

INTEGRATION OF EDUCATION FOR SUSTAINABLE DEVELOPMENT (ESD) INTO MIDDLE SCHOOL SCIENCE TEACHING THROUGH LESSON STUDY

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Abstract

The purpose of this study was to introduce the integration of Education for Sustainable Development (ESD) concept into middle school science lessons through lesson study. Four teacher educators from Sagaing University of Education and Sixteen middle school teachers from four basic education schools in Sagaing Township participated in this study. Using adapted Dudley (2014)'s lesson study cycle process, lesson study of science lessons from Grade Six science textbooks was conducted. Both Qualitative and Quantitative methods were used and data collecting instruments were semi-structured interview, observation and achievement test. Results of the initiated lesson study significantly indicated that there are improvements of science teaching learning process in terms of teachers' content knowledge, teaching methodology, and student achievement. As part of participating in interactive lesson study cycles, teachers became more aware of ESD concepts in science lessons and began openly reflecting on students' participation around science activities during their post-lesson discussions. Although lesson study improves teachers' professional development with teacher collaboration and student achievement, on the other hand, the teachers are still unfamiliar with ESD themes and they need to understand ESD concepts more clearly. Therefore integration of ESD concepts into science lessons is a difficult task for teachers and there are many challenges for implementing the integration of ESD into science teaching.

Keywords: education for sustainable development, middle school teachers, lesson study

Introduction

Education is an essential tool for achieving sustainable development and the role of teachers, in turn, is central to implement Education for Sustainable Development (ESD). The teachers therefore need to understand the ESD concepts and have ESD practices. With regards to ESD concept, there is a difference between education about sustainable development and education for sustainable development. The former is an awareness lesson or theoretical discussion and the latter is the use of education as a tool to achieve sustainability (Mckeown, 2002). Development is a holistic approach in which people systematically enhance their capacity to solve their own problems while promoting their cultural, social and economic well-being. Sustainable development occurs when this process is conducted in a manner that can be sustained over a long term (Wiltshire, 2008). Young people are the future and teachers play a key role in the appropriate socialization of young people for sustainable development. To equip teachers to function effectively for the appropriate socialization of young people, they have to understand what ESD is and how it can be implemented. ESD is a complex and evolving concept. It is therefore impossible to attempt to understand ESD by providing a simple definition. Moreover, different cultures and societies perceive sustainable development in many different ways. A more meaningful way to understand ESD is to examine its rules, principles and value, and methods used in its delivery (NZ AID, 2009). ESD is already a part of the formal education. Depending on each country's historical background and educational perspectives, various approaches or strategies exist around the world to integrate ESD into formal education. Approaches vary from

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more conventional, for example integrating ESD concept and SD issues in existing school subjects, to more innovative one, for example adopting a whole school approach to ESD and SD issues (Wals, 2009). According to the previous baseline survey research, the teachers still require to understand more ESD concepts and to do ESD practice with ESD teaching approaches. Therefore this study aimed at introducing the conventional approach, i.e. integrating ESD into existing middle school science subject.

Aim and Objectives of the Research

The aim of this study is to introduce the integration of ESD concepts into teaching middle school science teaching and specific objectives are:

- To integrate ESD concepts into existing middle school science topics through Lesson Study
- To investigate the middle school science teachers' teaching skills addressing ESD
- To investigate the improvement of students' science achievement
- To suggest the teachers to use Lesson Study in their science teaching

Definition of Key Terms

Sustainable Development - development that meets the needs of the present without compromising the ability of future generations to meet their own needs (UNESCO, 2012)

Education for Sustainable Development - the process that seeks to integrate values and perceptions of sustainability into not only education systems but one's everyday personal and professional life (Wals, 2009)

Lesson Study - An approach in which groups of teachers collaboratively plan, teach/observe and analyze their teaching (Dudley, 2014)

Review of Related Literature

Sustainable Development and Sustainability

In 1987, the Brundtland Commission Report described the concept of sustainable development as development that meets the needs of the present without compromising the ability of future generations to meet their own needs. The sustainability is a paradigm for thinking about a future in which environmental, social and economic considerations are balanced in the pursuit of development and an improved quality of life (UNESCO, 2012).

