



What Korean Students of Grade 9 Know in Chemistry

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Abstract

National Assessment of Educational Achievement (NAEA) of Korea which is carried out for grade 6, 9, 12 is national-wide criteria referenced assessment and science of NAEA is carried out for grade 6, 9. In this study, analyzed ability of students which is shown in 2010, 2011, 2012 NAEA of science of grade 9 focusing in chemistry. The ability of students was divided into 4 levels which is advanced, proficient, basic and below basic. An item which is solved by most students of some achievement level was treated as representative item of that achievement level. And we analyzed representative items of each achievement level, finally drew abilities of students of each achievement level. Advanced level students of grade 9 in chemistry could understand phase change related with heat flow, could understand mixture separation experiment related with characteristics of matter and could control variables in experiments. Proficient level students could understand phase change related with particle, could interpret data of typical experiments, and could understand that characteristics of matter was used in mixture separation. Basic level students could understand simple principle of some concept which was shown in real life, simple hands on activities of typical experiments.

1. Introduction

New national curriculum which is called as 2009 revised curriculum of Korea is being administered in elementary, secondary school. The important goals of new curriculum of Korea are related with creativity, problem solving ability.

In Korea, have been using National Assessment of Educational Achievement (NAEA) to know and confirm that students of elementary and secondary school could reach the ask of national curriculum. NAEA of Korea which is carried out for grade 6, 9, 12 is national-wide criteria referenced assessment. The subject of NAEA consists of National Language, Mathematics, English, Social Studies and Science. Science of NAEA is carried out for grade 6, 9. The framework of Science of NAEA is like next table 1.

Table 1. The framework of Science of NAEA

Contents domain	Motion and energy(physics), Matter(chemistry), Life(biology), Earth and space(earth science)
Cognitive domain	Knowledge, Inquiry
Item number	Elementary: multiple choice 28, supply type 4 Secondary: multiple choice 32, supply type 8

The results of NAEA of Korea have been used in educational decision and curriculum change. And so the analysis results of science could be used to find characteristics of students in science[1].

In this study, we used the data of NAEA of science in chemistry to find out the characteristics of students by the educational achievement level (advanced, proficient, basic, below basic level). I hope that the characteristics of educational achievement level could be used to understand students, to plan lessons.



2. Research Method

2.1 Data Sources

This study used the data of 2010, 2011, 2012 NAEA of science of grade 9 focusing in chemistry. The number of students by each educational achievement level is like Table 2. 10 items of matter(chemistry) is written every year NAEA. And so the total number of items of chemistry which was used in analyzing are 30 items.

Table 2. The number and % of students by each educational achievement level

year	Total number	advanced		proficient		basic	
		number	%	number	%	number	%
2010	658,303	131,308	19.95	243,039	36.92	230,485	35.01
2011	634,974	110,134	17.34	278,758	43.90	213,715	33.66
2012	624,513	84,194	13.48	277,490	44.43	232,954	37.30

2.2 Data Analysis

The procedure of this study are like Table 3 to find out the characteristics of students by the educational achievement level(advanced, proficient, basic, below basic level).

Table 3. The procedure of this study

Step	Concrete explanation about step
Selection of target items to analyze	-select 30 items to analyze -grade 9 data of NAEA which are items, rates of response in each achievement level
Reclassification of items by special criteria	-special criteria are 'middle region', 'achievement criteria' -achievement criteria: a kind of specific curriculum which has the purpose of writing items -middle region: combination name of similar achievement criteria which is like Sate of Matter and Change of State, Structure of Matter, Characteristics of Matter and Separation of Mixture
Decision of representative items	-decide representative items which solved by almost students of each educational achievement level -classify representative items to each educational achievement level
Analysis of items	-analyze each items with item constituent factors -item constituent factors are content and material, cognitive domain and ability to solve item
Draw of characteristics of each educational achievement level	-draw characteristics of each educational achievement level with analysis of representative items of each educational achievement level -put together characteristics of each educational achievement level to generalize
Suggestion of teaching guidance in view of students' ability	-suggest teaching guidance with the help of the characteristics of educational achievement level



3. Results

3.1 Analysis example of an advanced representative item

This is an advanced representative item with the constituent factor of state change of water (Figure 1). This item is asking students if they can know what kind of state change is and how heat flow is when familiar state change is suggested. And this item is using situation that 'it becomes cool when sprinkle water in the yard on a hot summer day', 'body temperature goes down if wipe hot body with wet towel'. Through the analysis of this representative item of advanced level, we could know that most of advanced students know that the suggested phenomenon of this item are state change from liquid to gas and it absorb energy.

