10.6 DEVELOPMENT AND EVALUATION OF AN ELEMENTARY SCHOOL TEACHER WORKSHOP ON WEATHER DIRECTLY LINKED WITH CLASSES

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1. INTRODUCTION

The lack of interest in science displayed by many students is considered as a social problem in Japan. In 2002, the Ministry of Education, Culture, Sports, Science and Technology launched the Science Literacy Enhancement Initiatives. Thus, comprehensive policies have been implemented to support and promote educational efforts in science, technology, and mathematics. The program entitled the Science Partnership Program supports the following three activities, which put researchers or experts and facilities in a university or research institution precollege level classes on science, technology, and mathematics: (1) a lecture at a school given by researchers and experts who are invited from a school or local school board, (2) a lecture at a university or research institution where precollege students are given opportunities to experience and study cutting-edge science and technology, and (3) teacher training that is carried out by a local school board, university, or research institution. The program finances all expenses, including the participants' traveling expenses.

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We developed a two-day elementary school teacher workshop on weather in the teacher training programs. The workshop has been held and evaluated. In this paper, we show the purpose and activities of this workshop and describe how the participants evaluated the program contents.

2. PURPOSE OF THE WORKSHOP

In the past 10 years, weather information from sources such as satellite and radar images and weather forecasts has been easily accessible through the Internet or some storage media. These data can furnish various kinds of information on weather and, if applied in classes, can aid students' understanding. Through activities involving the use of a computer, the Internet, and weather sensors, participants can learn the basics of weather information how to interpret weather information, how to access weather data, and examples of how to apply this information in their classes. In addition, the workshop introduced simple experiments that arouse students' interest.

It is expected that the participants will implement the activities and experiments learnt at the workshop in their classes or introduce these at teacher workshops conducted in their schools or communities. Through the participants, the workshop aims to encourage students' interest in weather, thereby promoting their scientific literacy.

Table 1. Example of a workshop schedule in the year 2005.

(Wednesday, August 3)	
1000–1015	Orientation
1015–1215	Satellite imagery interpretation
1315–1515	Weather forecast
1530–1700	Simple experiments on atmosphere
(Thursday, August 4)	
0930–1010	Discussion on the previous day's activities
1010–1115	Weather information via the Internet
1130–1230	Atmospheric measurement using sensors
1530–1630	Atmospheric measurement at Mt. Teine
1630–1700	Evaluation

The workshop is intended for elementary school teachers—particularly those who did not major in science at their universities—to encourage overall improvement of elementary science education.

3. OUTLINE OF THE PROGRAM

Table 1 shows an example of the schedule used in 2005. The program utilizes a hands-on approach by allowing participants to perform activities on a computer, use the Internet, take measurements using weather sensors, and conduct simple experiments.

3.1 *Satellite imagery interpretation*

Weather satellite imagery has great potential as a teaching material. This is because images from space have a strong visual appeal for students. By using such images in class, a student's perspective can expand from the local view of the weather as observed in the student's surroundings, to a synoptic- or planetary-scale view of the weather system.

First, the basics of remote sensing and the interpretation of satellite images are explained. The following topics are covered: (1) the difference between clouds when observed from space and from the earth, (2) the history of weather satellites, (3) the types of weather satellites, (4) the principles of satellite observation, (5) the characteristics of visible imagery, (6) temperature determination by detecting infrared rays, (7) the characteristics of infrared imagery, and (8)

Activity: WHAT DO YOU FIND OUT FROM SATELLITE IMAGES?

Observe the infrared images of the globe for a year and summarize your findings on the following points.

a) What did you find out about Australia?

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b) What did you find out about India?

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c) What did you find out about the swirling of clouds?