The New Zealand Parliamentary Commission for the Environment (UNESCO, 2010) explains that: Sustainability is the goal of sustainable development and it is an unending quest to improve the quality of people's lives and surroundings, and to prosper without destroying the life-supporting systems on which current and future generations of humans depend. Like other important concepts, such as equity and justice, sustainability can be thought of as both a destination and a journey. To live sustainably means finding ways of developing which will improve everyone's quality of life without damaging the environment and without storing up problems for future generations or transferring them to people in other parts of the world. It requires an understanding that inaction has consequences and we must find ways to innovate and change at all levels within society.

Concepts of Sustainable Development

UNESCO has also described the concepts of sustainable development which are important concepts to include in education systems oriented towards sustainable development as follows:

Interdependence: People are an inseparable part of the environment. We are part of a system that connects individuals, their culture, their social and economic activities and their natural surroundings.

Diversity: The Earth and all its inhabitants are characterized by great variety – biologically, culturally, linguistically, socially and economically. We need to understand the importance and value of each of these forms of diversity to the quality of human life and the health of ecosystems.

Human rights: Everyone has an inalienable human right to freedom of beliefs, speech, assembly and protection under the law, as well as to the conflicts that enable them to act on these rights such as access to basic education, food, shelter, health and equal opportunity.

Global equity and justice: This principle is called intra-generational equity and emphasizes that the rights and needs of others are met so that a fair and abundant quality of life is provided for everyone around the world.

Rights of future generations: This principle is called inter-generational equity. It emphasizes that the lifestyle choices we make today always affect the capacity of future generations to have the same range of choices we have.

Conservation: The natural world contains a range of renewable and finite resources that humans can develop to satisfy their needs. The lifestyle choices we make need to respect the long-term sustainability of these resources, and the need for conservation of nature for its intrinsic worth, not only its utilitarian value.

Economic vitality: Economic growth depends upon a dynamic state of economic vitality in which everyone has the opportunity and skills to access the resources required for a satisfying quality of life, within a framework of sustainable development.

Values and lifestyle choices: Values that reflect concern for human well-being, economic vitality and the quality of the environment are required to ensure that we make lifestyle choices that contribute to a sustainable future for everyone.

Democracy and civic participation: People are more inclined to care for others and the environment when they have the right, the motivation and the skills to participate in the decisions that affect their lives.

Precautionary principle: Sustainable development issues are complex, and scientific advice on an issue is often incomplete or divided. In situations of such uncertainty, there is a need to act judiciously and with an awareness of potential unintended consequences.

Therefore the role of Education for Sustainable Development is to integrate these concepts and abilities into education, training and public awareness systems at all levels and in all sectors of society.

Education for Sustainable Development

According to the many reports on ESD providing a variety of definitions which share common elements but are subtly different, Wals (2009) defined ESD as:

- a means of empowering people with new knowledge and skills to help resolve common issues that challenge global society's collective life now and in the future;
- a holistic approach to achieve economic and social justice and respect to all life;
- a means to improve the quality of basic education, to reorient existing educational programmes and to raise awareness.

In 1992, the United Nations Conference on Environment and Development, held in Rio de Janeiro, resulted in a publication Agenda 21. Chapter 36 of Agenda 21 on education identifies four major thrusts: Improving quality of education; Reorienting existing curriculum to address sustainability; Increasing public understanding and awareness of sustainability; Providing training to all sectors of the workforce towards sustainability (Mckeown, 2002).

Components of ESD

ESD is more than a knowledge base related to environment, economy, and society. It also addresses learning skills, perspectives, and values that guide and motivate people to seek sustainable livelihoods, participate in a democratic society, and live in a sustainable manner. ESD also involves studying local and, when appropriate, global issues.

Knowledge: Sustainable development encompasses environment, economics, and society. Therefore, people need basic knowledge from the natural sciences, social sciences, and humanities to understand the principles of sustainable development, how they can be implemented, the values involved, and ramifications of their implementation. Some basic knowledge people need to have:

- Rates of use of renewable resources do not exceed their rates of regeneration.
- Rates of use of nonrenewable resources do not exceed the rate at which sustainable renewable substitutes are developed.
- Rates of pollution emission do not exceed the assimilative capacity of the environment.
- Minimize the use of nonrenewable resources.
- Prevent erosion of renewable resources and so on.

