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Innovation lesson plan of fertilizer dilemma story for integrated knowledge practicing through Lesson Study

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Abstract. The paper clarified the developing lesson plan of fertilizer dilemma story for integrated knowledge practicing through lesson study. Through the PD program using lesson study, the theoretical framework of dilemma story was adopted to reference of the developing lesson plan. Methodology regarded paradigm. Participants included primary school teachers as team teachers, supervisors, expertise university lecturer, and school director. The primary school teachers as team teachers include a science teacher, a mathematics teacher, a technology teacher, and an art teacher in Nongsonghong district, Khon Kaen, Thailand. The developing lesson plan of fertilizer dilemma story for integrated knowledge practicing through lesson study will be interpreted through document analysis and participant observation. The innovation lesson plan of fertilizer dilemma story for integrated knowledge practicing could be summarized through the outcomes of lesson study design – plan, see, and reflect. The results provided the overview of the lesson plan of fertilizer dilemma story for integrated knowledge practicing that could be viewed through the structuring questions for ethical dilemma fertilizer story and example of dilemma story chemical fertilizer. This study may have implications for development program for integrate the curriculum in Thailand.

Keywords: fertilizer, dilemma story, lesson study, integrated knowledge STEM curriculum reform.

1. Introduction

Thailand educational reform was developed to support the rapid change in the 21st century. The commitments to the ASEAN Community in 2015 also make human resources for accelerated development to strengthen the country to educate people for a new society and economic organization [1], [2], [17]. Currently, the goals of the whole educational system are to educate Thai citizens as competent, healthy human beings with wholesome minds, intelligence, knowledge, ethics, proper behaviors and cultural life [3] [18].

Ethical dilemma story pedagogy involves teaching strategies that support the engagement of students in values learning in the classroom. Dilemma stories provide opportunities to develop and use the skills of critical and creative thinking for students in the learning area of many subjects, and focus on development content, skills and ethics understanding together. Ethical dilemma stories in the context of education for sustainability help students to develop the knowledge, skills, values, and motivation to respond to the complex sustainability issues they encounter in their personal and working lives. Rather than people being demotivated by an undesirable future that ignores



sustainability issues, education for sustainability encourages a “futures-orientated” attitude that provides motivation for social action (The national education plan (2017-2036)). A framework is provided for a context for teaching in a variety of subject areas and for growth in the use of twenty-first century skills, including critical and creative thinking, collaboration and communication which is similar to the focus of ethical dilemma story pedagogy. Ethical dilemma stories support the teaching of education for sustainability by encouraging students to understand the issue and investigate the fundamental problems behind the issue. Values clarification, the common denominator of ethical dilemma story pedagogy and education for sustainability, focuses on challenging values to enable students to realise a personal connection to sustainability. Ethical dilemma story pedagogy, through the use of a personal story, encourage students to consider a greater range of ethical values and enhance their personal connection to the issue, promote the idea of collaboration and reflection to solve problems, and make a decision. Since this study is based on ethical dilemma story pedagogy with values clarification, it could also be described as an education for sustainability study [4].

Based on the authors’ experiences and conceptualization in the curriculum in Thailand, it can be seen that the curriculum is the target of education, especially for science courses at the primary level which in the past has not been as important as science should not be clearly separated and later separated by focusing on the importance of science in organizing science and learning activities from the past. Up until now studying, researching, experimenting, and inquiry are the heart of learning management. But from education, classrooms, science learning activities, especially in small schools in the countryside, there are still schools that teach science only from Textbook, so it is a challenge for those responsible and especially nowadays, science plays a greater role in human daily life, combined with the advancement of technology, resulting in the education management to be consistent with each era or event and integrate the curriculum.

It is evidenced that students who are involved in integrated learning approach perform equally well as, or better than, students whom are taught in traditional approach [5], [6], [7]. In terms of academic accomplishment, the socio-emotional learning assimilated curriculum assists students to gain higher academic scores. Integrated approach also brings about deeper learning where students further expand their learning from surface level to in-depth level. This learning shift allows students to deepen the understanding of the content and enable them to take charge of their own learning [8].

