Environmental Education (EE) Program based on the Concept of Education for Sustainable Development (ESD)
-ESD, Lesson Plans and Structure-

Edited
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Feb 2015

To Head teachers, teachers and students in three collaborating schools in a rural area of Zambia

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Introduction

"Education for sustainable development (ESD)" has been globally promoted with the rise of our concerns of socio-ecological risks. We could say that the aim of ESD is to raise the good adult or citizen who can contribute to build a sustainable society.

On the basis of the idea of ESD and ccollaborating with teachers of three schools in a rural area of Zambia, we conduct our practical study on the development of community and school-based environmental education (EE) program. One school is now in the state of transition from basic school to primary and secondary school. Another one was originally community school but is now primary school. The other is community school. It is the three year research from FY 2013 to FY 2015 of Japan (April 2013-March 2015).

Our research purpose is "What EE program would be possible and acceptable to the teachers of schools in a rural area of Zambia?" Then the research questions are "How can we link the environmental elements of life in this area with learning activities in the EE program?" and "How does the developed EE program relate to the idea of ESD?"

This booklet is one of products of our practical research. Beside the lesson plans we developed, it includes some information of ESD, lesson design and its implementation, suggestion to lesson study approach and characteristic feature of lesson conducted by teachers in a rural area of Zambia that we observed as appendices.

We really hope this booklet makes some contribution to the improvement of education in schools in a rural area of Zambia.

1. What is Education for Sustainable Development (ESD)?

1.1 Concept of ESD

ESD is now globally promoted with the rise of our concerns of social-ecological sustainability.

ESD is now globally promoted with the rise of our concerns of social-ecological sustainability; Post-UNDESD, SDGs, and so on. According to the Department of Environment, Transport and the Regions, UK, ESD is defined as follows;

> ESD is about the learning needed to maintain and improve our quality of life and the quality of life to come. It is about equipping individual, communities, groups, businesses and government to live and act sustainably; as well as giving them an understanding of environmental, social and economic issues involved.
> (Department for Environment, Transport and the Regions, 1999).

ESD focus is broad in terms of time as well as its coverage.

Firstly it clearly indicates that ESD focuses not only on the present but also on the future generations in terms of quality of life. Secondly, ESD covers rather broader issues in every aspects of human life in the world. These may include social-ecological unfavorable changes like deforestration and global warming and so on, and its impacts, political conflicts including terrorism, gender equality, peace, economic recession and so on.

1.2 Aim of ESD

The aim of ESD is to raise good adult or citizen.

We defined that the aim of ESD Aim of ESD:is to raise the good adult or citizen who can contribute to build a sustainable society. Thus we developed our EE program to foster the good adult who will contribute to build the sustainable community in a target area.

ESD has not any specific content to it but is "Frame for Learning"

As ESD is also the "Education" not "of" but "for" the sustainable

development of human society, it has not any specific content but would be a kind of frame of learning to raise those who are equipping with various competencies to live and act sustainably.

1.3 What consists of the "Frame"?

Four Pillars of Learning as frame of ESD learning

"Four Pillars of Learning" is reflecting the comprehensive approach of education to foster "Good adults/Citizens" who contribute to build a sustainable society. Its meaning is always updated depending on the various situations and times of the world. Now we could understand the meaning of each pillar of learning under the aim of ESD as our concern of social-ecological sustainability is being raised (UNESCO, 2015 *Rethinking Education*, UNESCO Publishing: Paris, P. 39).

The frame for ESD learning consists of four aspects of learning where each pillar of "Learning to Know," "Learning to Do," "Learning to Be," and "Learning to Live Together" corresponds to each side of frame, as given in Figure One with meaning of each pillar..

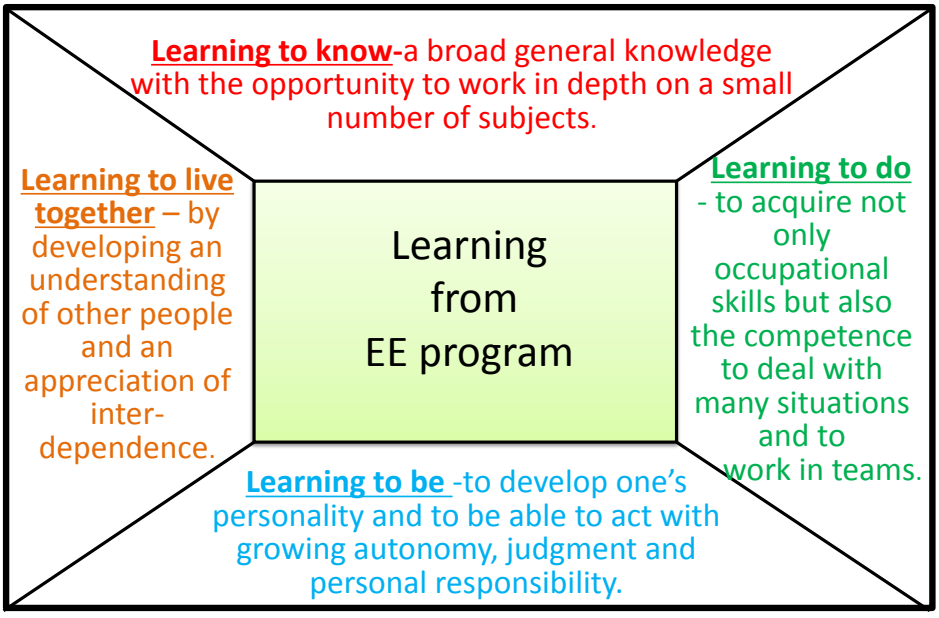


Figure One Frame of ESD learning

We could define the ESD as "Shape of learning" that is characterized by viewing learning of students through this frame. Later, we will show concretely the learning emerged from EE program in terms of each pillar.

2. Planning of Lesson for Environmental Education

2.1 Concept of planning of lesson

1-*Community-based lesson*: It is necessary for a teacher to know the various aspect of social and natural environment of target area, since Lesson should become approachable to students.

2-*Students'experience-based lesson*: It is necessary for a teacher to know the students' daily experience, since lesson should be meaningful to them.

3-*Curriculum-based lesson*: It is necessary for a teacher to understand the curriculum content and intention that are closely related to environmental issues.

2.2 Activity of lesson

Introducing verbal or non-verbal activity as much as possible

In order to encourage students' involvement into a lesson, a teacher should incorporate verbal or non-verbal activity or both as follows;

- Verbal activity includes answering to the question from a teacher, group or whole classroom discussion and presentation of summary or conclusion of discussion.
- Non-verbal activity includes drawing, expressing something (shape of a certain tree, for example) using a whole body, as given in Figure 2.

Figure Two: Students are expressing the shape of tree in the worksheet in the lesson of "Tree Observation (Nov. 2015)

- Mixed use of verbal with non-verbal activities could be also recommended within one lesson to energize a lesson. For example, after discussing in a group, a student presents summary or conclusion of discussion in front of his or her classmates, as given in Figure Three.

Figure Three: Group discussion (left) and presentation of summary of discussion (right)

In this context, a teacher should call for comments or question from students in a classroom. If not, a teacher should do those.

