

## Trial on Environmental Study at an Elementary School in Thailand on Hypothesis-Experiment-Instruction Method Learning about Law of Conservation of Mass

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### タイ国小学校における環境学習・質量保存の法則についての仮説実験授業の試み

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**Abstract** : To investigate the procedure of student's environmental study by Hypothesis-experiment-instruction method learning, "Law of conservation of mass" was learned at a environmental study class, elementary school in Thailand. At the environmental study class "Substance and Weight" of 5th grade 45 students, "the Law of conservation of mass" was taught by 7 steps of practical experiment using water, clay, wood piece, stone, sugar, cookie, and weight scale and balance scale. Consciousness and understanding of students on each step of learning were measured using estimation worksheets by 7 steps of "Substance and Weight" experiment. It was investigated that the students got over the understanding on "the Law of conservation of mass" during each step of experiments, and improvement on consciousness of interest and will for practical environmental study activities. This practical study let it became plain about the procedure of students' understanding; "which step made the students to be clear with environmental study with Hypothesis-experiment-instruction method about the Law of conservation of mass".

**Keywords** : hypothesis-experiment-instruction method, elementary school in Thailand, environmental study class

## I. Introduction

### 1.1 Situation

Hypothesis-experiment-instruction method (Itakura method\*) study becomes popular at environmental study class in Asian countries. Practical method of Hypothesis-experiment-instruction is based on proving hypo-thesis (estimation and critical thinking about reason) by the experiments co-operated with teacher and students. The procedure of learning is consisted of some steps of the experiment. The point that should be clear is "which steps is the most effective for learners, and how teacher leads to the right perception".

For more than these 5 years, authors are researching about new teaching method using IT media and

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renovation on the learning method on primary education under the collaboration research between Pranakhon si Ayutthaya Rajabhat university and Kyoto university of Education. Jirasart Witthaya school is the largest private school with more than 4,200 students and 150 teachers in Pranakhon si Ayutthaya province in Thailand, co-operated with Pranokhon si Ayutthaya Rajabhat in educational phase. Jirasart Witthaya school is challenging for the innovation of own education system on every subject and every grade from K-12 levels. In this study, it is expected that the Hypothesis-experiment-instruction method study should be authorized in the primary and the early secondary education levels.

## 1.2 Object

To investigate the procedure of student's environmental study by the method of about "Law of conservation of mass", "Substance and Weight" was learned at the environmental study class, at 5th grade elementary class in Thailand. And the analysis was done on the records of class (video recording, observation) and 41 worksheets that students wrote down about their estimations, prospect and opinions in the classes.

## II. Method

### 2.1 Environmental Study Class

The environmental study class "Substance and Weight" on the method of the Law of conservation of mass was done in the 5th grade with 41 students at Jirasart Witthaya school in Pranakhon si Ayutthaya in January of 2008. The "Law of conservation of mass" was tested in the 7 experiment steps by the teacher and 41 students using the real materials and the measuring tools; water, clay, wood piece, stone, sugar, cookie, and cooking scale and balance scale.



Picture 1 Teacher shows the process of weight Measurement

Using the materials and the comparative items of 7 experiment steps are shown in Table 1. As shown in Table 1, all experiment steps in weight measurement were comparative; before and after.

**Table 1 Materials and Comparative Items of Experiments**

| Experiment | Using Materials                      | Comparative Items (weight measurement)    |
|------------|--------------------------------------|-------------------------------------------|
| Step 1     | Changing shape of clay               | Clay (Before / After)                     |
| Step 2     | Clay sticking over the scale         | Clay (Before / After)                     |
| Step 3     | Clay leans on something              | Clay (After)                              |
| Step 4     | Whole cookies and Smashed cookies    | Cookies (Before / After)                  |
| Step 5     | Piece of wood floating in Water bowl | Water bowl + Wood (After)                 |
| Step 6     | Small stone sinking in Water bowl    | Water bowl + Small.stone (After)          |
| Step 7     | Dissolved sugar cubes in Water bowl  | Water bowl + Sugar cubes (Before / After) |

In order to explain about the procedure of study and experiments, the sample procedure of the first step of experiment is shown in Table 2.