To develop lesson plan of dilemma story for integrated knowledge practicing, the team teaching need to be formed. And, the authors need to organize the professional development program. In the development and implementation of professional teacher’s development program for integrate the curriculum; the lesson study could be used to organize teachers to do team teaching. The main concept of lesson study is to encourage teachers to work in a group to conduct researches on teaching and learning in a collaborative, systematic, continuous, long-term manner [9]. Intaraprasit [10] expanded the lesson study to be used in various levels including primary, secondary, higher education throughout the region, in particular in the subject of mathematics. Lesson study is also taught to undergraduate and post-graduate students of the Faculty of Education, Khon Kaen University as to broaden their teaching practice by focusing on student-centered approach. In addition, lesson study can build team-working collaboration among teachers in enhancing professional development through teacher-led instruction improvement that leads teachers to process life-long teaching improvement by themselves, even without having experts to keep them study further. By sustaining use of this approach, the outcomes should be evident in a greater achievement of students’ learning [11], [14], [15], [16].

2. Methodology

Methodology regarded paradigm. The developing lesson plan of fertilizer dilemma story for integrated knowledge practicing through lesson study will be interpreted through document analysis and participant observation.

2.1 Participants

Participants included primary school teachers as team teachers, supervisors, expertise university lecturer, and school director. The primary school teachers as team teachers include a science teacher, a mathematics teacher, a technology teacher, and an art teachers in Nongsonghong district, Khon Kaen, Thailand.

Table 1 Participant's general information

Number	Name	Gender	Teaching Subject	Age	Graduate	Years of teaching experience
1	T. Fa	Female	Science	32	Master's Degree	7
2	T.Aom	Female	Technology	26	Bachelor's Degree	3
3	T.Boat	Female	Math	28	Bachelor's Degree	4
4	T.Joe	Male	Art	26	Bachelor's Degree	3

2.2 Method of developing lesson plan of fertilizer dilemma story through lesson study

The lesson plan of fertilizer dilemma story for integrated knowledge practicing through lesson study was developed through a program for professional teachers' development program using lesson study integrate the curriculum. Through the PD program, the following theoretical framework of dilemma story was adopted to reference of the developing lesson plan.

Dilemma is a difficult issue to decide because there are conflicting thinking bases. If you decide on one idea, it may conflict with one another. If you have clear guidelines and decision-making mechanisms will make decisions that are appropriate for each situation. Each situation will make the decision maker not feel guilty or be reprimanded later. The dilemma process in teaching is presented in Figure 1. There are mechanisms to cover the following cases.

- The simple matter is to make a conclusion for the decision to be followed by everyone.
- The issues in specific cases to make guidelines those other teachers can follow.
- The issues are concerned with unconfident learners' person, providing them a mechanism for internal consultation.
- The issue that cannot be concluded in the organization, finding the way to consult the external experts.

According to process of developing lessons, it can be concluded in this study that the implementation of lesson study development mainly consists of 3 steps-including Plan-See-Reflect Cycle as the figure 2. And, the lesson study development implementation was provided the activities and expected outcomes as the table 2.

2.3 Data collection and analysis

The developing lesson plan of fertilizer dilemma story for integrated knowledge practicing through lesson study will be interpreted through document analysis and participant observation. According to the final process of plan, see, and reflect, the innovation lesson plan of fertilizer dilemma story for integrated knowledge practicing will be highlighted.