2.3 Composition of lesson

A lesson should be structuralized

Generally, a lesson consists of 3 part or components, "Introduction," "Development" and "Wrap-up or Consolidation". Each part or component has specific aim as follows;

1-Introduction: Reflecting on the previous lesson and raising students' interest in the lesson topic or content to introduce them smoothly into the present lesson. At the end of this part, the present lesson topic with its aim is shown.

2-Development: It is the main body of lesson. Various learning activities as mentioned in the previous section are introduced to achieve the lesson aim.

3-Wrap-up/Consolidation: The lesson is summarized by a teacher to reflect and consolidate the learning in the present lesson. In order to reflect, consolidate the learning in the present lesson or evaluate whether and to what extent the aim of lesson is achieved, he or she could make some requests to the students as follows;

- What did you do in the present lesson?
- Are you interested in the present lesson? If so, what are you interested in?
- What did you learn in the present lesson?
- What does your learning in the present lesson relate to your daily life?"

2.4 Resources for a lesson

Anything around you and your students can be used in environmental education

Anything around your students can be used as a teaching resource for environmental education according to your lesson topic and content as follows;

- Natural objects: Tree/Forest, River (Figure Four), Mountain, Grassland, etc.
- Artificial objects: Farm, Garden, Well (Figure Four), House, Dam, Living wares (Figure Four), etc.
- Social object: School, Market, Transportation system, Administrative agencies, Health post, etc.
- Human: Farmer, Merchant, Village elders, Nurse, Community health worker, Minibus driver, etc.

Figure Four: River and bridge (left), a well with hand pump (middle), items in a daily life (right) displayed in front of students

In order to make a lesson effective, interesting and meaningful for students as much as possible, a teacher has to select the most suitable teaching resource(s) for the lesson topic and content from a wide variety of objects or human in the environment of him or her and student.

3. Lesson plans for environmental education

Four lessons has been developed

3.1 Outline of lesson plan

We developed the following lessons collaborating with teachers in a rural area of Zambia;

- *Water in daily Life*

  In order to raise students' awareness of importance of water, drawing and transporting water from water source to home, students draw the water use in their daily life (Figure Five; left).

- *Water Cycle-Evaporation and Condensation*

  Students study the precipitation of rain (Figure Five; right) based on the scientific concepts of evaporation and condensation

Figure Five: Drawing and transporting water by carrier (left) and rain in a rural area (right)

- *How to measure air temperature?*

  Students study the way of measuring air temperature using a thermometer.

- *How to observe a tree?*

  Students study the way of observing tree systematically (Figure Six).

Figure Six: Observing tree in a school yard

3.2 Lesson Plan

3.2.1 Water in daily life

1-Lesson flow

Name of Teacher		
School:		
Subject:	Social Development Studies	
Grade:	Two (stipulated in the curriculum but because of language, conducted actually for G4 or G6 students)	
Topic:	Water	
Sub-topic	Water in daily life	
Teaching and Learning aids:	Pupils books, Water, Bucket, Chart	
REF	Teachers Guide, Pupils books (p. 61)	
Rationale:	In this lesson, learners are expected to relate to water use with their daily life. Learner will appreciate to take care of the sources of water. This is the second of the three lessons that cover the topic.	
Specific Outcome	Draw and discuss the use of water	
	Draw the scenes with using water in their daily life	
Pre-requisite:	Learners have the knowledge on water uses in their daily life	
Lesson process		
Stage	Teaching and Learning Activity	Learner's activity/Learning Points
Introduction (5 min)	1-Teacher tells students what he did in this morning; Washing face, Making a tea and Shaving using a leather blade. Then Teacher tells that he uses same thing in three different kinds of things in this morning and asks what is it? After waiting for students' answer, teacher provides his/her answer "Water" and then shows lesson topic of today: Water.	Listening to teacher Thinking teacher's question and answering: a face towel, a cup, and so on
Development, Step 1(15 min)	Teacher gave one sheet of paper to each students, and ask them to draw the use of water in their homes. Monitoring the drawings to see their drawings and choose the learners whom teacher will ask to present.	Students draw the use of water in their homes: Cooking, Cleaning, Washing, Watering, Drinking, Bathing
Step 2 (10 min)	Teacher asks his/her selected learners to present the experiences in their daily use of water with showing their drawings Writing use of water presented on the blackboard	Students present: playng with water, Moulding, Gardening, Washing, Smearing clay to the houses Other students listen to the presentation
Step 3 (5 min)	Teacher categorizes the use of water by food, cloth, shelter, health and enjoyment.	Looking at blackborad and answering to teacher's question regarding the categorization by food, cloth, shelter, health and enjoyment.
Step 3 (5 min)	Teacher consolidates on pupils experiences-draw a picture of how they are using water: We use water in various ways in our home. Then asking question: Why the water is important for you and your family?	Listen to teacher carefully and think teacher's question and answer.
Conclusion (5 min)	Teahcer emphacises following issues; Water is one of the most important things for us to live. We have to take care of water and water resource. So, the drawing of water is the most important works for you and your family.	Take good care of water and water sources
Evaluation	How many drawings they made in Step 1. How they presented in the Step 2. Their answers to the question at the end of Step 3.	

2-Examples of students' drawings in the lesson of "Water in daily life" (Figure Seven)

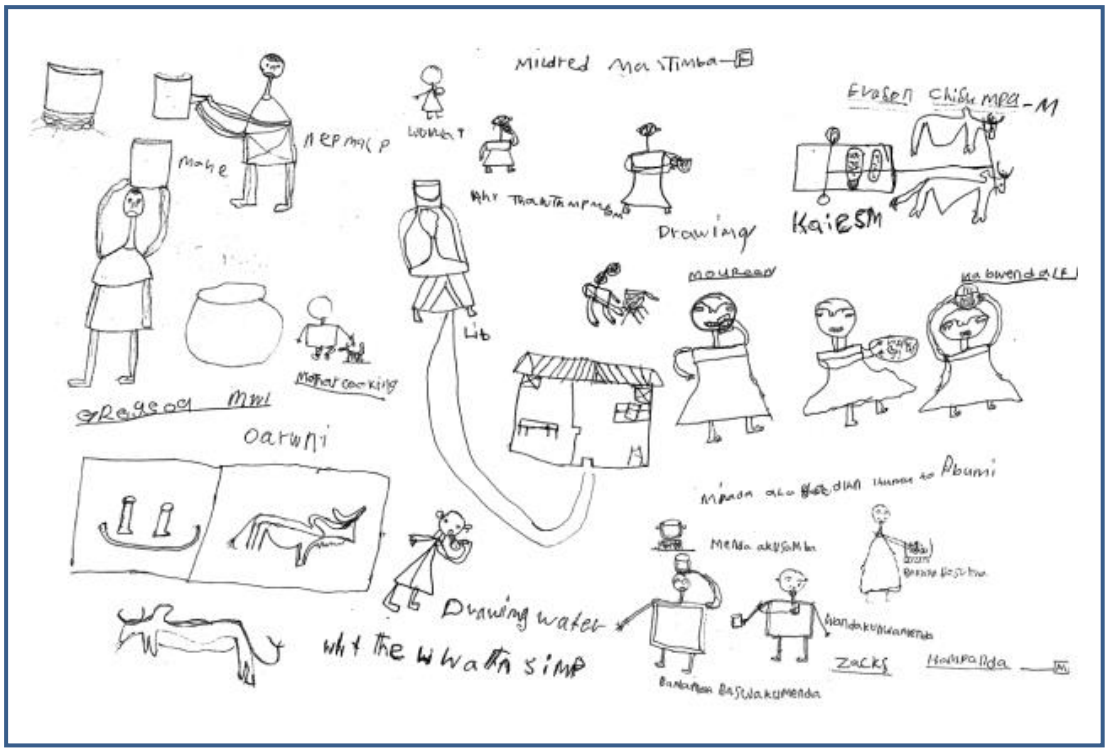


Figure Seven: Examples of students' drawing

3-Teaching tips

- *Monitoring and question*
  Please monitor the drawing by students and ask what they are drawing, as necessary.