**Table 2 Sample Procedure of Step 1**

| Procedure                           | Teacher's Activities                                                           | Students' Activities                      |
|-------------------------------------|--------------------------------------------------------------------------------|-------------------------------------------|
| Phase 1: Introduction               |                                                                                |                                           |
| 1                                   | Distribute questionnaire & Worksheet                                           | Read on questionnaire and Worksheet       |
| 2                                   | Explain about the experiment                                                   | Listen to teacher's explanation.          |
| 3                                   | Weigh former clay by Cooking scale                                             | Write weight of former clay on Worksheet  |
| Phase 2: First Intuition            |                                                                                |                                           |
| 4                                   | Change shape of clay                                                           | Watch teacher changing shape of clay      |
| 5                                   | Show changed clay                                                              | Write first intuition on Worksheet        |
| 6                                   | Count number of intuition from students by raising hand/ Record on blackboard  |                                           |
| 7                                   | Ask first intuition reason to Students                                         | Answer about first intuition reasons      |
| Phase 3: Before Experiment          |                                                                                |                                           |
| 8                                   | Direct group discussion                                                        | Discuss their reason of weight estimation |
| 9                                   |                                                                                | Discuss on answers Together               |
| 10                                  |                                                                                | Write second estimation on worksheet      |
| 11                                  | Count number of estimation from Students by raising hand/ Record on blackboard |                                           |
| 12                                  | Ask estimation reason to Students                                              | Answer about estimation Reasons           |
| Phase 4: Confirmation of the answer |                                                                                |                                           |
| 13                                  | Show weight of changed-shape clay                                              | Confirm the weight of former clay         |
| 14                                  | Confirm correct Answer.                                                        | Write correct answer in Worksheet         |
| 15                                  | Ask opinions & questions of Students                                           | Present opinions & Questions              |
| 16                                  | Conclude experiment Step                                                       | Write understanding on Worksheet          |

## 2.2 Assessment

The level of students' understanding about the Law of conservation of mass was measured by the 7 steps of experiment using the worksheets and the questionnaires by steps of environmental study. To let each students record the first intuition and the second estimation and the correct answer with their description (reason and opinion), the worksheet was produced as shown in Figure 1.

| Substance and weight                  |           | No. 1              | New 1                    |                   |
|---------------------------------------|-----------|--------------------|--------------------------|-------------------|
|                                       |           | a: First Intuition | b: Before the Experiment | c: Correct Answer |
| Question 1                            | a b c d   |                    |                          |                   |
| Question 2                            | a b c     |                    |                          |                   |
| Question 3                            | a b c     |                    |                          |                   |
| Question 4                            | a b c     |                    |                          |                   |
| Question 5                            | a b c d e |                    |                          |                   |
| Question 6                            | a b c d   |                    |                          |                   |
| Question 7                            | a b c     |                    |                          |                   |
| Findings, Opinions and More Questions |           |                    |                          |                   |

Figure 1 Worksheet for Recording Experiments

The students marked “round” for the first intuition, “square” for the second estimation and “cross” for the correct answer on the symbol (a, b, c...) of answer items. After the class, the statistics data was totaled and analyzed. The descriptions were recorded.

## III. Results and Analysis

### 3.1 Results

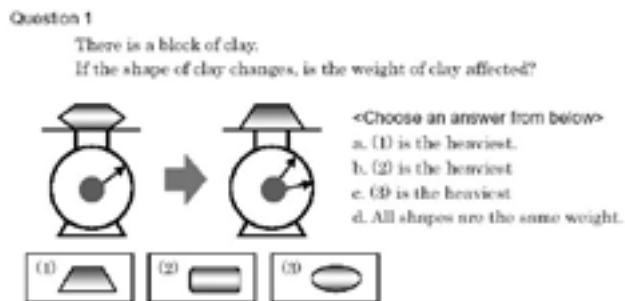
As statistic results of assessment, the number of correct answer on the first intuition and on the second estimation are shown in Table 3.