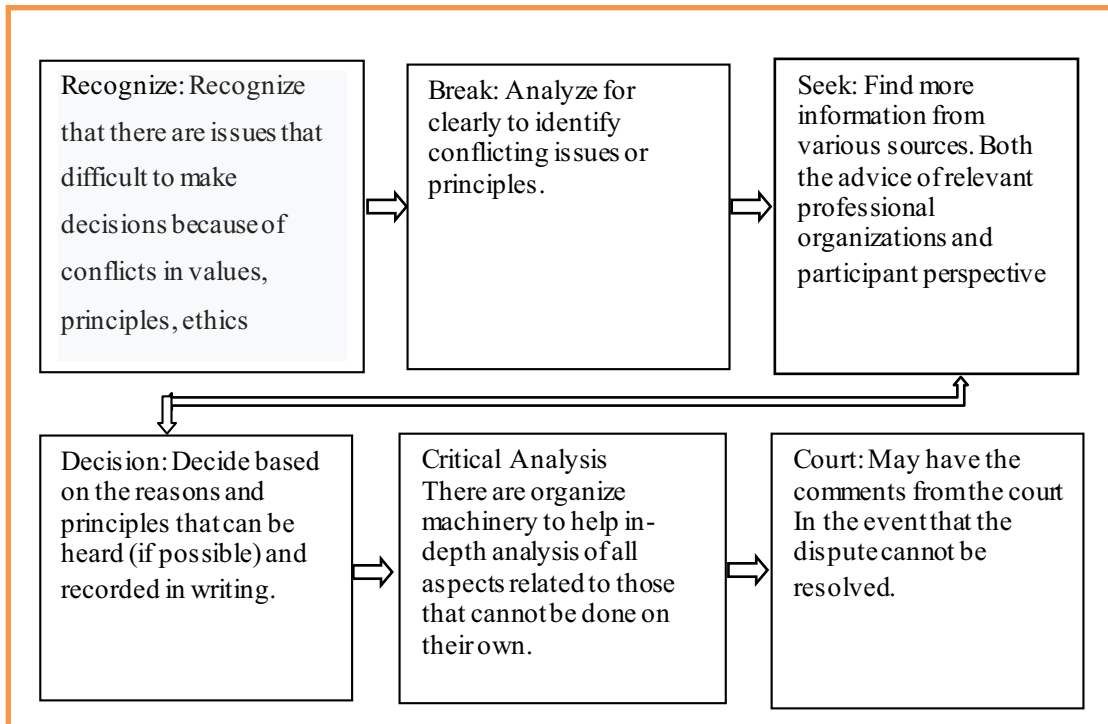


Figure 1: Dilemma Process

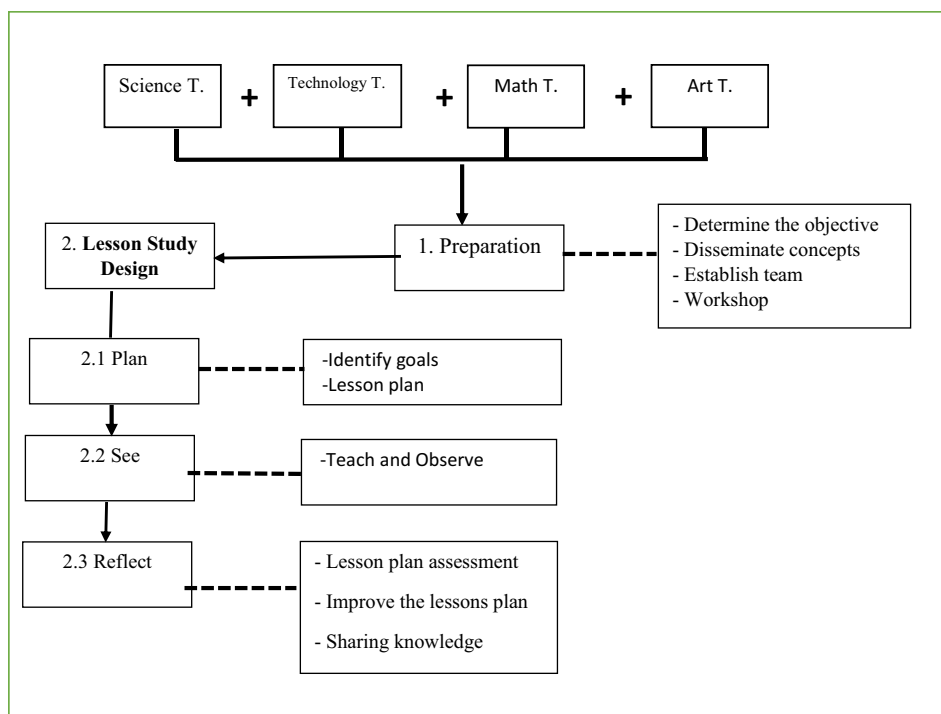


Figure 2: Conceptual framework of professional teachers' development program using lesson study integrate the curriculum

Table 2: Lesson Study Development Implementation

1. Preparation: Determine lesson study development methods - Disseminate concepts of lesson study development - Group and assign responsibilities to develop lessons for each teacher - Seek more information and coordinate with knowledgeable experts - Schedule and arrange meetings in a systematic and professional manner			
2. Lesson Study Design		Activities	Expected Outcomes
Plan	1.1 Identify goals	Conduct a meeting to identify operation plan	Plan and discussion of current lesson plans
	1.2 Lesson plan	Identify Lesson plans	lesson plan and teaching media/tools
See	Teach and observe	Teacher observes, records, and collect data by other teachers in the group	Results of observation reflecting teachers' teaching and students' learning and thinking process
Reflect	3.1 Lesson plan assessment	Teaching review, discuss, analyze, and evaluate	New ideas, suggestion to solve issues for future lesson plans
	3.2 Improve the lessons plan	Improve lesson plan and teaching aids	Improved lesson plans
	3.3 Sharing knowledge	Write a report, Findings presentation	Report and presentation of the collaborative work of lesson plan from all teachers