Issues: ESD focuses largely on the major social, economic, and environmental issues that threaten the sustainability of the planet. Earth Summit in Rio de Janeiro identified the key issues in Agenda 21. Some are:

- Population and sustainability, Protecting and promoting human health, Changing consumption patterns,
- Combating deforestation, Protecting the atmosphere, Conservation of biological diversity,
- Strengthening the role of farmers and so on.

Skills: To be successful, ESD must give people practical skills that will enable to continue learning after they leave school, to have a sustainable livelihood, and to live sustainable lives. The types of skills pupils need as adults are:

- The ability to communicate effectively (both orally and in writing).
- The ability to think about systems (both natural and social sciences).
- The ability to think critically about value issues.
- The capacity to move from awareness to knowledge to action.
- The ability to work cooperatively with other people (McClaren, 1989, as cited in Mckeown, 2002).

Perspectives: ESD carries with it perspectives that are important for understanding global issues as well as local issues in a global context. Every issue has a history and a future. Looking at the roots of an issue and forecasting possible futures based on different scenarios are part of ESD. Some of the perspectives associated with ESD students understand are:

- Social and environmental problems change through time and have a history and a future.
- Contemporary global environmental issues are linked and interrelated between and among them.
- Humans have universal attributes (e.g., they love their children).
- Considering differing views before reaching a decision or judgment is necessary.
- Technology and science alone cannot solve all of our problems, etc.

Values: Values are also an integral part of ESD. Understanding values is an essential part of understanding one's own worldview and other people's viewpoints. Understanding one's own values, the values of the society he lives in, and the values of others around the world is a central part of educating for a sustainable future. For example, Respect and care for the community of life, Ecological integrity, Social and economic justice, etc.

Therefore, these five must all be addressed in a formal curriculum that has been reoriented to address sustainability (Mckeown, 2002).

Integrating ESD in Teacher Education

The guide book (UNESCO, 2018) describes that ESD empowers learners to take informed decisions and responsible actions for environmental integrity, economic viability and a just society, for present and future generations, while respecting cultural diversity. It is about lifelong learning, and is an integral part of quality education. ESD is holistic and transformational education which addresses learning content and outcomes, pedagogy and the learning environment. It achieves its purpose by transforming society. To integrate ESD,

Learning content: Integrating critical issues, such as climate change, biodiversity, disaster risk reduction (DRR) and sustainable consumption and production (SCP), into the curriculum;

Learning outcomes: Stimulating learning and promoting core competencies, such as critical and systemic thinking, collaborative decision-making, and taking responsibility for present and future generations;

Pedagogy and learning environments: Designing teaching and learning in an interactive, learner-centered way that enables exploratory, action oriented and transformative learning. Rethinking learning environments – physical as well as virtual and online – to inspire learners to act for sustainability;

Societal transformation: Empowering learners of any age, in any education setting, to transform themselves and the society they live in:

- Enabling a transition to greener economies and societies, i.e., equipping learners with skills for green jobs and motivating people to adopt sustainable lifestyles.
- Empowering people to be global citizens who engage and assume active roles, both locally and globally, to face and to resolve global challenges and ultimately to become proactive contributors to creating a more just, peaceful, tolerant, inclusive, secure and sustainable world.

In UNESCO guide book, the earlier attempts at integrating ESD in schools and educational institutions at all levels have been described.

Examples of current curriculum mainstreaming practices are:

- Creating a standalone ESD-specific subject;
- Embedding ESD in existing subjects or across the curriculum;
- Adopting a thematic, issue or problem-based approach like climate change, air pollution, deforestation etc., based on the local realities;
- Incorporating the use of teaching and learning methodologies consistent with ESD principles of learner-centered and participatory approaches, such as field trip;
- Conducting ESD-based co-curricular or extra-curricular activities, such as the use of student clubs and associations and activities;
- Engaging with the local community, often through project-based learning opportunities.

In this study, integrating ESD into middle school science topics was implemented through Lesson Study.