Table 3 Number of Correct Answer on the First Intuition and on the Second Estimation  
(Number of Students)

| Step              | 1 | 2  | 3  | 4  | 5  | 6  | 7  |
|-------------------|---|----|----|----|----|----|----|
| First Intuition   | 0 | 23 | 18 | 21 | 17 | 30 | 26 |
| Second Estimation | 3 | 28 | 23 | 27 | 15 | 32 | 35 |

### 3.1.1 Experiment Step 1

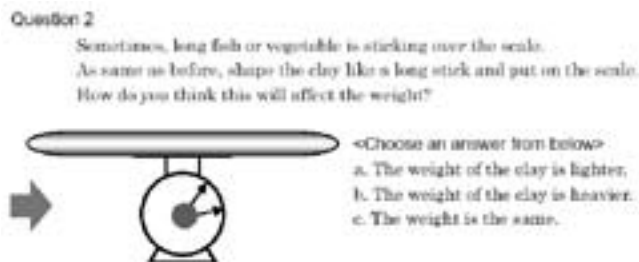
On the 1st experiment on changing the shape of clay, the all of 41 students selected incorrect answers of the different weight at the first intuition. It may be caused by teacher's inducing explanation to variety selection of answer. The second estimation after students' discussion before experiment of the result confirmation, the number of students who selected the incorrect answers of the different weight decreased but even to 38. It seems that students might not have the recognition on Substance and Weight yet.



Questionnaire 1 Changing Shape of Clay

### 3.1.2 Experiment Step 2

On the 2nd experiment on changing the shape of clay to be sticking over the scale, 23 students selected correct answer of the same weight at the first intuition, although teacher's inducing explanation to variety selection of the answers. The second estimation after students' discussion before experiment of result confirmation, the number of students who selected correct answer of the same weight increased to 28. Still 13 students might not have the recognition on Substance and Weight yet.



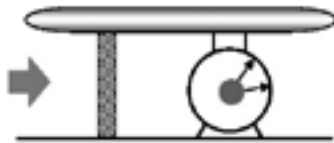
Questionnaire 2 Changing Shape of Clay to be Sticking Over the Scale

### 3.1.3 Experiment Step 3

On the 3rd experiment on setting the clay leaned on, 18 students selected correct answer at the first intuition. The second estimation after students' discussion before experiment of result confirmation, the number of students who selected correct answer increased to 23. Still 18 students might not notice Dispersion of Weight yet.

## Question 3

We understand the weight is the same when sticking out over the scale.  
If the clay leans on something is the weight affected?



<Choose an answer from below>

- a. The weight is the same.
- b. The weight is lighter.
- c. The weight is heavier.

Questionnaire 3 Clay Leans On



Picture 2 Students' Discussion

### 3.1.4 Experiment Step 4

On the 4th experiment on changing the shape of cookies, 21 students selected correct answer of the same weight at the first intuition. The second estimation after students' discussion before the experiment of result confirmation, the number of students who selected correct answer of the same weight increased to 27. There still 14 students did not have the recognition on Substance and Weight even at the 4th experiment.

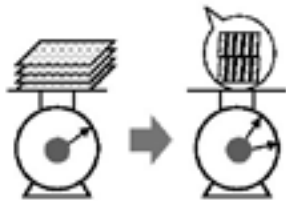
### 3.1.5 Experiment Step 5

On the 5th experiment on floating wood piece in a water bowl, 17 students selected correct answer of the same weight at the first intuition. The second estimation after students' discussion before experiment of result confirmation, the number of students who selected correct answer of the same weight decreased to 15.

## Question 4

Weigh a full bag of cookies, the weight is ( ) gram.

How is the weight affected if the cookies are smashed into tiny pieces in the bag?



<Choose an answer from below>

- a. The smashed cookies are lighter than whole cookies.
- b. The smashed cookies are heavier than whole cookies.
- c. The weight does not change.

## Questionnaire 4 Whole Cookies and Smashed Cookies

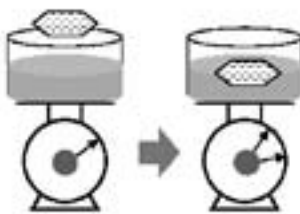
It seems that the students could not put theory of Substance and Weight that they learned into the next practice, might be perplexed by the floating wood piece.

## Question 5

There is a piece of wood, and the weight is ( ) gram.

Next, there is water in a bowl, and the weight is ( ) gram.

How is the weight affected when the wood float in the water?