3. Results

Lesson study design (plan, see, and reflect) allowed the lesson study participants to come up with the innovation lesson plan of fertilizer dilemma story for integrated knowledge practicing. The overview of the lesson plan of fertilizer dilemma story for integrated knowledge practicing could be viewed through the structuring questions for ethical dilemma fertilizer story and example of dilemma story chemical fertilizer.

3.1 The structuring questions for ethical dilemma fertilizer story

The fertilizer learning unit provided students' learning in practicing knowledge about science, technology, mathematics and arts through ethical dilemma story pedagogy on chemical fertilizer. To prepare students to become adults who have a role to participate in social responsibility and save the ecosystem from chemical fertilizer using, which is a problem in communities and is a crisis world, the arts will be held by students as their justifications and creative communication. The art related to the story of the language will help to develop the morality and ethics that will occur in the process of ethical dilemma story pedagogy and the development of students in the 21st Century.

The ethical dilemma fertilizer story was provided based on the story of Keaw and Kla family chemical fertilizer using in the rural areas of Khon Kaen, Thailand. Then, the classroom provided also the 6 story questions. These questions oriented students to move forward to practice knowledge about science, technology, mathematics, and arts. This happened because students will show their answer when they present the soft projects. And, these questions enhance them to show their justifications for their developing possible solutions about ethical dilemma chemical fertilizer story. Regarding on these 6 questions, students may reflect themselves about: 1) need for knowledge, 2) need for investigating, and 3) reflect for students' awareness. The 6 questions for ethical dilemma fertilizer story were provided as the table 3.

Table 3: Summary of questions asked in the Ethical Dilemma story about chemical fertilizer

Story Part	Questions
1	What do you think a chemical fertilizer is and is it harmful to the people?
2	If you were him, will you use a chemical fertilizer? Why? Give the reason. Use technique Think, Pair, Share
3	For the reason of Kaew, Keng and Kla. Whom do you agree with? Why? Use technique Think, Pair, Share
4	Do you think that in each plant want a different ratio nutrient? Study a ratio of an appropriate ratio for the growth of (Math) Use technique Think, Pair, Share
5	From comments of Kar, Keng, Koy and Kaew effect of fertilizer application and do not use fertilizer. The soil never fertilizes. Do you think that all three types of soil will affect the growth and the yield of the rice, Is it difference? How? (Use the technique. Think, Pair, Share)
6	After the students learned that, The reason for low rice yield. Soil quality is not good because the fertilizer is not right. How will Kaew father solve the problem? (Learn more about learning Center) Summarize and present knowledge from learning Center) (Use the technique. Think, Pair, Share)

3.2 Example of dilemma story chemical fertilizer

According to the structuring questions for ethical dilemma fertilizer story, the PD program participant have implement the lesson plan in their classroom. Consequently, the example of dilemma story chemical fertilizer could be provided as following.

Dilemma Story chemical fertilizer

Keaw and Kla are friends. Their houses are close which are located in a rural area and their family is a close neighbor. The parents of both Keaw and Kla are also a farmer. Their main job is not only growing rice but also growing vegetable. Animal husbandry for example buffalo, cow, duck and chicken is a professionally supplemented. Keaw and Kla are the students in grade 5 of an elementary school. Both of them are in the same class. Every day, they will walk to school together.

One evening, at Keaw's home her dad talked to her mom and her that he would go to the market to buy a chemical fertilizer to nurture the rice

Keaw: "Why do you buy a chemical fertilizer?"

Dad: "I buy it to soil maintenance for rice"

Keaw: "In the past, I have never seen that you used a chemical fertilization but the rice still grow up naturally, right?"

Dad: "Yes, I won't use it but rice will not grow up and less productivity. My friend told me that if you use a chemical fertilization you will get more productivity"

1. Warm Up Question

What do you think a chemical fertilizer is and is it harmful to the people?

