is a process during which sugar disappears”. These students used a P category to explain their ideas. Some students (n=10) referred to heat as the cause that made sugar dissolve. Only four students could explain that dissolving is a process in which sugar mixes with water (scientific conception). This response fell into a category M1 which referred to as the substances remaining unchanged but their appearances have been changed.

For explaining about solute in solvent, most students (49 students) used a category P to explain the change of solute in solvent; they explained that “Sugar dissolves in water” or “hot water makes sugar dissolves” or “sugar changes into water or liquid” or “sugar disappears” or “sugar decomposes or gets smaller”. Only one student held the scientific conception that “sugar mixes with water and exist in water”.

Regarding the explanation of the conservation of matter, 38 students used a category A to explain it. They offered the misleading idea that it was impossible to get the sugar back. Most students explained that “sugar has changed into water or liquid already”. The idea of changes in states of matter is influenced this kind of responses. Most students explained that “sugar does not disappear but just changes into water”. For example, one student said “I cannot get sugar back. If I put sugar-water in the freezer, I will get sweet ice”. Other students explained that “sugar dissolves or mixes with water”. Only eight students responded a category M1 who explained that they could “get the sugar back by evaporation of water”

The findings from the solution process are

- 1) The students can explain only observable situations such as sugar dissolving, sugar disappearing, sugar changing into water.
- 2) Most students do not have any idea about conservation of matter.

3) There is some confusion in the students' minds between change in state of matter and solution process.

3. Separation of Mixtures

An idea of separation of mixture was to find out whether the students could give a reason relating to the properties of substances in mixtures and considering the way to separate mixture. The students' responses about this concept were presented as following.

Table 4.4 Number of The Students' Categories of Responses Concerning Separation of Mixture

(n = 50)

| Separation of mixture | Category | | | | | | | |
|--|----------|---|---|----------|-----|---|---|-------------|
| | P | A | D | M 1* | M 2 | T | C | No response |
| Using filter (sieve, paper filter, and cloth filler) | 29 | - | - | 1 | - | - | - | - |
| Pour or suck water from sand | 16 | - | - | - | - | - | - | - |
| Boil or evaporate water | 1 | - | - | 1 | - | - | - | - |
| Use hand to hold sand from water | 1 | - | - | - | - | - | - | - |
| Use magnetic | 1 | - | - | - | - | - | - | - |

* Scientific conception

Five methods were presented how to separate sand from water. Most students explained that filtration was the best way to separate but only one student explained about the properties of sand which stay the same even separated from water (M1-

scientific conception). This student said because “sand grains are bigger than the filter holes or the filter holes are smaller than the sand grain”.

Most students explained that their methods related to their everyday life. Some students used these methods before but they did not give any explanation about how the methods related to the properties of substances (water and sand). These students’ responses were categorized into a P category which described only what students saw but did not give any reason.

However, a student who chose the evaporation method used a category M1 to explain her method. She said “Once boiled instant noodle in water and I found that the water had gone but that the instant noodles had remained in the bowl. I think sand will remain in the same way”. This showed her attempt to relate her daily experience to this situation.

The findings showed that most students were familiar with the separation of mixture from their everyday life, but, they could not give reasonable explanations about the properties of substances in the mixture.

4. Chemical Reaction

The forming of new substances in a chemical reaction and the irreversible process of chemical reaction were the explanations expected from the students. However, the students’ ideas about chemical reaction were showed in the interesting findings below.

Table 4.5 Number of The Students' Categories of Responses Concerning Chemical Reaction

(n = 50)

| Chemical reaction | Category | | | | | | | |
|-------------------|----------|---|----|-----|-----|----|-----------|-------------|
| | P | A | D | M 1 | M 2 | T | C* | No response |
| Burning paper | - | - | - | 4 | - | 17 | 29 | - |
| Rusty Nail | - | 6 | 44 | - | - | - | - | - |
| Eno | - | - | 24 | - | - | - | 26 | - |

* Scientific conception

The students have different responses to different contexts. Rusty nail was the most problematic context for this group of students. None of the students used a category C to explain rusty nail. Forty-four students chose a category D which was that the rust had changed place. For example “Rust is already in the nail” or “Rust inside the nail comes out after the nail reacts with water”. Six students explained that “The nail reacts with water and air or humidity in air” but they did not explain where the rust came from so their responses fell into category A. This shows that they do not understand how a nail reacts with water and air.

The students' responses to burning paper and Eno were in the same way. Most students (n= 29) thought that “new substances are formed after the burning processes e.g. ash” and twenty six students explained that “The bubbles were formed when Eno combined with the water”. Seventeen students used a category T which explained that a substance changes into another. They said “ash or black paper comes from heat”. Another four students used a category M1, they explained that “the substances change their characteristics after burning”. These students thought the substances only changed their form but still be the same substances.