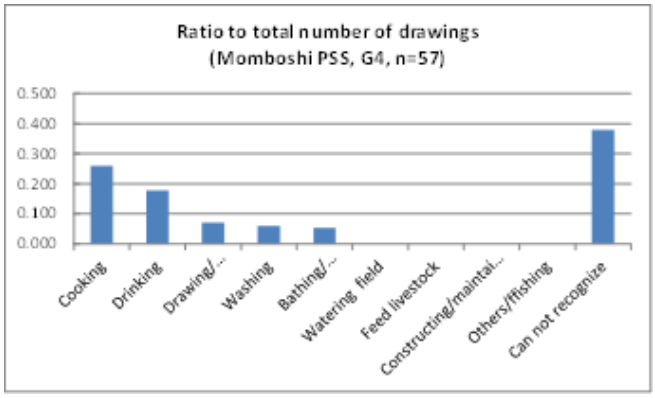
- *Comments and question on presentation*
  Please call for questions or comments after student presented his or her experience(s) of water use in a daily life with showing his or her drawing. If no question or comment is made by students, please make comment or question by a teacher on the presentation of student.

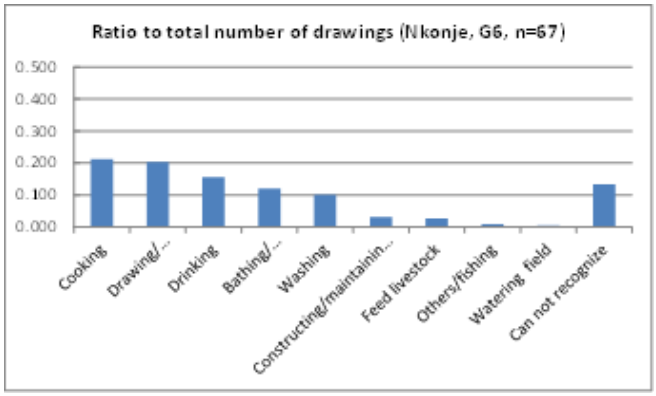
- *Categorizing together with students*
  Categorization is to show the wide variety of use of water. Please categorize daily water use that is drawn by students.

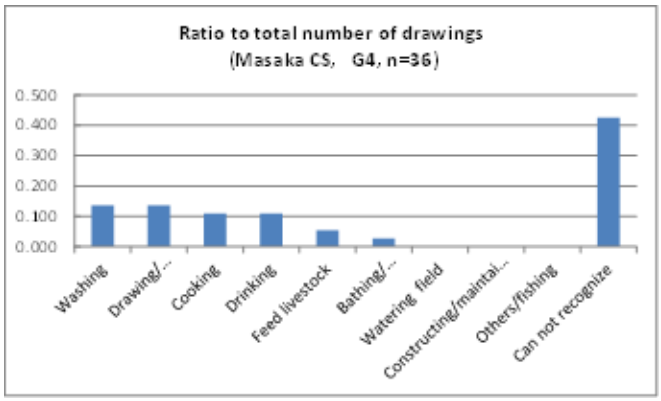
4-Analysis of students' drawing

The ratio of number of each water use to the total number of drawings was indicated in the following three charts. It can be seen from three figures, "Cooking," "Drinking," "Drawing water," "Bathing" and "Washing" may be the familiar water uses in their daily life.

In the case of G4, the pictures that could not be recognized what they drew are higher in its ratio than that in the case of G6. The drawing activity may be difficult for them. One of ways of solving this difficulty, teacher may request to students to put the foot note beneath each drawing of them.







3.2.2 Water cycle-Evaporation and condensation

- Lesson plan A

Lesson Plan -2nd draft (Planning: November 25, 2014 By Chikamori)		
Name of Teacher	K. Chikamori	
School	Momboshi PSS, Masaka and Nkonje CS	
Subject:	Integrated Science	
Grade:	6	
Topic:	Water Cycle	
Sub-topic	Where is water coming from and how water is going back to the place where it was born?	
Teaching and Learning aids:	Blackboard and Chalk	
Relivance to Curriculum 2013	UNIT 3 The Environment; 6.3.1 The water cycle system; The process of evaporation and condensation in environment; Effect of water cycle	
General outcome and its relationship with lesson desigen	Ability, Skill & Attitude: Ability to co-operate, Willingness to share knowledge: Application of "Group work" Understanding: Understanding of human and environment	
Rationale:	In this lesson, learners are expected to learn co-operatively with their classmates with sharing their knowledge in a group work activity and to understand the relationship between rain and their daily life.	
Specific Outcome	Students understand where water comes from and how it goes back to the place where it was born.	
Pre-requisite:	They have already learned water resourse and its uses for in their daily life in SDS lessons in Grade 2 as well as evaporation and condensation in (Science?) in Grade 3 (?). They know when rain falls, it is not clear with sun shine but cloudy in the sky based through their daily experiences.	
Approach	Co-operative work in a group and question and answer approach	
Lesson process		
Stage	Teaching and Learning Activity	Learner's activity/Learning Points
Introduction (8 min)	Writing the subject (Integrated Science) and lesson topic (Where water is coming from and going back to ?) on the blackboard). The teacher says that today we learn where water comes from and going back to: Water cycle (write on a chalkboard). Teacher asks students that do you know the things that include "Cycle" in their name? Teacher draws a bicycle on a blackboard and then asks that where the "Cycle" is in this picture for ice braking activity. - Teacher tells students that you alraedy learned water resourse and the use of water in your life in SDS lesson in Grade 2. Teacher asks students have you ever learned "Evaporation"? Then teacher asks several students "where are you drawing water? and what are you using water to?" Teacher asks students to make group: 4-5 students per group	Listening to teacher Thinking teacher's question and answering Expected answer: River, well; Bathing, cooking, drinking, washing
Development, Step 1 (15 min)	Teacher writes the following questions on a blackboard and ask students to discuss the answer in a group. And then picking several groups to get answer. Question-1: Where water comes from as a rain? Question-2: When it is raining, whether sky is generally clear with sun shine or cloudy? Questions-3: Where water of rain is going to? Teacher summarize the students' answers as one chart on a blackboard.	Students are thinking the question-1 in a group and answering to Question-1: Sky, River, Well, etc.; Question-2: cloudy Question-3: Land, River, Well, Field, etc
Development, Step 2 (10 min)	Teacher said that I will give you some questions. Please discuss the answer in a group. Then teacher writes the following questions on a blackboard and ask students to discuss answer in a group; Question 4: Where water goes back to? Question 5: How is water going back to the place where it was born? Teachet summarizes students' answers using the previous chart in step 1.	Students are thinking the question-1 in a group and answering to Question-4: Sky, Cloud., ect. Question-5: Water vapor (Evaporation)
Conclusion (6 min)	Teacher says the follwoing episode with question, and then asks students to discuss the answer in a group; Do you know Mr.Nkonkola, Head teacher of Masaka? Mr. Nkonkola said to me that I'm worrying about that raining is smaller and smaller in Momboshi. Question 6: What is the bad thing because of the smaller raining? After indicating Q6, teacher asks students to come in front and then write their answer on a blackboard. Teacher says that if we cannot keep the water cycle, river has no water and crop will die. Thus we cannot get food. Question7: What and how to do with the short of rain?: It is home work; Please ask your parents, peoples in your neighborhood, elders, and so on.	Thinking answer based on their learning so far not only in this lesson but also their previous learning from G1 and presenting their answer; Expected answer: Because we cannot get water from the well or river. Well may dry up. Expected answer: Evaporation of water is smaller, Smaller making of cloud

