Study on energy education method for elementary school students to internalize energy conservation behavior.

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Abstract. In Japanese elementary school, there are few descriptions about energy in current school curriculum guidelines, and there is not adequate education on the energy that is the basis of the country. Therefore, in this research, the aim is to develop energy conservation environmental education materials that can be incorporated as elementary school classes, in order to establish the attitude of conserving energy conscious awareness and practicing energy conservation behavior. In August of 2018, under the cooperation of local community halls, energy conservation education was conducted for elementary school students who were recruited. Eight participants were divided into two groups, energy education using homebrew textbooks, making models of houses, etc., and classes on energy through discussion and presentation. As a result of the verification, this material is suitable for senior students over 3rd grade and the degree of difficulty is appropriate, and there is a possibility that it may be effective for consciousness formation of energy conservation, but the result of the level being too high for first grader of elementary school.

1. Introduction

The Sustainable Development Goals (SDGs) advocated by the United Nations include the topic of “Quality Education for All,” and the Japanese government is promoting ESD (Education for Sustainable Development) as an implementation measure aimed at achieving this. To promote the improvement and improvement of the teaching materials used at school sites.

Research on education for improving energy literacy has already been conducted, and three gods have conducted energy saving education for junior and senior high school students by making use of Nudge’s method. Akaishi and his colleagues used Nudge’s method to provide energy saving education for college students. Although both students were verified about the change in the student’s consciousness immediately after the class, the verification of the energy saving consciousness after some time after the class was not performed, and the education was It has not been clarified how it affected the energy saving consciousness in the long run. In addition, primary school children are not targeted for education, and an effective energy saving education method for primary school children has not been clarified.

In this research, the aim is to develop energy conservation education materials that can be incorporated as elementary school class with the goal of establishing a practical attitude of conserving energy conservation consciousness and energy conservation behavior in daily life. In addition, the method of measuring the educational effect itself is also a subject of research, and the same children will be observed over the medium to long term even after the class, and it will be verified whether it led to the establishment of consciousness and attitude formation at home.
In this report, development of teaching materials and energy conservation education using the teaching materials are described.

2. Development of teaching material

2.1. Reference study

In developing teaching materials, a survey of reference studies from the field of energy education and educational design in order to decide what to incorporate were conducted.

From the field of energy education, Mr. Sajima stated that it is important to capture energy from the five perspectives of "existence", "useful", "limited", "harmful", "conservation" in order to improve energy literacy [3]. Table 1 shows these five viewpoints. These viewpoints were created in a research aimed at "to foster humans who realize a recycling-based society and a sustainable society by solving energy environmental problems and pursuing better way of using energy". In Suzuki's research [2], this can be done by conducting learning aiming at the integrated formation of "definite recognition formation", "formation of subjective learning style", "rich human formation". In order to achieve certain recognition, education is practiced by taking energy problems from the five viewpoints of "Existence", "Useful", "Limited", "Harmful" and "Maintenance", and features of multiple fields It is necessary to make use of it in energy education.

From the field of educational design, in the ARCS model, which is a learning motivation model advocated by John M. Keller, in order to draw motivation for learning "Attention", "Relevance", "Confidence" and "Satisfaction" are necessary [4]. Table 2 shows the outline of the ARCS model. The ARCS model is a system model that assists instructional designers to tackle problems of motivation for learning. In the ARCS model, a framework organized into the four factors of "Attention", "Relevance", "Confidence" and "Satisfaction", motivational strategies corresponding to each factor, and procedures for motivational design have been proposed. Speaking of motivation seems to be a contrivance in introduction, but the ARCS model shows that it is possible to devise the entire learning process.