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d) Draw trends of cloud movements**.**

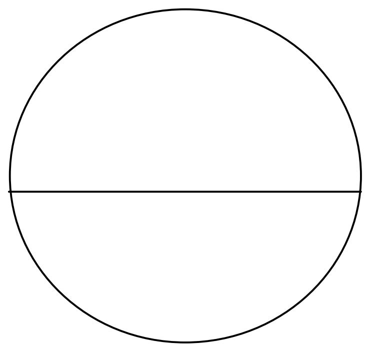

Fig. 1. An activity sheet displaying the global annual infrared images, which can be used by the participants in their classes. The Japanese text has been translated into English.

the discrimination of cloud types using infrared and visible images. An infrared radiation thermometer is used to demonstrate that the temperature of objects is determined by detecting their infrared rays. To display satellite images on a monitor screen, a software program that students can easily handle is applied (Suzuki et al., 1999). This program has the minimum necessary functions by which weather can be studied through image animation, coloring by temperature or brightness, displaying cloud-top temperatures, and superimposing an infrared image on a visible image.

Next, a subject is addressed—the activity of which is shown in Figure 1—that makes free use of the infrared images of the globe taken every 3 hr for a year with the software. The following can be observed: (1) Diurnal temperature variations on the continents. This is because land surface temperatures change visibly on a daily basis owing to incoming solar energy; (2) In India and the northern part of Australia, the rainy season and the dry season for each year are revealed by cloudy and clear periods; (3) Clouds in a mid-latitude or tropical cyclone rotate counterclockwise in the northern hemisphere and clockwise in the southern hemisphere; (4) Clouds in mid-latitudes generally move from west to east, whereas cloud clusters near the equator generally move from east to west; (5) A few cloud clusters develop into tropical cyclones and typhoons; (6) Few clouds exist at latitudes of 20 to 30 degrees.

A CD-ROM of annual weather satellite data with a software program was distributed to all the participants for practical use.

3.2 *Weather forecast*

Weather data and weather forecast are explained through the Internet. As an example, the following data offered by the Japan Meteorological Agency (http://www.jma.go.jp/jma/indexe.html) are shown: temperature, precipitation, wind, sunshine duration, snow depth in various parts of Japan, and satellite and radar images. Daily and weekly forecasts as well as nowcasts are also shown. Next, using this information, a subject titled "When you are a TV weather newscaster, how do you explain tomorrow's weather forecast?" is assigned. A subject that combines science and language can be used in classes. In this manner, students' abilities with regard to scientific judgment and presentation can be developed. Students should resort to logical grounds on a daily basis because the weather varies in an infinite manner. The sentences presented on TV should be concise and clear: for example, past, present, and forecasted weather should be expressed distinctively.

3.3 *Simple experiments on atmosphere*

Simple experiments on atmosphere primarily making use of everyday materials are

Table 2. List of experiments that were presented at the 2005 workshop.

(on atmospheric pressure)
- “Egg in a bottle”
- “Crushing an aluminum can”
- “Balloon in a flask”
- “Cartesian diver”
- “Syphon cup”
- “Snapping splittable chopsticks”
- “Magdeburg experiment using two mixing bowls”
- “Hanging up a cup by another cup”
- “Holed plastic bottle”

(on wind and vortex)
- “Protractor anemometer”
- “Tornado in two plastic bottles”
- “Vortex in a jar”

(on clouds, raindrops, and ice crystals)
- “Cloud in a plastic bottle”
- “Sampling of raindrops (Bentley's method) ”
- “Supercooling of bottled water”
- “Making ice crystals in an icebox”

Figure 2. A picture of the experiment "Hanging a cup by another cup," at which the participants gazed intently.

Figure 3. A picture of atmospheric measurements using sensors at Mt. Teine.

introduced to amuse and amaze students. Table 2 shows a list of the experiments. The experiments are classified into three groups: experiments on atmospheric pressure; wind and vortex; and clouds, raindrops, and ice crystals. A kit for a Cartesian diver that is commercially available by the name of "SQUIDY" from Steve Spangler Science (http://www.stevespanglerscience.com/product/1163) was brought back for use in each participant's school. Figure 2 shows a scene from the session held in 2005.

3.4 *Using information via the Internet*

Various kinds of information that could be used in the participants' classes are introduced: (1) determining the hottest and coldest regions in the world. Here, the data from the Weather Underground (http://www.wunderground.com/) are used, (2) watching the sky in various parts of the world through web cameras installed at different locations around the world, (3) educational assistance on sunshine and shade, cloud classification, weather forecasting, and weather proverbs in the digital contents of the Japan Science and Technology Agency (http://www.rikanet.jst.go.jp).