Lesson Study (LS)

Lesson Study is a highly specified form of classroom action research focusing on the development of teacher practice knowledge. Lesson Study involves groups of teachers collaborative planning, teaching/observing and analyzing teaching and learning in research lessons. It blends all the features of professional learning that improve learning and teaching: the professional learning takes place over time; it happens in real classrooms with real group; it involves an element of collaborative enquiry or experiment between teachers who are trying to solve a problem or improve an approach (Dudley, 2014). He also argues that lesson study helps teachers to:

- See pupil learning occurring in much sharper detail than is usually possible.
- See the gaps between what they had assumed was happening when pupils learned and what it is actually happening.
- Find out how to plan learning which is better matched to the pupils' needs as a result.
- Do all this in the context of a supportive teaching learning community which is strongly committed to helping pupils to learn and to the professional learning of the members of the group.
- Change their teaching to better support learning as a result.

A Lesson Study consists of a cycle of at least three research lessons that are jointly planned, taught/observed and analyzed by a Lesson Study group as shown in Figure 1.

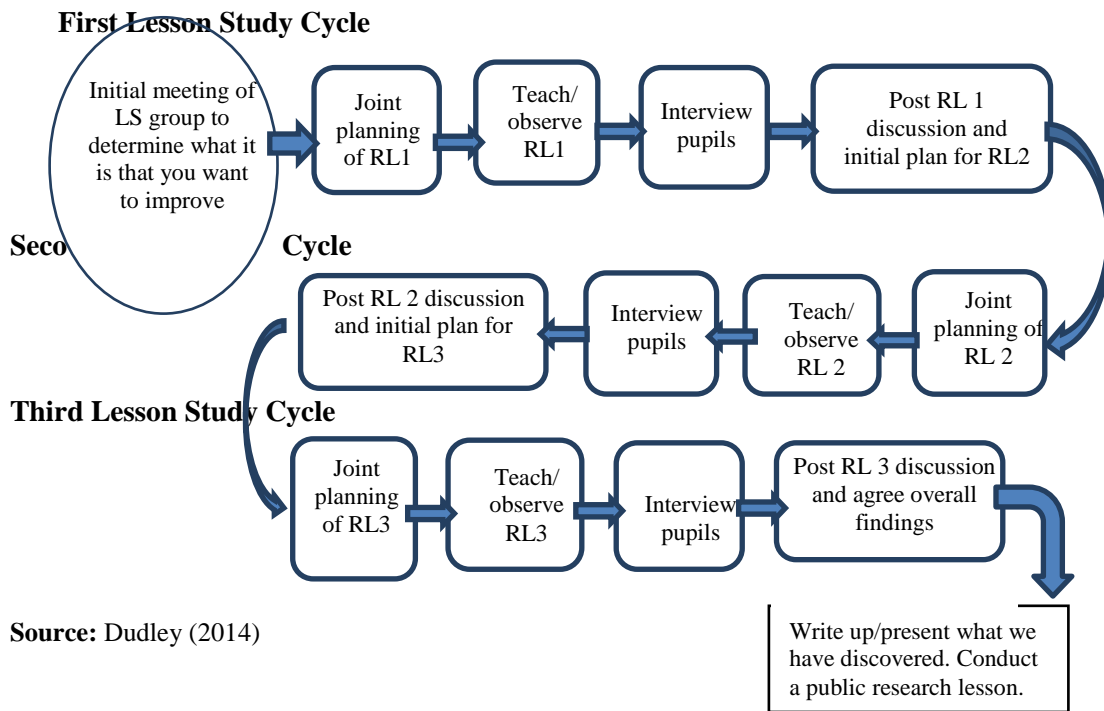


Figure1 The Lesson Study Process

Although Dudley’ Lesson Study process consists of three research lessons, this study was conducted with two research lessons. Using the following adapted balanced focus on pupil learning research lesson, Lesson Study groups jointly plan, teach /observe and analyze the science lessons.