Monday morning Keaw always go to school with Kla. Keaw told Kla that her father would buy a chemical fertilizer

Kaew: "last night, my father invited me to go to buy chemical fertilizer at the market on Saturday to nurture the rice because my father wants to get more productivity."

Kla: "It's good. Chemical fertilizer is good. My father has used it for a few years. Do you believe that the production of my father is doubled?"

Kaew: "But I think using chemical fertilizer may affect the growth of rice? Or if we eat the rice with chemical fertilizer it may be dangerous."

Kla: "Come on. If the chemical fertilizer is not good, why would they generate it and nowadays, almost all the people used it."

2. Question

If you were him, will you use a chemical fertilizer? Why? Give the reason.
Use technique Think, Pair, Share

Today at Kaew and Kla's school Teachers are teaching sciences about the growth of plants.

Teachers: "Good morning everybody. Who eat breakfast?" (Students raise their hands.) "Very good, last week .I taught about nutrients necessary for the body. Do you remember?"

Kaew: "I remember. Nutrients necessary for the body has 5 categories is 1) protein, 2) Carbohydrate, 3) fat, 4) mineral and 5) vitamin"

Teachers: "Correct! Our body can get nutrients necessary for the body all 5 types. Each type has different nutritional value. And then, do you think that plant need nutrients like people?"

Kang (Students in the room): "I think that plants do not but plants need water only. Nutrients which we have to put it down are chemical fertilizer."

Kla: "I agree with him that plan needs water and nutrients like people but we don't need to feed it because it can find their own food naturally in soil. My dad grow it by not using any fertilizer, when it rains, it grows. Like a tree in our school, we don't need to feed it, we just give it only the water and it will grow up.

3.Question

For the reason of Kaew Keng and Kla. Whom do you agree with? Why?
Use technique Think, Pair, Share

After that Teachers and students discuss about the growth of plant on the issue "Does plant eat food? How does it eat? What does it eat?"

Teachers: "The plant is an organism that needs to eat the food." (learn more about the factor of the growth of food)

Kla: "I know. At my home, my father said that we should put fertilizer on the rice. "Food is called a fertilizer, right?"

Teachers: "Yes. " Food for plant is called a fertilizer" Confirm! "Did you know that plants need nutrients like a human, called "nutrient." And, do you know? "What are the essential nutrients for plants? The classroom was silent for a moment. "Do you want to know?"

Students: "Yes" Students' answer!

Teachers: So, we will search for answers. "What are the essential nutrients of plants? And in each nutrient, how it's important for the growth of plant?"

(In Career and Technology: "students find the answers.")

Teachers and students have shared knowledge. The food of plants, we are called "fertilizer" and "fertilizer" called "nutrient" and there are many kinds of it and the essential nutrients needed for plants have 3 types which are 1) Nitrogen (N), 2) phosphorus (P), and 3) Potassium (K).

The study of plant nutrients could be summarized as follows:

1. Nitrogen: has functions and importance for plants is
 - 1) Grow plants and quick set especially in the early stages of growth.
 - 2) It promotes the growth of leaves and stems, making the stem and leaves are dark green.
 - 3) Promotes protein production
 - 4) Flowering control and the fruit of the plant.
 - 5) Increase productivity; especially plants that give leaves and stems.
2. Phosphorus: has functions and importance for plants is
 - 1) It promotes the growth of both rootlet and root branch, especially in the early stages of growth.
 - 2) Accelerate the plants faster and helps its flowering, fructification and seed formation.
 - 3) Helps potassium uptake from soil to be more useful.
 - 4) Increases resistance to certain diseases make a good productivity.
 - 5) Keeps the stem strong and do not fall
 - 6) Minimize the effects of nitrogen on plants.
3. Potassium: has functions and importance for plants is
 - 1) Promotes the growth of root and soaking roots and nutrients better.

- 2) Need to create fruit pulp. To produce starch and fruit, it is very popular for potassium fertilizers to accelerate flowering and head growth.
- 3) Allows the plant to resist changing light temperature or humidity
- 4) Helps plants resist various diseases.
- 5) It enhances the quality of vegetables and fruits, making the plants more colorful and adds sweetness.
- 6) Help prevent the effects of nitrogen and phosphorus.

After the students have summarized knowledge by drawing and coloring (Art), this allows students aware of the benefits of the required nutrients for plant all 3 types that it's important and there are different functions.