<Choose an answer from below>

- a. The weight increases by the weight of the wood.
- b. The weight does not change.
- c. The weight increases to half of the weight of the wood.
- d. The weight decreases due to the wood soaking the water.
- e. Other (your idea: )

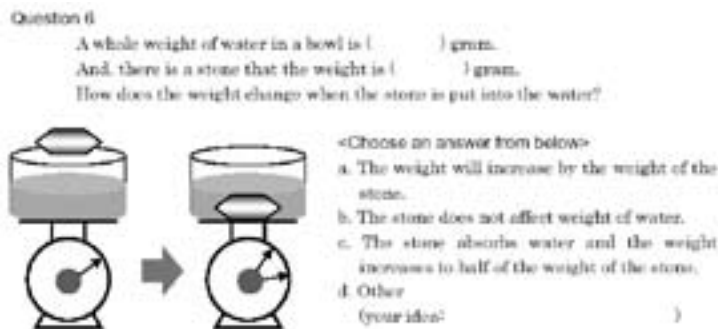
## Questionnaire 5 Piece of Wood Floating in Water Bowl



Picture 3 Counting Students' Estimation on Black Board

### 3.1.6 Experiment Step 6

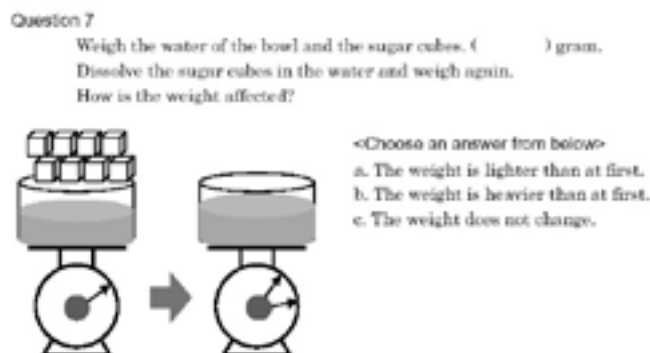
On the 6th experiment on sinking small stone in a water bowl, 30 students selected correct answer of the same weight at the first intuition. The second estimation after students' discussion before experiment of result confirmation, the number of students who selected correct answer of the same weight increased to 32. Still 9 students might not have the recognition on Substance and Weight yet. After the experiment using floating wood piece, it is easier to suppose the situation of the sinking small stone in a water bowl.



Questionnaire 6 Small Stone Sinking in Water Bowl

### 3.1.7 Experiment Step 7

On the 7th experiment on dissolved sugar cubes in water bowl, 26 students selected correct answer of the same weight at the first intuition. The second estimation after students' discussion before experiment of result confirmation, the number of students who selected correct answers of the same weight increased to 35. However, it seems that students could not believe their eyes, might be perplexed by little increase of water level in the bowl. Still 6 students might not have the recognition on Substance and Weight to the final experiment.



Questionnaire 7 Dissolved Sugar Cubes in Water Bowl

## 3.2 Analysis

The procedure of the correct answers at each steps of estimation and experiment is shown in Figure 2.

On the 1st experiment on changing the shape of clay, almost all the students estimated incorrect answers of different weight at the first intuition, and it was not corrected even at the second estimation after students' discussion. It seems that students might not have the recognition on Substance and Weight yet. On the 2nd step of experiment on changing the shape of clay to be sticking over the scale, 23 students selected correct answer of the same weight at the first intuition, although teacher's inducing explanation to variety selection of answer. The second estimation after students' discussion before experiment of result confirmation, the number of students who selected correct answer of the same weight increased to 28. Still 13 students might not have the recognition on Substance and Weight yet. On the same way, from the 2nd step to the 4th step of experiment, about 5 students change their answer after the second estimation.

On the 5th experiment on floating wood piece in a water bowl, 17 students selected correct answer of the same weight at the first intuition. The second estimation after students' discussion before experiment of result confirmation, the number of students who selected correct answer of the same weight decreased to 15. It seems that students could not put theory of Substance and Weight that they learned into the next practice, might be perplexed by floating wood piece. On the 6th experiment on sinking small stone in a water bowl, 30 students selected correct answer of the same weight at the first intuition. The second estimation after students' discussion before experiment of result confirmation, the number of students who selected correct answer of the same weight increased to 32. Still 9 students might not have the recognition on substance and weight yet. After the experiment using floating wood piece, it was easy to estimate on the sinking small stone. On the 7th experiment on dissolved sugar cubes in water bowl, 26 students selected correct answer of the same weight at the first intuition. The second estimation after students' discussion before experiment of result confirmation, the number of students who selected correct answers of the same weight increased to 35. However, it seems that students could not believe their eyes, might be perplexed by little increase of water level in the bowl. Still 6 students might not have the recognition on substance and weight to the final experiment.