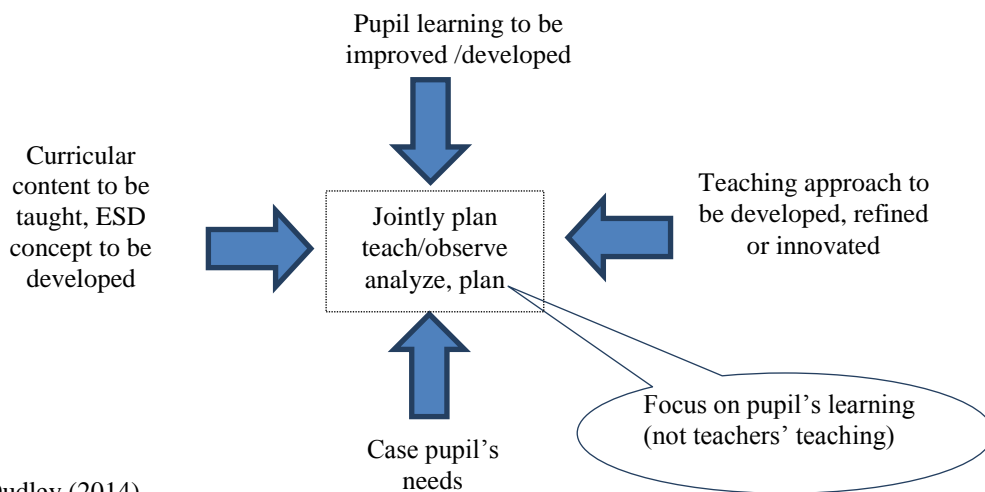


Figure 2 The adapted balanced focus on pupil learning in ESD research lesson

Materials and Method

Method

In this study, Qualitative (Case study) and Quantitative methods were used.

Participants

Four teacher educators from Sagaing University of Education and sixteen junior teachers from four basic education schools in Sagaing Township participated voluntarily in this study.

Instruments

Data collecting instruments were semi-structured interview, observation and achievements test items. Four semi-structured interview questions were for focus group teachers and two questions for post lesson interview with the case pupils. Three questions were for observation in the classrooms and 20 items for grade six students' academic achievement.

Procedure

The relevant literatures were studied and referred to explain ESD concepts, to introduce examples of good practices on ESD, and to help in preparing lesson study activities which the teachers can use to enhance their understanding of the topics in ESD such as the importance of trees/plants for survival, interdependence, renewable energy, and environmental pollution, etc. Lesson Study group consisted of four teacher trainers from Sagaing University of Education, and sixteen junior teachers from four basic education schools. Among them, four teachers did not participate in observing the classroom teaching because they had to teach primary classes in parallel. In conducting lesson study, Dudley (2013, as cited in Dudley, 2014)' lesson study cycle process: Plan;Teach; Observe and Reflect/ Post lesson discussion, was used. In planning step, teacher educators facilitate the participants in formulating goals to be achieved or identifying problems to be solved, selecting science lesson topics, identifying lesson objectives, preparing teaching learning materials and creating learning activities, constructing post-test questions, observation sheets. Lesson study group members selected two model teachers to teach the research lessons and the rests were observers, and also identified the case pupils who were might typify different groups of learners in the class (pupils who are making good, average or below average progress in academic achievement). The case pupils were interviewed at the end of lesson. Finally, the lesson study group members conducted post lesson discussion and reviewed the research lesson, refined it and taught as lesson study cycle 2 to the next class. The lesson study group members agreed to conduct the lesson study by the following schedule as in Table 1.

Table 1: Lesson Study Program for Middle School Science Lessons integrating with ESD

<i>Learning objectives:</i>	
The teachers will be able to plan and teach the science lessons integrating with ESD	
Day 1	<ol style="list-style-type: none"> 1) Reflecting workshop experiences: ESD themes; knowledge, attitude, skills, perspective and value and identifying issues to be concerned in their teaching-learning situation 2) Selecting science topics based on the monthly plan prescribed in teacher's manual 3) Dividing the participants into two groups
Day 2	<ol style="list-style-type: none"> 1) Identifying learning objectives for science contents and as well as for ESD 2) Constructing items for student assessment at the end of the lesson 3) Identifying teaching/learning materials and activities to be used during the lesson 4) Preparing observation checklist
Day 3&4	<ol style="list-style-type: none"> 1) Preparing teaching/learning materials 2) Reviewing to the learning objectives, materials, activities, assessments worksheets
3 rd & 4 th week	Implementing research lessons in two classes by each group

Findings

Research results are presented in four parts: results for lesson study planning, student academic achievement, post lesson focus group discussion, and post lesson case pupil interview.