In addition to the findings obtained from these studies, I heard "Teaching materials are not teaching everything, but what can be thought from there", "Teaching material should include surprises caught in the heart and exciting and enjoyable manufacturing." from Professor T Tanoue of Kyushu University who is familiar with educational methodology, and developed teaching materials with reference to such findings.

| Table 1. Five viewpoints |
|---------------------------|
| **Existence** | There are various energies in personal surroundings. |
| **Useful** | Energy is indispensable to human life. |
| **Limited** | The energy resources available to humans are limited. |
| **Harmful** | Inappropriate use of energy is causing environmental destruction. |
| **Maintenance** | We need to think about sustainable use of energy from the viewpoint of "circulation", "inhibition" and "symbiosis". |
Table 2. ARCS model

| Main classification | Definition | Subcategory | Contents |
|---------------------|------------|-------------|----------|
| Attention           | Gain attention of learners. To stimulate curiosity to learn. | Perceptual Arousal | Use a novel, surprising, or uncertain event for classes to attract and keep learners' attention. |
|                     |            | Inquiry Arousal | Ask questions or make learners make problems to stimulate behaviors for information. |
|                     |            | Variability   | Maintain learning interests by changing element of class. |
|                     |            | Familiarity   | Use specific terms and examples and concepts related to learners' experiences and values. |
|                     |            | Goal Orientation | Prepare a sentence or example that shows the goal and effectiveness of the lesson, and instruct the learner whether to present the achievement purpose or not. |
|                     |            | Motive Matching | Use the teaching strategy that suits the learner's motive profile. |
|                     |            | Learning Requirements | In order to enable the learner to predict the probability of success, we show what the goal is and present criteria for evaluation. |
| Relevance           | Meet personal needs and goals that affect learner's positive attitude. | Success Opportunities | Provide a level of challenge that allows you to experience meaningful success in learning and post-learning conditions. |
|                     |            | Personal control | Provide opportunities to control learning, and provide feedback, helping to attribute the cause of success to ourselves. |
|                     |            | Intrinsic Reinforcement | Give the opportunity to use newly acquired knowledge and skills in real or similar situations. |
|                     |            | Extrinsic Reward | Give emotional feedback and enhancement to maintain desired behavior. |
|                     |            | Equity | Maintain the results and criteria of achievement at all times constant. |
| Confidence          | Help students succeed and helps to realize confidence and realize that success depends on their ingenuity. | |
| Satisfaction        | Strengthen achievement with (internal and external) awards. | |

2.2. Lesson plan

The class is assumed to be incorporated into the time of integrated learning in elementary school, and two frames (90 minutes), which is the number of frames per week defined in the elementary school course of study, was used as a measure of class time.

Table 3 shows the class plan. For each item of the plan, the contents were determined by setting the classification of ARCS model to be targeted and distributed for each item of the plan. As a flow of the class, In order to keep students focused and tackling classes at all times, learning formats such as lectures, discussions, workshops and presentations are made as continuous as possible. In addition, there were a lot of scenes where you could use the knowledge you got in class to connect with your child's confidence and satisfaction.

In "Lecture on Energy", as it is important to get the attention and interest of the children as an introduction, it was planned to explain the energy from the everyday that the children have experienced. In addition, the content of the class was to actively make questions and presentations and to draw attention from the children.

In "Energy search in house ①", it is thought that it is possible to think about energy in connection with the child's past experience by using a picture. In addition, it is thought that learning environment can be changed and children's attention can be maintained by thinking from pictures rather than lecture forms.

In "making a model" and "drawing your house ①", the purpose is to bring about change in classes and to give children the fun and connection of craftsmanship.

In "Lecture on the environment", Lectures will be given on the limited nature of energy and the negative impact on the environment, which has not been widely practiced in conventional energy
education. Also, this plan works to be able to think about what kind of action children can do for energy conservation.

In "Energy Search in Home ②", by using a picture as in the first time, children can think in conjunction with their experiences, and use their knowledge gained during class to think and present places where energy conservation can be made in their lives.

In "Write your own house ②", as an opportunity to use the knowledge acquired in the class and, in "At the end", by distributing the summary and the certificate of completion, the children can continue to be interested in energy conservation in the future.

### Table 3. Class plan

| Item                             | Target                                                                 | ARCS model               |
|----------------------------------|------------------------------------------------------------------------|--------------------------|
| Lecture on Energy                | Introduction and explanation of energy around us.                      | Attention, Relevance     |
| Energy search in house ①         | Have the group think about energy while looking at the picture in the house. | Attention, Relevance     |
| making a model                   | Have the model make a model while imagining the house you want to live. | Attention, Relevance     |
| drawing your house ①             | Have the picture painted while imagining the house you want to live.   | Attention, Relevance     |
| Lecture on the environment       | To improve energy literacy, lecture related to finite energy and environmental problems. | Attention, Relevance, Confidence |
| Energy Search in Home ②          | Have them thinking about energy conservation that they can see while looking at the picture in the house. | Confidence, Satisfaction |
| Write your own house ②           | Have the picture painted what kind of house you want to live in after finishing class. | Satisfaction             |
| At the end                        | Complete the class and fill out the questionnaire and distribute the certificate of completion. | Confidence, Satisfaction |

2.3. Content of teaching materials

In order to teach the class in accordance with the class plan, house model kit and book type teaching materials on energy were created as teaching materials.