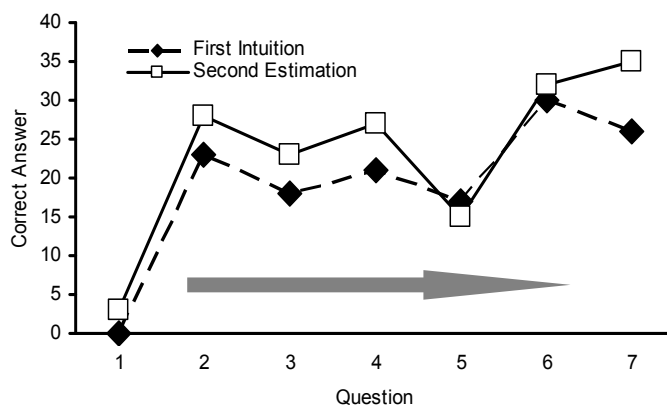


Figure 2 Procedure of the Correct Answers at Each Steps of Experiment

## IV. Consideration and Conclusion

### 4.1 Consideration

It was investigated that the students got over the understanding on “the Law of Conservation of Mass” during each experiments step by step, and improvement on consciousness of interest and will for practical environmental study activities. On the 5th experiment of floating wood piece in a water bowl and on the 7th experiment of dissolved sugar cubes in water bowl, the students who selected correct answer of the same weight at the first intuition and the second estimation were decreased. It seems that the experiments on changing of the shape made the students deceive.

### 4.2 Conclusion

This practical study let it became plain about the procedure of students’ understanding. Step by step, the alternative series of the experiments made the students’ understanding clear on the Law of conservation.

## References

\*Kiyonobu Itakura (1967), Instruction and learning of concept “force” in static based on Kasetsu-Jikken-Jugyo (Hypothesis-experiment-instruction): A new model of teaching science, Bulletin of National Institute for Educational Research. Vol.52, pp.1-121

### การศึกษาทดลองสิ่งแวดล้อมในการเรียนรู้ของนักเรียนระดับประถมศึกษา โดยใช้กระบวนการเรียนการสอนแบบสมมุติฐานการทดลองในหัวข้อกฎทรงมวล

**บทคัดย่อ:** เพื่อการตรวจสอบสิ่งแวดล้อมในการเรียนรู้ของนักเรียน โดยใช้กระบวนการเรียนการสอนแบบสมมุติฐานการทดลองในหัวข้อกฎทรงมวล ศึกษาภายในห้องเรียนของนักเรียนชั้นประถมศึกษาปีที่ห้าจำนวนสี่สิบห้าคน รายวิชาสารและน้ำหนัก หัวข้อกฎทรงมวลได้ถูกสอนภายใต้การดำเนินการตามเจ็ดขั้นตอนในการทดลองโดยใช้น้ำ ดิน เศษไม้ หิน น้ำตาลทราย ขนมหูกี้ และเครื่องชั่งน้ำหนัก ผลการเรียนรู้และความเข้าใจของนักเรียนในแต่ละขั้นตอนการทดลองได้ถูกวัดโดยใช้แบบการประเมินตามเจ็ดขั้นตอนของการทดลองหัวข้อสารและน้ำหนัก ผลที่ได้จากการตรวจสอบปรากฏว่ากลุ่มนักเรียนเป้าหมายสามารถทำความเข้าใจในแต่ละขั้นตอนของการทดลองตามหัวข้อกฎทรงมวล และมีพัฒนาการในความตระหนักและความสนใจในการฝึกปฏิบัติกิจกรรมในการเรียนรู้โดยใช้สิ่งแวดล้อม ซึ่งในการฝึกการเรียนรู้นี้ได้กลายเป็นพื้นฐานในกระบวนการทำความเข้าใจของนักเรียนถึงขั้นตอนที่สร้างให้นักเรียนเกิดความเข้าใจอย่างต่อเนื่องถึงสิ่งแวดล้อมในการเรียนรู้โดยใช้กระบวนการเรียนการสอนแบบการตั้งสมมุติฐานการทดลองกฎทรงมวล