Lesson Study Planning Step

Teachers in the schools involved in this study were deeply concerned about the issues such as lack of student interest in learning, lack of creating learning activities which encourage student participation and being not enough teacher questions that prompt student's critical thinking. Therefore, as their overall goal for Lesson Study, the teachers identified the following:

“To create learning activities and materials which stimulate student interest, and help the improvement of student participation”

The teachers noted that their traditional teaching techniques: explain the text content orally; ask students to read the text, and then give the exercises already existed in the textbook need to be changed. One teacher said that they never ask any questions that evoke the student thinking. Within the meeting, teachers agreed on the following over-arching goal:

“To make questions that prompt student critical thinking”

Keeping these goals in their mind, the teachers planned their research lesson of the topics which have been selected in accordance with their monthly plan for this academic year. They identified the learning objectives for each science lesson integrating with ESD. The selected topics and the respective learning objectives are described in Table 2.

Table 2 Selected topics of Middle School science lessons integrating with ESD

Grade/Topic	Learning Objectives
Grade six Malleability and Ductility of Matters	- Students understand the concepts by experimenting themselves and reflect on how these properties of metals can be utilized in their daily lives.

The lesson Study groups referred to the suggested questions (Shuilleabhain, 2015) to be used for observation and for post lesson case pupil interview and the posttest questions.

Questions for focus group discussion at the end of the research lesson

1. Was the flow of the lesson coherent and did it support student's learning of the concept?
2. Were the activities and the materials helpful in achieving the goal of the lesson?
3. Did the group discussion help promote student understanding?
4. Did the teacher's questions engage and facilitate student thinking?

Questions for post lesson interview with the case pupils

1. What did you enjoy most about that lesson?
2. What did you learn? (What can you do now that you could not do? What can you do better? How is it better?)

Post-test items were based on the textbook exercises.

During the lesson (physical properties of metals: malleable and ductile), three main activities were provided Grade six students to:

- 1) Study the physical properties of objects by hammering and identify them metal or non-metal
- 2) Experiment on the concepts 'malleable and ductile' with metals such as Copper wire (which is pulled into thin and longer one), and a piece of Lead (which is hammered into thin sheet).
- 3) Classify the given objects into metals and non-metals and then students had to give things made of metals which are used in their daily lives (e.g., Gold, Silver, Copper, Brass, etc.).

Student Achievement

After the lesson, post-test (Grade six) was administered immediately.

The students' learning outcomes from the post-test are as indicated in Table 3.

Table 3 Evaluation of student learning outcomes for Grade six

Student Achievement	Day 1 (N=35)	Day 2 (N=48)
Mean (Total)	68.9%	76.4%
Case pupils (High achiever)	92.5%	90%
Case pupils (Average)	75%	76%
Case pupils (Low achiever)	62.5%	82.5%

As indicated in Table 3, average students' academic achievement being immediate assessment, are above 65% in cycle 1, and in cycle 2 their achievement improved to over 75%.

These achievement values were the worth of Lesson Study, collaborative planning, teaching/observing and freely, productive suggestions. In particular, Pupils in low learning groups were discovered to be making an academic success even above the level of average groups in cycle 2 (Day 2).

Post Lesson Focus Group Discussion

During the lesson, each teacher had to observe each case pupil to get information about three events on the questions: (1) How many times did the case pupil ask questions to their teacher or themselves? (2) How many times did the case pupil answer their teacher's questions? (3) How did they participate in the group activity?

From the teacher's observation, it was found that some pupils asked questions to their teacher. For example, one common question is "*Sayagyi, what is this?*" (Given materials) They then answered themselves what they thought. And the teachers observed that there is no pupil who did not answer their teacher's question although the numbers of time are not the same.

The common utterance of the observer teachers was,

"They measure the length of wire themselves...stretch it with plier...then they measure the wire again...I can see their satisfaction on conceptual understanding of the science concept 'ductility of metal' themselves."