- Lesson plan B

The lesson plan B was designed by Ms. Ayana Oki, International Education Course, Graduate School of Education (Master course), Naruto University of Education. One of foci of this lesson is to solve the problem of instruction medium in English.

1-Lesson flow

topic	6.3.0 The environment
Subtopic	6.3.1 The water cycle
Specific outcomes	6.3.1.2 Describe the process of evaporation and condensation

Step & time	Learning activity	Teacher's activity
Introduction 15 min.	●Review the rain cycle.	○Explain about rain cycle using a chart. "I focus on evaporation and condensation" "Today's topic is the process of evaporation and condensation."
	●Read the lesson topic and write it, and draw the chart of rain cycle on a notebook.	○Request the students to read the topic and write it on their notebook. "Please put notebook on your desk and write the topic and draw the chart of rain cycle."
step 1 10 min.		1. Evaporation
	●Answer the teacher's questions of Evaporation	○Check the definition of evaporation. "What is Evaporation?"
		○Write the definition of evaporation on a blackboard and read it first.
	●Read the definition of Evaporation aloud after the teacher, then write it on the notebook.	○ Request the student to read the definition of evaporation on a blackboard and write it.
	●Answer the teacher's question. "Gas" "No (invisible)"	○Check the knowledge of water vapor. "What is state of water vapors?" "Can you see the gas?"
	● Add the word of process of evaporation on the rain cycle chart.	○Write the process of evaporation on the rain cycle chart. "Evaporation change in the state from liquid to gas"
		2. Condensation
	●Answer the teacher's questions of condensation	○Check the definition of condensation. "What is condensation?"
		○ Write the definition of condensation on a blackboard and read it first.
	●Read the definition of condensation aloud after the teacher and write it on the notebook.	○ Requesting students to read the definitions of condensation and write it on your notebook.
	●Answer the teacher's question. "Liquid" "Yes (visible)"	○Check the knowledge of small drops. "What is state of small drops?" "Can you see the liquid?"
	● Add the word of process of condensation on the rain cycle chart.	○Write the process of evaporation on the rain cycle chart. "Condensation change in the state from gas to liquid"
Step 2 15 min.	●Draw the chart of the kettle and water in it.	○Request the students to draw the chart.
	●Think about teacher's question and drawing the situation of the spout of a kettle.	○Request the students to draw the situation of the spout of the kettle to check these phenomenon. "What will happen near the spout of a kettle when water is boiled in the kettle? Please draw in the chart."
	● The students who have a miss conception draw the chart on a big paper again.	○ Check the students' drawings, and pick up the students who don't understand the differences between water vapor and steam to draw the chart again.

2-Teaching tips

- In this lesson, in order to visualize the lesson content as much as possible as well as to avoid the problem of English as an instruction medium, several charts were used, as given in Figure Eight. These include the drawing of boiling of water in a kettle (upper), cards indicating the scientific term with its corresponding Chitonga, and a table for wrapping up what students learned in this lesson (lower).

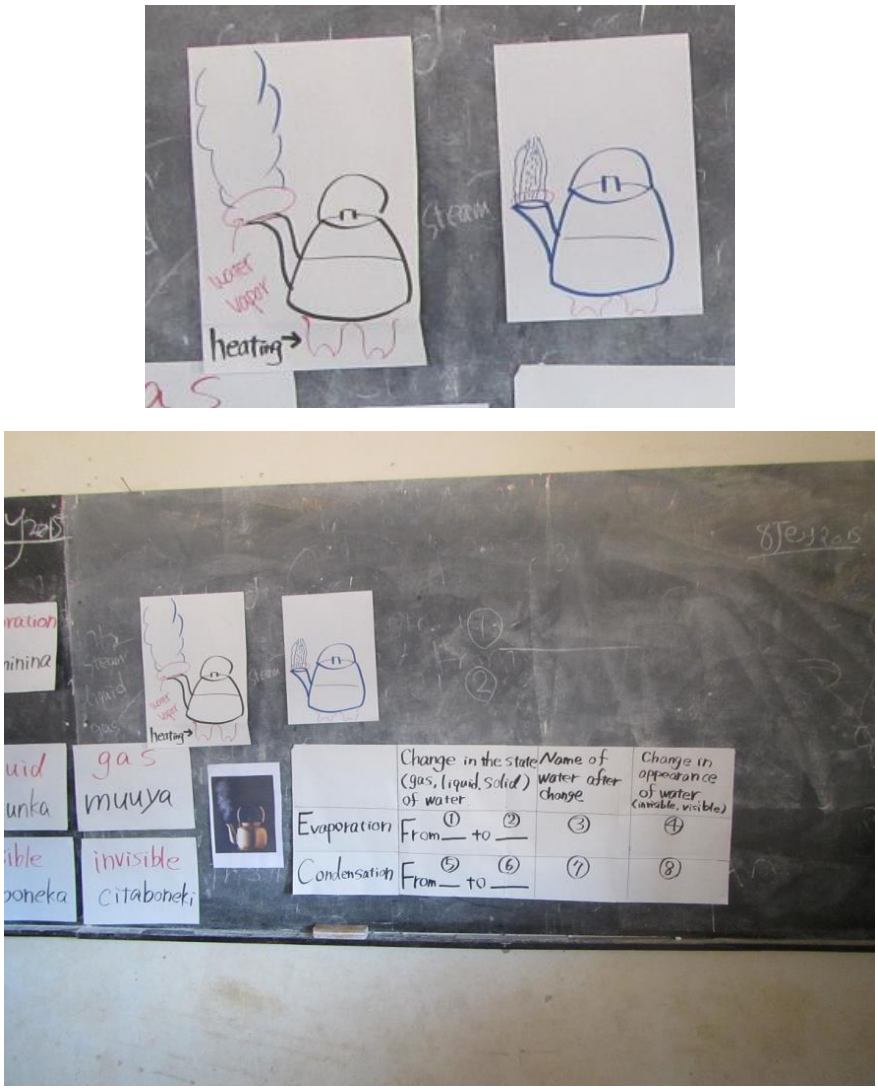


Figure Eight: Charts used in the lesson
Boiling water in a kettle (upper), and
cards for English-Chitonga and table for wrapping up (lower)

- A teacher uses also a sentence-type summarization for wrapping up, if many students feel difficulty in using a table. But using table-type summarization, a teacher can provide students with the opportunity to summarize what they have learned by a table.