Figure 1. An advanced representative item example with item information

<p>(2012)16. Below phenomenon are examples that state change of matter is used in the real life.</p> <p>-It becomes cool when sprinkle water in the yard on a hot summer day -Body temperature goes down if wipe hot body with wet towel</p> <p>Select both of symbol of state change which meets upper situations and right expression of energy flow.</p> <div style="text-align: center;"> </div> <p>a. A, absorption b. A, emission c. B, absorption d. B, emission e. C, absorption</p>	Item information						
	achievement criteria		To explain energy flow of state change with particle arrangement				
		level	a	b	c	d	e
	%	advanced	1.58	0.41	84.99	12.46	0.52
		proficient	5.22	4.10	52.46	35.04	3.08
basic		9.49	15.45	30.30	34.23	10.22	
below basic		14.33	23.16	22.25	25.30	13.42	
	total	6.76	8.75	47.13	31.23	5.89	

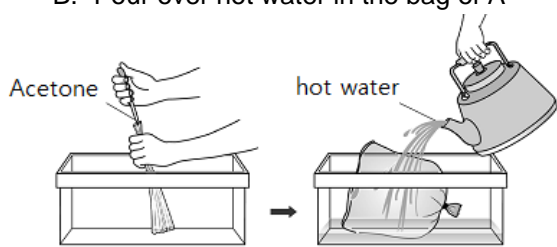
3.2 Analysis example of a proficient representative item

This is a proficient representative item with the constituent factor of state change of acetone (Figure 2). This item is asking students if they can know molecular level change when acetone evaporates in the sealed bag. And this item is using situation that liquid acetone evaporates to gas in the sealed bag when it pours over hot water.

Through the analysis of this representative item of proficient level, we could know that most of proficient students understand state change in the level of molecule, for example they know that acetone molecules go away from each other but the kind of or number of molecule does not change and also the total weight does not change when acetone evaporates in the sealed bag.



Figure 2. A proficient representative item example with item information

<p>(2011)9. Below experiments are about state change of acetone</p> <p>[procedure]</p> <p>A. Spill 5 drops of acetone in the vacant bag, and seal bag with string to prevent acetone from remove.</p> <p>B. Pour over hot water in the bag of A</p>  <p>[result] The bag inflated.</p> <p>Select true sentence about upper experiment.</p> <p>a. Acetone changed to different material</p> <p>b. Acetone molecules went away from each other</p> <p>c. Acetone disappeared, and water vapor was produced</p> <p>d. The weight of bag which has acetone increased</p> <p>e. The number of acetone molecule in the bag increased</p>		Item information					
		achievement criteria		To explain state change (evaporation, liquefaction, coagulation, fusion, sublimation) of matter with particle model			
	level	a	b	c	d	e	
%	advanced	0.2	98.3	1.3	0.2	0.1	
	proficient	1.0	81.8	10.0	3.1	4.1	
	basic	3.7	35.7	20.8	17.2	22.5	
	below basic	13.7	15.1	26.5	24.0	19.8	
	total	2.4	65.7	12.9	8.4	10.4	

3.3 Analysis example of a basic representative item


This is a basic representative item with the constituent factor of phenomena of evaporation and diffusion (Figure 3).

This item is asking students if they can understand phenomena of evaporation which is taking place on the surface of liquid and apply to new phenomena. And this item is using situation of dry of wet laundry, production of salt at the salt farm, production of water droplets on the surface of leaves, crack of soil floor while drought, decrease of water in the fish bowl.

Through the analysis of this representative item of basic level, we could know that most of basic students know that the situation of water molecule spread is different from the situation of production of water droplets on the surface of leaves.



Figure 3. A basic representative item example with item information

<p>(2010)16. Phenomena that water molecule spreads into the air by free motion itself on the surface of water liquid is expressed.</p>  <p>Select unrelated phenoma wiht upper one.</p> <ol style="list-style-type: none"> Wet laundry dried Salt was produced at the salt farm Water droplets was produced on the surface of leaves Soil floor cracked from a drought Water of fish bowl decreased 	Item information						
	achievement criteria		To explain phenomena of evaporation and diffusion with molecular motion				
		level	a	b	c	d	e
	%	advanced	0.1	0.2	98.3	1.0	0.4
		proficient	0.5	1.1	94.4	2.7	1.2
basic		4.4	7.9	72.4	9.1	6.0	
below basic		13.6	19.3	31.7	19.6	15.0	
total		2.8	4.8	82.4	6.0	3.9	

4. Conclusion

We could conclude with the analysis of items in each educational achievement level.

Advanced level students had ability like below in addition to the ability of proficient level students.

In the middle region of 'State of Matter and Change of State', they could understand state change of matter related with energy flow. In the middle region of 'Characteristics of Matter and Separation of Mixture', they could exactly understand the mixture separation experiment which is used by characteristics of material. And it was possible to control variables in that experiment. In the middle region of 'Structure of Matter', they could interpret heating curve of pure material and mixture, and understand the meaning of molecular model.

Proficient level students had ability like below in addition to the ability of basic level students.

In the middle region of 'State of Matter and Change of State', they could understand state change of matter in view of particle and molecular motion. And they could understand the relation between pressure and volume of gas and the relation between temperature and volume of gas through the analysis of experiment results. In the middle region of 'Characteristics of Matter and Separation of Mixture', they could understand that the boiling point, density, and solubility are characteristics of matter, and could understand phenomenon of separation of mixture are related with the characteristics of matter. In the middle region of 'Structure of Matter', they could infer the concept of molecule and the concept of particle in the chemical reaction. And they could understand ion model and compound model, and also know the simple feature of periodic table.

Basic level students had ability like below.

In the middle region of 'State of Matter and Change of State', they could understand simple principle of evaporation and diffusion in the common phenomena of real life, and know simple operation activities to control pressure or volume of gas. In the middle region of 'Structure of Matter', they could express simple symbol of element and chemical formula.



References

- [1] Choi, W. (2013). Comparison of the Characteristics of each Educational Achievement level of Elementary and Middle School Students Shown in the Chemistry Items of the National Assessment of Educational Achievement, Journal of the Korean Association for Research in Science Education, 33(6), 1186-1201.