3.5 *Atmospheric measurement*

Atmospheric measurements are taken using a LabPro (Vernier Software & Technology) device with atmospheric pressure, temperature, and humidity sensors. The data are displayed on a calculator (TI-83 Plus, Texas Instruments). The pressure, temperature, and humidity in a building are first measured in order to familiarize the participants with handling the devices. Thereafter, the participants climb Mt. Teine, which is 1024 m in height, by a bus and an aerial ropeway. During the ascent, measurements are taken at the foot, the middle, and the top of the mountain (see Figure 3). Typically, participants observe pressure and temperature differences of 11 kPa and approximately 5ºC, respectively, between the foot and the

Table 3. Composition of the workshop participants.

Q. "What subject did you major in at your university?"	
1. Science	32%
2. Others	68%
Q. "Do you think that science is easy to teach?"	
1. Yes	51%
2. No	49%
Q. "What is your purpose behind attending this workshop?"	
1. "To improve myself"	24%
2. "To implement my learning in class"	76%

Table 4. Workshop evaluation by a questionnaire filled out by the participants.

Q. "Did you achieve your purpose of attending this workshop?"	
1. "I achieved it."	40%
2. "I somewhat achieved it."	52%
3. "I cannot say."	2%
4. "I did not completely achieve it."	6%
5. "I did not achieve it."	0%
Q. "Do you think that the workshop items can be used in classes?"	
1. Yes	94%
2. No	0%
3. "I cannot say."	6%
Q. "What do you think about our teaching method?"	
1. Very bad	0%
2. Bad	4%
3. "I cannot say."	6%
4. Good	56%
5. Very good	34%
Q. "Will you recommend your colleagues to attend the same workshop?"	
1. "I will never recommend this workshop to my colleagues."	0%
2. "I will not recommend this workshop to my colleagues."	3%
3. "I cannot say."	6%
4. "I will recommend this workshop to my colleagues."	41%
5. "I will definitely recommend this workshop to my colleagues."	50%

top of the mountain. Further, they can intuitively feel the difference in pressure by the bulging of a sealed packet that they carry up the mountain.

Atmospheric pressure, temperature, and humidity sensors were lent to the participants in compliance with their request.

4. EVALUATION OF THE WORKSHOP

The workshop is held every summer at Sapporo. Seventeen, thirteen, and eighteen teachers participated in the program in 2003,

Table 5. Average degree of the difficulty of each session as evaluated by the participants on a scale of 1 to 5: 5 (very difficult), 4 (difficult), 3 (average), 2 (easy), and 1 (very easy).

Satellite imagery interpretation *	2.6
Weather forecast *	3.2
Simple experiments on atmosphere *	2.1
Weather information via the Internet *	2.8
Atmospheric measurement with sensors **	1.9
Atmospheric measurement at Mt. Teine **	1.8

* average in 3 workshops.
** average in 2 workshops.

2004, and 2005, respectively. Table 3 shows the composition of the participants. Of the total number participants, 68% did not major in science at their universities, and 49% considered it difficult to teach science in school. Further, 76% of the teachers had participated in the workshop with the aim of putting their learning to practical use in their classes. The composition of the participants suited the purpose of the workshop.

The program was evaluated using a questionnaire that was mailed to the participants at the end of each workshop and also at the end of the school year (approximately 8 months after the workshop).

4.1 *Evaluation through the workshop*

Table 4 shows the participant's general evaluation of the workshop: 90% replied that they achieved their purpose of participation, that the workshop items could be used in their classes, and that the method of teaching adopted at the workshop was good or very good. In addition, 90% replied that they would consider recommending or definitely recommend their colleagues to attend the same workshop, if the same workshop would be held. Further, as shown in Table 5, the participants evaluated the difficulty of each

Table 6. Average values of participants' responses on how they wish to use the items in their classes, using one of five grades; the grades ranged from 5 ("I really want to use the workshop items") to 1 ("I never want to use the workshop items").