Note: This work is a part of master thesis of Ms. Oki entitled as “Study on the lesson in a school in a rural area of Zambia”. It has been submitted to Graduate School of Naruto University of Education in 2016.

In this thesis, she also strongly suggested the importance of caring of a note-taking of students by teacher. The summary of her thesis is as follows;

1. Research purpose and questions

1.1 Research purpose is to get the suggestions for the improvement of science education in Zambia by exploring the teaching approach to solve the difficulty in terms of language used in a lesson.

1.2 Research questions are as follows;

Question 1: What is the actual situation of lesson?

Question 2: How are students grasp a lesson in their learning?

Question 3: What is the approach to encourage students’ understanding of contents of lesson using English as instructional medium?

2. Results

2.1 Actual situation of lesson

2.1.1 Teacher

- Teachers aspire to take student-centered approach such as question and answer activity, and group work in their lesson.
- Their primary focus to convey the contents and few activity to care and teach students’ note-taking could be seen.

2.1.2 Students

- They have challenges in their note-taking because of language barrier to English: Many students may have difficulty to write English word based on their understanding of its meaning based on my observation.

2.2 How do students grasp a lesson in their learning?

Many students follow faithfully what a teacher is talking.

- They take note with following the teacher’s instruction as faithfully as possible
- There can be seen not many but a few students who actively involved in a group work as well as discussion.
- The primary learning activity of students may listening and what they have listened may be the content of lesson

2.3 What is the approach to encourage students' understanding of contents of lesson using English as instructional medium?

1) To show a chart to help students to make their image of learning contents
2) Introducing native language corresponding to scientific term in English
3) Reading aloud for several times leads the learning activity to fix the sentence pattern and its memorization

The concomitant application of 2) with 3) may support greatly to construct students' construction of scientific concept.

4) It is suggested that note-taking encourages students' understanding of learning contents as others also suggested the correlation between both. (Kishi, Tsukuda & Nojima, 2004)

- The first step for improvement of students' understanding of contents may be to improve the teachers' interest and approach for students' note-taking

3. Discussion

- One of biggest challenges is that some scientific terms cannot find their counterpart in native language.
- Considering the situation in a classroom where almost all students have not textbook, only their notebook is crucial not only for students to study both in a classroom and after-school but also for teachers to monitor how and what they learn and learned in a classroom.

- Supplementary material for learning of water: Data on water quality

<Firstly I would like to remind you that this is conventional data. if you want to say something about water quality, for example, public health issues and well water, please ask officially authorized institutions to test water.>

In every 3 or 4 months from June 2014 to July 2015, we measured the water quality of water for six indicators including the concentration of nitrate and nitrate nitrogen, total hardness as calcium carbonate content, total alkaline and pH using conventional test paper. Turbidity is evaluated by an eye observation, as shown in Table One.

Each water sample was collected from the tap water of TICO office near the 1st school (Sampling site: the 1st school), from the bucket in front of head teacher's office of the 2nd school (Sampling site: The 2nd school), and from the

well with hand pump in a school yard of the 3rd school.

The data on water quality as one of supplementary materials will provide the scientific basis in designing a new science lesson in which the students participate in testing water quality using their five senses. Its sample lesson plan and worksheet is indicated below.

Table One: Water quality of three schools

Sampling site	Month	Nitrate Nitrogen (mg/L)	Nitrite Nitro-gen (mg/L)	Total Hardness as Calcium Carbonate (mg/L)	Total alkaline (mg/L)	pH	Turbidity
The 1st school (Project site office of TICO)	June	1	0	120	180	7.2	Clear
	Sept.	1	0.15	120	120	7.5	Clear
	Nov.	1	0	120	120	7.2-7.5	Clear
	Feb.[2)]	1	0	120	120	7.2-7.5	Clear
	July[2)]	1	0	120	120	7.2~7.5	Clear
The 2nd School	June	1	0	0	20	6.8	Clear
	Sept.	0	0	50	40	6.4	Turbid
	Nov.	1	0	25	20	6.8	Highly turbid, (Salty)
	Feb.[2)]	0	0	0-25	0-20	6.4	Turbid
	July[2)]	0	0	250	120	7.2	Clear
The 3rd School	June	0	0	250	180	7.2	Clear
	Sept.	0	0	250-425	180<	7.8-8.4	Clear
	Nov.	0	0	250-425	180	7.5	Clear
	Feb.[2)]	0	0	250	120-180	7.5	Clear
	July[2)]	0	0	250-425	120	7.5-7.8	Clear

[1)] In June: From deep well in the school yard; [2)] 2015

About the indicators of water quality

- Nitrate and nitrite nitrogen: Inorganic nitrogen in surface and underground water exists as nitrate ion (NO_3^-), Nitrite ion (NO_2^-) and ammonia (NH_3^+). The major route of entry into a surface water of river and stream as well as into underground water may be primarily human waste from a toilet and animal waste from a farm in a rural area like a target area. The entire samples in Table One show concentrations of both nitrate and nitrite nitrogen is relatively low in their concentration.

- Hardness of water: It indicates the dissolved calcium and magnesium concentration. The value in Table One is expressed the water hardness as a total calcium carbonate content. We can see the well water from Nkonje shows highest in its total hardness.

- Total alkaline: It indicates the capacity of sample water in neutralizing acids. Carbonate (H_2CO_3) and Bicarbonate or hydrogencarbonate (HCO_3^-) may play the primary role in this capacity of water. You can see the correlation between the Total alkaline and pH, the indicator of concentration of hydrogen ion in sample water.

3.2.3 How to measure air temperature?

1-Lesson flow

Name of Teacher		
School		
Subject:	Integrated Studies	
Grade:	Six	
Topic:	Weather condition in local area	
Sub-topic	Measuring temperature-How to read a thermometer	
Teaching and Learning aids:	Thermometer, Worksheet	
Specific Outcome	6.4: Environment, 6.4.2 Observe, measure and record prevailing weather conditions in local area (SDS curriculum 2003) 6.3.0 The environment, 6.3.1 Water cycle, 6.3.1.2 Describe the process of evaporation and condensation (Integrated Science Curriculum 2013); 5.5.0 Material and energy, 5.5.2 Heat condcutor, Determin the temperature of human body; boiling water, and air inside and outside of classroom (Integrated Science Curriculum 2013)	
Rationale:	In this lesson, learners are expected to acquire the skill in measuring an air temperature.	
Specific Outcome	Measuring an air temperature in degree of celcious by reading a thermometer	
Pre-requisite:	Experience of the change in an air temperature with changes in time (Morning, afternoon and night, inside and outside of classroom)	
Approach	Student's experience and inquriy-based approach	
Lesson process		
Stage	Teaching and Learning Activity	Learner's activity/Learning Points
Introduction (8 min)	Teacher tells students that "How did you feel this morning? I felt cold and how about you?" Then teacher asks that "How do you think is it hotter or colder this afternoon?" After waiting for students' answers, teacher provides his idea. It may be hotter in this afternoon than in the morning.Then teacher asks students: "what should we measure to show that my idea is true scientifically?" After waiting for students' answer, Today we learn how to measure a temperature using some device (write on a blackboard). Depending on the student number, they are divided into gorups (2-3 students/group)	Listening to teacher Thinking teacher's question and answering Expected answer: Cold or very cold Expected answer: Thermometer
Development, Step 1 (15 min)	Teacher draws the picture of thermometer. And then teacher asks students "Do you know the name of device to measeure a temperature?" Please tell me and then write its name in English and Chitonga on your notebook. After students answer and write the name of device on a notebook, showing a big thermometer teacher explain working principle of thermometer by a physical activity to indicate up and down of indicater of thermometer with increase and decrease in a temperature. Then teacher explain how to read graduation of a thermometer.	Students answer to each question
Development, Step 2 (10 min)	Teacher draw four kinds of indication of thermometer on a blackboard. Then teacher ask students to answer to the question of "Please read a thermometer and write the temperature in degree of centigrade on your notebook". After monitoring that they write the temperature for each thermometer, teacher pick up one student and ask him or her to write his or her answer on a blackboard for each picture of thermometer.	One student who is picked up by teacher presented his or her answer to each question.
Conclusion (7 min)	Teacher asks students following questions and write their answer on a notebook. 1) What is the name of apparatus for measuring an air temperature? 2)[After drawing the picture focused on the part of temperature of big thermometer on a blackboard] What is the temperature in our classroom? Please tell me the temperature in degree of centigrade.	Thinking answer based on their learning so far in this lesson and tell his or answer to teacher.