The teachers interpreted that they could make their students interested in learning experiences and participated in activities. One of the observer teacher said that almost all students answered their teacher's questions.

In post lesson discussion, one of the teacher, less experienced junior teacher commented,

"Collaborative planning makes me more confident in and satisfied with teaching and learning situation."

One experienced teacher, who was selected as a model teacher said,

"We usually teach the content as prescribed by the textbook... and rarely prepare science activities... this is because I thought it would be time consuming...Now I realize that planning, collaborative planning is worth."

Also he said openly,

"I don't know some chemicals and simple laboratory apparatus, and I've never seen them"

These results indicated that the middle school science teachers' content knowledge and pedagogical knowledge need to be improved.

Post Lesson Pupil Interview

The post lesson pupil interview was conducted at the end of the lesson individually. It took about five minutes. For the question, "*what did you enjoy most about that lesson?*"

Generally the students answered that they enjoyed learning the lesson because they had opportunities to do practical. This means that they learned actively because of hands on activity (learning by doing).

Specifically, one case pupil replied,

“I am very excited in pulling the wire because I think it will be cut, but it become longer.”

Another common response was that “I did answer all questions correctly without doing homework.” Another question, “What did you learn? (What can you do now that you could not do? What can you do better and how is it better?)” Every student replied that they had learned a lot of and they want to do like this next time. However, they could not give the answers clearly on the question of how it is better.

Discussion

In group work, allowing the student time to examine the materials using their senses and to brainstorm ideas of what they find out about the attributes of the materials and asking them to write the properties of the materials, lead to the improvement of student’s critical thinking skill and make the students feel the result of group accomplishment. Critical thinking competency is one of the key competencies for sustainability: the ability to question norms, practices and opinions; to reflect on one’s own values, perceptions and actions; and to take a position in the sustainability discourse. Moreover the student gets collaborative competency. It is also the key competency for sustainability the student must possess. Collaboration competency is the ability to learn from others; to understand and respect the needs, perspectives and actions of others (empathy); to understand, relate to and be sensitive to others (empathic leadership); to deal with conflicts in a group; and to facilitate collaborative and participatory problem solving (UNESCO, 2017).

From case pupil post discussion, the case pupil’s responses (particularly, low achiever but not slow learner) indicated that he could participate in the activities, share his ideas with others in the discussion and do successfully group work. It was found that he was satisfied with his achievement. As a consequence, the students have a sense of self-worth combined with a respect for other individuals and cultures. This quality is also essential for the student who is educated for sustainability (NZAID, 2009).

The teachers participated in this study become realized that they need to help their students have qualities for being a sustainable person. This is because the student who is educated for sustainability has such qualities as a sense of responsibility to the environment, to other people and to the future of both; the will, knowledge and skills to translate this responsibility into action in both personal and public life and a capacity to see the links between individual and group actions and external events (NZAID, 2009). They become understood how ESD teaching strategies (learner-centered) are different from their traditional methods (teacher-centered) and rote learning. Generally, the learning objectives and the overall goals identified during the planning have been achieved. The teachers accepted that they could create the lively learning environment where students discover new things (students did not know before), share ideas, etc. The teachers observed the student interest in learning science

Conclusion

In science teaching, there are many topics related to ESD themes. In this study, the topic, the properties of metals is not directly related to ESD. Even though the topic selected in this study is not directly related to ESD themes such as ecology, health, water, pollution, etc., the teachers could make research lesson for improving students' competencies for sustainability. The aim of this study is to introduce how teachers can integrate ESD concepts into science teaching. It is therefore impossible for the expectation that the teachers will have sufficient teaching competency for sustainability. It would be challenged to implement ESD practices, reorienting education towards quality education. The challenges that Myanmar education system is facing are multi-dimensional, and most of them deal with key concepts in education reform, such as access, quality and equity (MOE, 2016). However, the result of this study was evidence that the teachers could make the science lesson plans which improve the students' competencies for sustainability and that ESD concepts can be integrated into science teaching through Lesson Study. Accordingly, the students will develop key competencies for sustainability which are the essential skills for developing citizens of 21st century.

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