Satellite imagery (CD-ROM) *	4.7
Weather forecast *	3.9
Simple experiments on atmosphere	
"Egg in a bottle" *	4.2
"Crushing an aluminum can" *	4.0
"Balloon in a flask" *	3.9
"Cartesian diver" *	4.1
"Syphon cup" *	3.6
"Snapping splittable chopsticks" *	4.1
"Magdeburg experiment using two mixing bowls" *	4.1
"Hanging up a cup by another cup" ***	3.8
"Holed plastic bottle" *	4.1
"Protractor anemometer" *	3.5
"Tornado in two plastic bottles" *	3.8
"Vortex in a jar" *	3.5
"Cloud in a plastic bottle" ***	3.6
"Sampling of raindrops (Bentley's method) " *	3.9
"Supercooling of bottled water" ***	4.3
"Making ice crystals in a ice box" ***	3.9
weather information via the Internet	
"Hottest and coldest places regions" **	3.8
"Watching the sky by web cameras" ***	4.1
"Digital contents of Japan Science and Technology Agency" ***	4.5
Atmospheric measurement **	4.0

* average in 3 workshops.
** average in 2 workshops.
*** average in 1 workshop.

session using one of 5 grades: 5 (very difficult), 4 (difficult), 3 (average), 2 (easy), and 1 (very easy). The average values of activities performed using a computer and the Internet were distributed around grade 3; those for the measurements by weather sensors and simple experiments, around grade 2. The level of difficulty was appropriate.

Table 7. Evaluation of the workshop at the end of the school year (approximately 8 months after the workshop).

Q. "Have you used the workshop items?"	
1. Yes	68%
2. No	32%
Q. "If 'No,' what is your reason for not using the workshop items?"	
1. "I do not teach 5th grade classes."	83%
2. "I had no time."	17%
3. "The items cannot be used at the elementary level."	0%
Q. "If 'Yes,' how did you use the workshop items?"	
1. "In my classes"	92%
2. "In other classes"	31%
3. "For in-school teacher workshops"	8%
4. "For teacher workshops at the community level"	4%

Table 6 shows the average values of the participants' preference to use the items in their classes using one of 5 grades ranging from 5 ("I strongly want use those") to 1 ("I never want use those"). Participants rated the following items as grade 4 and above: the satellite imagery (CD-ROM), the digital contents of the Japan Science and Technology Agency, watching the sky in various parts of the world through web cameras, and the atmospheric measurements. The experiments that were rated 4 and above were "supercooling of bottled water," "egg in a bottle," "Cartesian diver," "Magdeburg experiment using two mixing bowls," "holed plastic bottle," and "crushing an aluminum can."

4.2 *Evaluation through the classes*

At the end of the school year (approximately 8 months after the workshop), the participants received a questionnaire by mail, asking if the items in the workshop had been implemented in their classes. The questionnaire was returned by 81% of the partici-

Table 8. Proportion of participants who have used each item.

Satellite imagery CD-ROM *	77%
Weather forecast *	27%
Simple experiments on atmosphere	69%
“Egg in a bottle” *	23%
“Crushing an aluminum can” *	23%
“Balloon in a flask:” *	27%
“Cartesian diver” *	35%
“Syphon cup” *	12%
“Snapping splittable chopsticks” *	19%
“Magdeburg experiment using two mixing bowls” *	8%
“Hanging up a cup by another cup” ***	38%
“Holed plastic bottle” *	12%
“Protractor anemometer” *	12%
“Tornado in two plastic bottles” *	19%
“Vortex in a jar” *	4%
“Cloud in a plastic bottle” ***	25%
“Sampling of raindrops” (Bentley's method) *	19%
“Supercooling of bottled water” ***	0%
“Making ice crystals in a ice box” **	0%
Weather information via the Internet	
“Hottest and coldest places regions”**	17%
“Watching the sky by web cameras” *	10%
“Digital contents of Japan Science and Technology Agency” ***	23%
Atmospheric measurement **	6%

The experiments were done in * 3 workshops, ** 2 workshops, ***1 workshop.

pants. The results are shown in Table 7. Of the respondents, 70% used the items included at the workshop mainly in their and/or others' classes. Further, 30% of them were unable to implement the items mainly because they did not teach 5th grade classes, in which students are taught about the weather in Japan.