2-Teaching tips

- Instead of drawing a thermometer on a blackboard, teacher can use the chart on which four thermometers are depicted, as given in Figure Nine.

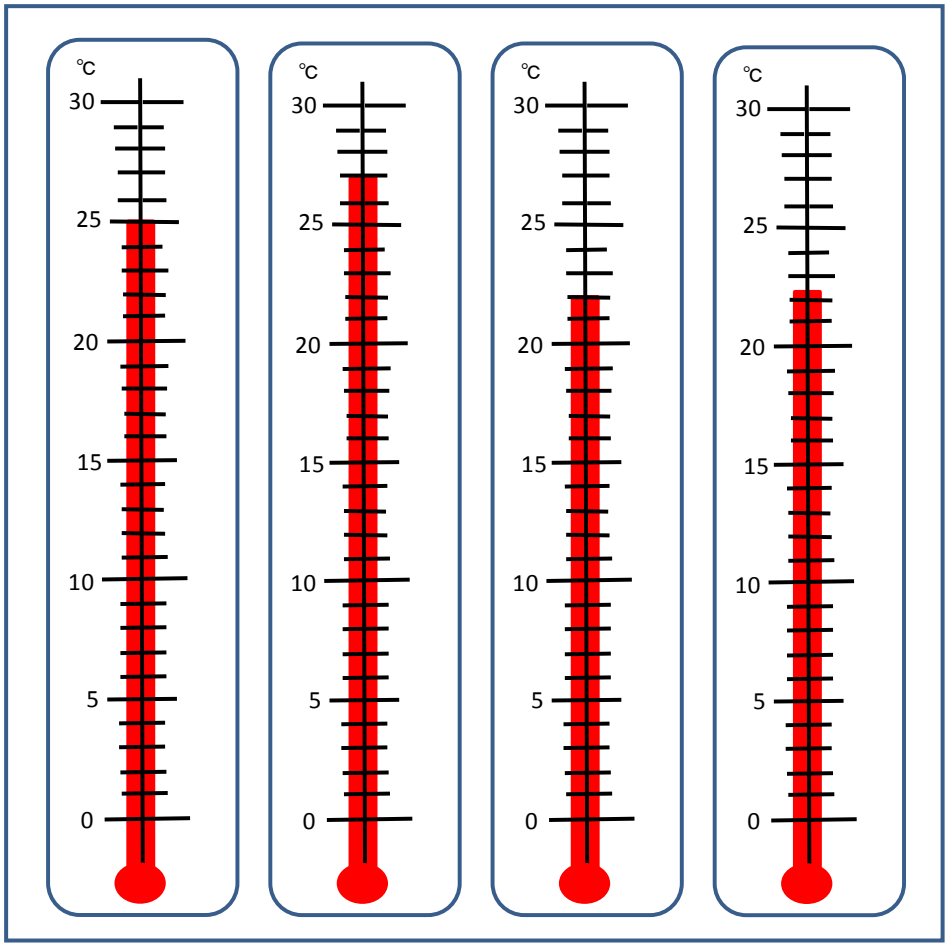


Figure Nine: Chart depicted four thermometers

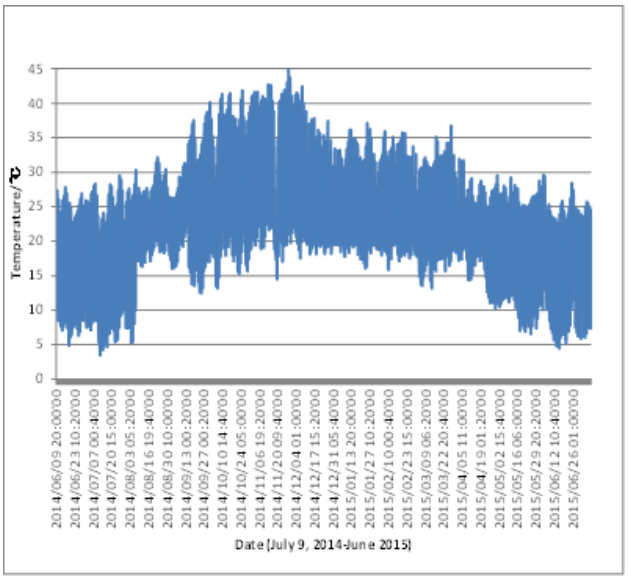
- The fourth one may be difficult for students to read a temperature, since the upper end of indicator is between grades. Teacher should emphasize that the temperature is between 22 and 23 degrees of centigrade and it is necessary to estimate the value with the eye.

- This lesson could be easily linked with mathematics lesson for data processing: Making table and graph of daily, monthly or annual change in air temperature, and reading its meaning from table or graph or calculating the difference between daytime and night, or daily, monthly and annual average of air temperature).

- Supplementary material for learning of measuring temperature: Annual change in the air temperature in a rural area of Zambia (June 2014-July 2015)

We recorded consecutively (in every 20 min) in three schools (two of them: inside of head teacher's office, the other one: outside of school building) from June 2014 to July 2015 using a data logger. Figure (Indicated below) shows one of example of annual change in the outside air temperature at one of three collaborating school.

The details in air temperature data are saved electronically in a flash memory for each school as one of supplementary materials. We hope these data provide the basic data for the lesson of site-specific environmental education in schools in a rural area of Zambia.



Change in the air temperature (outside of school)

The table (indicated below) shows the annual average, lowest and highest temperature in each school. Highest and lowest temperature was recorded in December and July, respectively.