4. Question

Do you think that in each plant want a different ratio nutrient? Study a ratio of an appropriate ratio for the growth of (Math)
Use technique Think, Pair, Share

Kla: Teachers. Then, my father put fertilizer into the soil to provide nutrients to the crops. Therefore, did he do the right thing? Two years ago, I made more rice.

Keng: Teachers. My home, I have used chemical fertilizers for many years. During the first four years, rice has grown very well. But, it changed two years ago. Rice yield is not good. Rice is stunted.

In spite of my father put more chemical fertilizer. I should stop using the chemical fertilizer because I have seen that the rice without chemical fertilizer could grow well and got high products of rice. No using chemical fertilizer also could save money.

Koy: Teachers. I knew from the head of the village about animal dung fertilizer. He has used fertilizers from animal manure for his plant. It grows well.

kaew: Teachers. This Saturday, My father is going to buy chemical fertilizer for rice. I will tell my father that chemical fertilizer is not good. We do not need chemical fertilizers.

5. Question

From comments of Kar, Keng, Koy and Kaew effect of fertilizer application and do not use fertilizer. The soil never fertilizes. Do you think that all three types of soil will affect the growth and the yield of the rice, Is it difference? How?
(Use the technique. Think, Pair, Share)

Teachers: Let's find the answer. In spite of chemical fertilizer contains essential nutrients for plants, but when used for a long time. The plants do not grow and produce less. How do students find answers? Why did it stunted barley and reduced yields?

Students may design some experiment to find the food nutrients.

6. Question

After the students learned that, The reason for low rice yield. Soil quality is not good because the fertilizer is not right. How will Kaew's father solve the problem? (Learn more about learning Center) Summarize and present knowledge from learning Center
(Use the technique. Think, Pair, Share)

Teachers: Based on further studies and data from soil characterization studies, we could summarize as follows:

The disadvantage of using chemical fertilizers for a long time included:

Chemical fertilizer does not spoil soil. However, if the land have not been put organic fertilizer for long time, the soil will be so tight that the plant cannot root. The plant does not grow. Chemical fertilizer is not a chemical, so it is not toxic.

Disadvantages of chemical fertilizers

1. Chemical fertilizer does not improve soil structure. It did not make soil properties like what organic fertilizer do.
2. Nitrogen fertilizers in ammonium form if use a large amount. And, if it has been put for a long time, it will make the soil more acidic. It is necessary to use cement to neutralize the acidity of the soil.
3. The user must learn to understand advantages and disadvantages of chemical fertilizers; otherwise, it will be damage to crops and to economic conditions.

4. Conclusion

It could be viewed that the lesson study could form teachers as team teaching for developing lesson plan of fertilizer dilemma story for integrated science, technology, mathematics and arts practicing in the real context.

Based on the 6 questions about ethical dilemma fertilizer story, the integrated fertilizer learning unit, then, was developed for Mezirow [12]'s transformative learning process. A disorientating dilemma of students, the first author as teacher wrote an ethical dilemma story of fertilizer to create for students a scenario and characters that bring the story to life. In my study, the story focuses on a sequence of ethical dilemmas about the social use of fertilizer for a science unit in the Thai secondary curriculum. The first stage, the first author intentionally creates a dissonance by identifying a problem or situation through which the learner becomes aware that a belief they may have depended on is no longer viable with situation of the conflict in the need to use organic fertilizers. Self-examination of students – the teacher keep pushing with warm up questions through ethical dilemma story. The student's awareness of a fundamental dissonance in what they believe leads to self-questioning which can be unsettling, possibly inducing anxiety. Then, sharing transformational uncertainty, exploring options committing, the teacher used Think Pair Share Teaching Strategy [13]. Key stages in the story where students engage with a dilemma question, the teacher increased the complexity of the Think, Pair, Share strategy of the story contained 'questions 2-3 on the ethical dilemma story' designed to encourage the students to think about the issue. After that, enhancing students on critical assessment will be provided by question 4. Preparing to act of students, answering questions 5-6 will provide students to develop ideas for finding solutions through experimentation, researching online, and discussing questions designed to develop critical reflection on their social values. Regarding on this lesson plan, it would provide student self-efficacy comes from engaging with opportunities to apply knowledge and enact beliefs in response to different and unpredictable situations and the final stage of transformation comes through the reintegration of beliefs evident in new disciplinary or professional habits. The student is aware of their transformation and readily applies their new knowledge and ways of thinking logically to new challenges.

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