Table 8 shows the proportion of participants who used each item for the 8 months after the workshop. Almost all the items were used. In particular, 77% and 69% of the participants had used the CD-ROM of satellite imagery that was distributed in the workshop and had conducted the simple experiments. Examples of teachers' comments on the satellite imagery were as follows. "Students expressed their excitement about satellite images by saying things like 'Wow! Moving!' and understood that cloud motions bring about weather changes." "The fact that they could observe cloud motions by themselves created a deep impression on students." "It is useful for students to understand cloud motions on the globe. It is something that has to be seen to be believed." The experiments that had been used by over 20% of the participants were "hanging a cup by another cup," "Cartesian diver," "balloon in a flask," "cloud in a plastic bottle," "egg in a

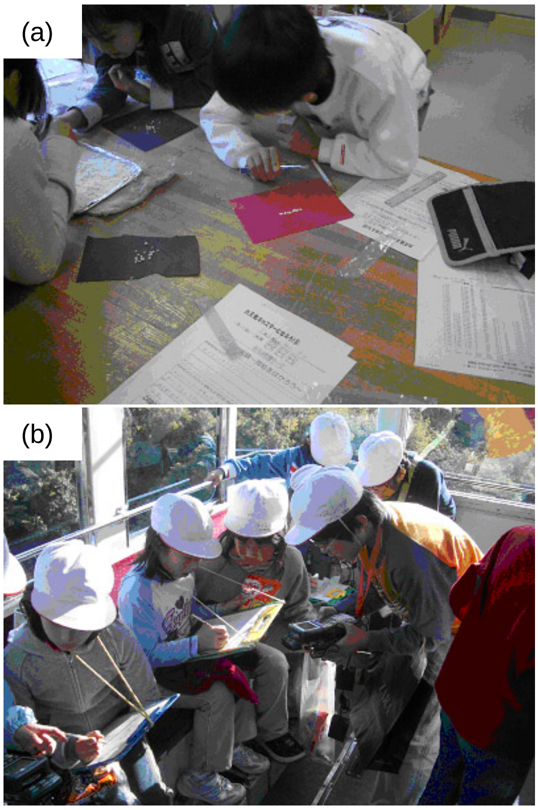

Figure 4. Pictures taken in a class entitled “You are a weather forecaster,” which was conducted by a participant in her school with our support: (a) the measurement of raindrops using the Bentley method and (b) atmospheric observation using sensors at Mt. Moiwa, which is located near a participant’s school.

bottle," and "crushing an aluminum can."

An example of the classes that were conducted by a participant and supported by us is an integrated study named "You are a weather forecaster." In this study, a CD-ROM of satellite imagery and raindrop measurement by the Bentley method was made. Further, atmospheric measurements were carried out at a mountain near the participants' school using the sensors, which we lent them. Figure 4 shows scenes of the classes.

5. SUMMARY

A two-day elementary school teacher workshop program on weather was developed, and the workshop has been held annually since 2003. It is particularly aimed at teachers who did not major in science, in order to improve elementary science education. The purpose is to provide participants with information on weather activities that can be applied in their classes. It is expected that the participants will implement these activities in their classes or introduce these at their own workshops conducted in their schools or communities. The program follows a hands-on approach and includes satellite imagery interpretation; weather forecasting; simple experiments on atmosphere; and atmospheric measurements carried out on a mountain with atmospheric pressure, temperature, and humidity sensors.

The participants completely understood the workshop contents. Over 90% of them replied that they achieved their purpose of participation and that the items could be used in their classes. The workshop items were used by 70% the participants mainly in their and/or others' classes. Almost all the items were used. This result shows that our selection of the items was reasonable. In particular, almost 70% of them had used the CD-ROM of satellite imagery and had conducted the simple experiments for approximately 8 months after the workshop till the end of the school year. The experiments that participants rated highly and actually used after the workshop were "Cartesian diver," "egg in a bottle," and "crushing an aluminum can."

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