The ideas from the chemical reaction survey were

1) The students understood that the chemical reaction of burning paper is an irreversible process. They could not get the paper back because it had changed into a new substance.

2) The students had difficulty to explain the formation of new substances. Many students used the displacement view.

Conclusion of Student Conceptions about Matter

In conclusion, the results show that Thai students' alternative conceptions are similar to literature review from other countries in many concepts. For example, solute disappears during dissolving (Prieto et al., 1989), and that the bubbles in boiling water are made of heat or water (Cosgrove and Osborne, 1981; Johnson, 1998(a)).

Other findings from this survey involved many issues about language. Many Thai words made the students confused and lead to misunderstandings. For example, the words for "matter" and "chemical substances" are similar in their pronunciation. Students regarded chemical substances as toxic and dangerous, so they think matter is also toxic and dangerous. As same as most students perceived gas was toxic substance because they knew only cooking gas. Many Thai words in everyday life are unclear when students use them. For examples, the word for "melt" is interchangeable with the word for "dissolve"; the word "hard" can also substitute to the word "solid"; all liquids are called "water". Some students try to use some words which they do not know the meanings. For example, some students use the word "state" instead of "shape of substances". Another problem about language is that some students have grammar problems, it is impossible to interpret their responses. The inadequacy of student language used and low written responses were kept in mind and taken into consideration to develop the instructional unit.

Most students are inconsistent with their ideas, and changed their ideas when they changed contexts. The activities in the instructional unit should relate to students' everyday life and appropriate for Thai context because from the survey, the students showed that they tried to apply their experiences or tried to build up what they knew. For example, students made references to their experiences about melting ice in everyday life. Some effects from Thai contexts, for example, student confusions between everyday language and scientific language as showed in previous paragraph should be addresses.

Moreover, none of the students have any ideas about the particle model. Some of them regard particles as something inside substances. Most students use their experiences at macroscopic level about substances to explain particles. For examples, particles get bigger, boil, and settle down at the bottom of container.

Teacher Perceptions about Teaching and Learning Matter

It is widely accepted that teachers play an important role in encouraging students to learn. The teachers' perceptions illustrate the way that the teachers deal with their classes and show the situation of primary classrooms in Thailand. The teachers identified several key perceptions of teaching and learning science.

The participant teachers noted that science is all around us in everyday life. Science should be reasonable, provable and uncertainty. The teachers recognized that students came to class with their own ideas and regarded science as the explanation of phenomena in everyday life and as the fundamental concepts for higher level learning. However, the teachers said that there were some difficulties in teaching and learning science at primary level.

The first difficulty is the unavailability of science equipment. This meant they were unable to carry out some experiments, so they bought some science equipment with their own money. Secondly, the teachers said there were difficulties because students lacked knowledge of science process skills and science content. In addition,

some students had their own personal problems with their families. Some students came from broken families, or some students came from poor families. Most of them did not pay attention to learning. Finally, the teachers said they had problems with their own knowledge. Most teachers lacked confidence while they taught because they acknowledged that they were not knowledgeable in science. They said they did not have any real ability to do science. The abstract concepts were hard to teach and they could not utilize and maintain some science equipment, perhaps, because of their lack of formal qualifications in science.

The teachers believed that practical work and learning from the real things could help the students develop their science process skills, content knowledge and relate science to everyday life. Most teachers replied that outside help such as inviting experts to teach and to help with practical works, and learning resources such as science exhibitions were beneficial for teaching and learning science. However, all teachers accepted that their teaching relied on textbook because they did not have enough knowledge about science and they did not have time to prepare learning activities.

Summary

The surveys of student learning and teacher teaching about matter from the six Grade 6 classes showed many issues which need to be taken into account in the to guide to the development a conceptual change-based instructional unit. Relating to the student learning about matter, most students had alternative conceptions in all concepts. First, the students had difficulties in using scientific terms to explain phenomena and held confusions between scientific language and language in everyday life. Second, the students had difficulties explaining unobservable changes in matter such as phenomena related to gases and solution processes. Finally, the students in this study had no idea about the particulate nature of matter.

For the survey of teacher teaching, the teachers said problems in teaching and learning science arise from many factors. First, there was the unavailability of science

equipment and learning resources. Second, the students did not pay attention in learning and some of them have personal problems which affect their learning. Finally, teachers said they had no confidence in teaching science because they had did not have enough content knowledge and science process skills. However, the teachers said they believed that learning from real things and practical works might help the students to learn science, especially for matter and its properties. So, the teachers need some guidance to help them to teach using these strategies.

These existing situation findings about teaching and learning matter provide important evidence for the development of a conceptual change-based instructional unit to resolve student difficulties in learning and to help teachers to prepare themselves to teach matter. The details of the development of an instructional unit for this purpose are presented in the next chapter (Chapter 5).