Table: Average, highest and lowest air temperature in a rural area of Zambia

	1st School	2nd School	3rd School
Average Temp. /℃	23.1	24.2	21.7
Highest Temp. /℃	38.7	37.6	45.0
Lowest Temp. /℃	10.2	12.0	3.5

1st and 2nd school : Inside head teachers' office; 3rd school : Outside of school building

3.2.4 How to observe a tree?

1-Lesson flow

Time	Teacher's activity	Students' activity
0-5	1-Self-introduction and explaining the aim of this lesson: Learning how to observe tree scientifically 2-Before giving worksheet, asking students to prepare a pencil or ball point pen. 3. Giving the worksheet to each students, and then explain the worksheet: Worksheet is printed in its both sides, please look at the page of 5 photos of trees and then please write your grade and name at the upper part of this page. 2-Explaining the "Example" of worksheet. How to get the outline of tree	Listen to a teacher
5-30	1-Asking students to do exercise-1 and then showing teacher's idea of outline of trees in four photos. 2. Asking some students to come in front and draw the the shape/outline of trees in four photos on the blackboard. 2-Asking students to go outside and then to do exercise- 2 (Observing for some distance away from the tree). 2-Checking students' works and telling them how to do, as necessary.	Doing exercise-1 and exercise-2 and if confusing, asking teacher how to do.
30-35	1-Asking students to do exercise-3, observing, touching the stem of tree. 2-Checking students' works and telling them how to do, as necessary.	Doing exercise-3 and if confusing, asking teacher how to do.
35-45	1-Asking students to share their works with classmates. 2-Asking students to express the outline or shape of tree that they observed using their own body. 2-Asking students to write their findings	Sharing their works with classmates. Expressing the outline/shape of tree using their own body. Confirming the home work: Writing findings

2-About lesson

2.1 Aim of activity

1.1 The primary aim of this activity is not to define or find out the name of tree but to raise students' interest in trees around them.

1.2 Students could learn through this lesson as follows;

1.2.1 Knowledge

- There are trees that are different in their shape and characteristics of bark

in the nature of target area. It hopefully encourages students' awareness of biodiversity.

1.2.2 Skill

- Students learn the way of drawing a tree
- Students learn how to observe a tree based on its outline and characteristics of bark.

1.2.3 Attitude

- Students become to be interested not only in trees but also in the other natural objects.

2. The application/linkage of this lesson to subjects

2.1 This lesson could be applied as the first/introductory lesson for the learning of plant in Integrated Science and/or "Importance of a forest" in SDS to attract students' attention to plant and/or forest.

2.2 This lesson could be linked to the learning of soil and water through the following questions;

What is the role of soil for a tree?; What is the role of water for a tree?

3-Teaching tips

- If the worksheet is not available because of lack of resources including a printer, copy machine and paper, please make the chart based on the worksheet and request students to write their answer on their notebook. The worksheet is indicated in pp.20-21.

- The sharing of works at the end of lesson could be deleted if students do not get used to share their works with their classmates.

- Students may confuse what they should do when asking students to write their findings. Thus teacher asks students that "What did you do in this lesson?" or summarizes the lesson briefly. Moreover teacher may ask "Are you enjoy the lesson? " or "If you enjoyed the lesson, what is the most exciting part in this lesson?" Then teacher asks students to write those things instead of findings on a notebook.

Lesson title: Tree Observation-Worksheet

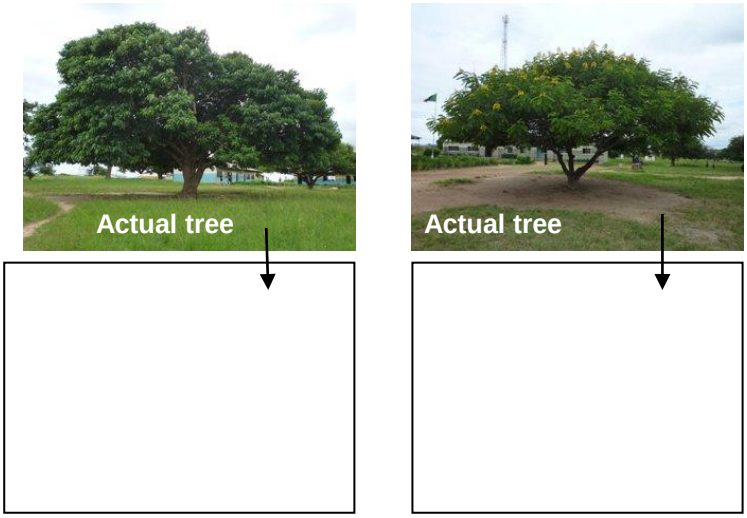
Grade _____ Name _____

1. Observing and drawing the outline of tree.

1.1 Example: Observing a tree from some distance away to get the "Outline" of the tree. Outline is rough shape, as indicated below;

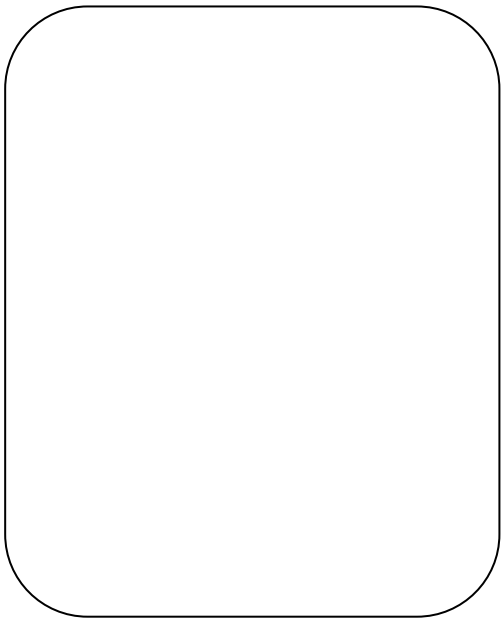
Real Tree Outline/shape of Tree

1.2 Exercise-1 : Please draw the "Outline" of the trees in the following photos.



1.3 Exercise-2: Please select one tree/group around your school, and draw the

outline/shape of the tree observing your group's selected tree from some distance away;



Outline of selected tree

2. Observing the bark of your group's tree

Exercise-3: Then please close to your selected tree, please investigate and write the color, hand feeling and pattern of its bark in the following space;

Color	Hand feeling	Pattern

5. Please express the outline/shape of tree using your body.

6. Please write your findings in this activity in the following space;

4. Structure of environmental education program and its

relationship with ESD

4.1 Structure of EE program

In order to develop EE program, we arrange our research outcomes including lesson plans, environmental quality data on an air temperature, indigenous knowledge of Mukuyu in relation to the life environmental elements of target area and structuralize EE program focusing on water as its theme, as given in Figure Ten.

The data on water quality will be also available as part of EE program as an additional lesson how to monitor the water quality in a daily basis using five senses, as shown in Appendix.

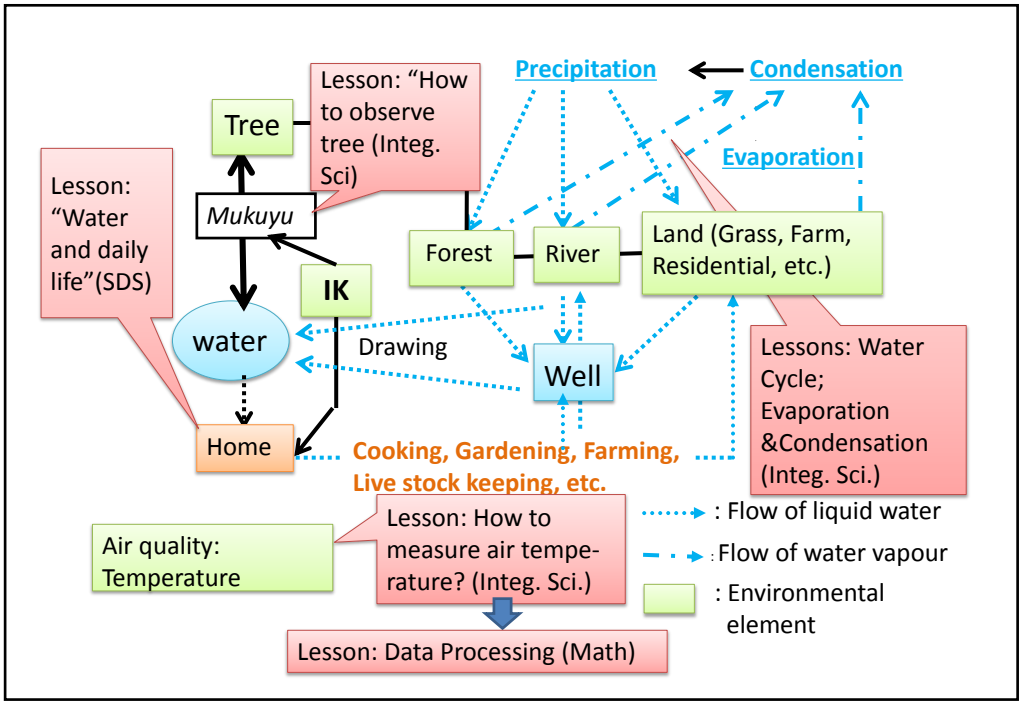


Figure Ten: Structure of EE program

4.2 The relationship of learning from four lessons in EE program with ESD

Table One (p.23) shows the relationship of learning emerged from four lessons in EE program with ESD based on the definition of each pillars of learning as mentioned earlier (Figure One in p. 5). Table One is applicable to characterize and evaluate students' learning in four lessons from the ESD perspective.

Table Two: The relationship of learning from four lessons in EE program with ESD

Lesson	Four pillars of learning as a frame of ESD			
	Learning to know	Learning to do	Learning to be	Learning to live together
Water in daily life	-Importance of water in human life. Because it is used in the various ways in a daily life	-Expressing his or her idea by drawing -Sharing his or her idea with others by presentation	-Responsibility for the family in his or her role of drawing water -Self-usefulness as a family member	-Importance and responsibility of them for water issues for his or her community
Water cycle –condensation and evaporation	- Basic and scientific mechanism of precipitation	-Thinking rain based on scientific concept	-Relationship between his or her daily life experience in terms of rain to the science of raining	-Raining and its impact to the life of people in community
How to measure an air temperature?	-Temperature can be measured by a thermometer	-Reading the temperature from a thermometer	-Relationship between his or her daily life experience in terms of change in environmental quality based on scientific data	-Change in an environmental quality and its impact to the life in community
How to observe tree?	-A tree can be characterized its shape in combination with the color, hand feeling and pattern of the bark	-Observing a tree systematically using senses of sight and touch	-Relationship and meaning of tree in his or her everyday life issues	-Importance and responsibility for tree issues for his or her community

Appendix: Water quality test using five senses

Flow of lesson

Time	Facilitator's activity	Student's Activity
13:00-13:02	1-Self-introduction of facilitator 2-Requesting students to put PET bottle of water that they bring from their home village on a desk.	1-Listening to self-introduction
13:02-13:10 Brain storming of water	1-Asking following questions; Q1: What is scientific nature of water? Q2: How is water used in your life? Q3: What is the relationship between water and your health? 2-Writing students' answers on a blackboard that is divided into two parts; Q1 | Q2 | Q3	1-Answering the questions
13:10-13:15	1-Summarizing the student's answer primarily focusing on the linkage of scientific nature of water with the water in daily life: Cooking, Health, Washing and so on.	1-Listening to facilitator's summary carefully
13:15-13:18 Testing water using visual, olfactory and taste senses.	[Observation of Clearness of Water by Eyes] 1-Requesting students to observe clearness of water in their own PET bottles and record the result in a worksheet.	1-Observing clearness of water in their own PET and record the result in a worksheet by three scales: Clear, Slightly Clear, Not clear
13:18-13:21	[Observation of Precipitates/Sediments in Water by Eyes] 1-Requesting students to observe where there are some precipitated substances at the base of their own PET bottle and record the results in a worksheet.	Observing whether there are precipitates/sediments at the base of their own PET and record the result in a worksheet by three scales: No precipitates/sediments, Some amount of precipitates/sediments but not big amount, Big amount of precipitates/sediments
13:21-13:26	[Observation of Scent of Water] 1-Giving the one plastic cup to each student and telling them to put your own water from your home into a plastic cup. 2-Requesting students to smell the water in their own PET bottle and record the results in a worksheet.	Smelling the water and record the result by three scale; No smell, Slight smell, Strong smell
Time	Facilitator's activity	Student's Activity

13:26-13:29	[Tasting water] 1-Requesting students to taste the water in their own PET bottle and record the results in a worksheet.	Tasting their own water and record the result by three scale; No taste, Slight taste, Strong taste
13:29-13:40 Summarizing the results	[Summarizing Results in a Table] 1-Telling the students that we will make a table to share and summarize the results from their observation. 2-Drawing the table on a blackboard (Table is indicated in p.29)	Drawing the table on the backside of worksheet.
13:40-13:45 Conclusion from the observation	[Conclusion] 1-Requesting students to make conclusion based on the results of the table by asking what conclusion you can make from this table of observation results. Please write your results on a worksheet.	Writing the conclusion on a worksheet.
13:45-13:55	Demonstration of Instrumental Analysis of Water: pH meter and Electrical Conductivity 1-Demonstrating how to measure pH that is representing hydrogen ion concentration of by conventional pH meter and conductivity* that is indicating the total amount of ions in water. 2-Measuring pH and conductivity of commercial water and the water from BS well.	Looking at the demonstration.
13:55-14:00	Summary of lesson: 1- Water is one of the most important substance in our daily healthy life (cooking, washing, drinking) , agriculture and industry. 2- We observed water with our senses: seeing, smelling and tasting. It is useful to monitor water quality in a daily base.	Listen to the summary by facilitator carefully

*pH is the indicator of hydrogen ion concentration in an aqueous solution: The higher the hydrogen ion concentration, the lower the value of pH.
**Conductivity measurement is the method for measuring the flow ability of electric current (unit: Siemens: S, its value is the inverse number of electrical resistance) in an aqueous solution: The more ions in water, the more electric current can flow and then the higher the conductivity.

Name _____ Grade
☐Female ☐Male

Name of Village Where You Got Your Water: _____

Please check(✓) in ☐ that fit to your observation result

1. Clearness of Water
   ☐ Clear ☐ Slightly clear ☐ Not clear

2. Precipitate/Sediment in Water
   ☐ No precipitate/Sediment
   ☐ Some amount of precipitates/sediments but not big amount
   ☐ Big amount of precipitates/sediments

3. Smell of water
   ☐ No smell ☐ Slight smell ☐ Strong smell

4. Taste of water
   ☐ No taste ☐ Slight taste ☐ Strong taste

Please draw the table on the backside of this worksheet.

5. Your conclusion

Table of Observation Results

Name of site where you got water	Clearness	Precipitate/ Sediment	Smell	Taste