2.3.1. Creation of house model kit. The house model kit is used with "Model making" and "Write your own house ①, ②". For the house model kit, a styrene board with a thickness of 2 mm was used, and all parts were cut beforehand so that a model can be created by gluing only. The house model made it possible for children to paint color freely on the outside and to let the children draw the ideal house of the child with a picture or a prepared card on the inside. Figure 1 shows an image diagram of the house model, and figure 2 shows an example of the card.
2.3.2. Creation of book type teaching material. Book type teaching material is used for lecture about energy and energy search in the house. Book type teaching material has content that can teach children five important viewpoints for improving energy literacy from the existence to the preservation. Table 4 shows the content of book type of teaching material created. Figure 3 and Figure 4 show everyone's Life ① and everyone's Life ②. In "Everyone's Life ①" by showing the life scenes at home as a picture, it was possible for the children themselves to think about places that use energy from among the pictures. Also, "Everyone's Life ②" as a summary of this teaching material, the content that can be considered by children is a place where energy conservation can be made from the life scene. Taking advantage of interviews with Professor Tanoue, these contents are considered to allow the children themselves to think rather than giving an answer.

| Page | Title                  | Contents                                                                 | Five viewpoints       |
|------|------------------------|--------------------------------------------------------------------------|-----------------------|
| 1    | Cover                  |                                                                          |                       |
| 2    | Our lives              | It shows that there is energy in daily life.                            | Existence             |
| 3    | What is energy?        | Explanation about daily energy.                                          | Existence, Useful     |
| 4–5  | Everyone's Life ①     | Explanation about electricity and gas energy in the house.               | Existence, Useful     |
| 6    | Energy used at home    | Explanation about the finite nature of fossil fuels.                    | Limited               |
| 7    | What will happen on Earth | Explanation about global warming and energy saving.                   | Harmful, Maintenance  |
| 8–9  | Everyone's Life ②     | Thinking about ways of energy conservation in your life.                 | Maintenance           |

Figure 3. Everyone’s Life ①
3. Implementation of Study Group
Using the developed teaching materials, a study group on energy conservation education entitled "Let's Play with Eco-Search Game!" for elementary school students was held at a community hall located in eastern district of Fukuoka city in August 2018. On the day, a total of 8 people including 3 first grade students, 4 third grade students and 1 fifth grade student participated in the study group. In consideration of differences in understanding by grade, participants were divided into lower grade group of only 3 first grade students, middle or high grade group of other students, and participated in adults as support staff in each group. During the class, cameras were installed before and after the classroom to record the state of the class, and audio recorders were installed for each group. Basically, the study group proceeded with the contents as planned, and when asked questions, a lot of children raised their hands and aspiring to present themselves. It took more time than schedule to create a model, and it took a total of 2 hours, but it seemed that children were working ambitiously until finally completing the questionnaire and receiving a certificate of completion. Figure 5 and Figure 6 show lesson scenes ① and lesson scenes ②.

4. Results
I describe the result of questionnaire to improve the content of teaching materials and transcription of voice recorder.

4.1. Questionnaire result
Table 5 shows the contents of the questionnaire conducted after class. The contents of the questionnaire mainly asked how children felt about the teaching materials. Figure 7 shows the results of the
questionnaire. There were many positive answers as a whole, but two first grade students answered "difficult" by question asking the degree of difficulty of the contents of question item 1, and it is thought that the study group was difficult contents for the lower grade children. All the members answered that the model work of question item 3 was fun, so there is a possibility that it is possible to create a teaching material that children can learn eagerly and happily by combining elements such as work and learning contents well.

Also, in the field of free description of the questionnaire, "I want to do something to make energy saving out at home even if I learned today." or "I want to do energy saving today from today.", "Energy conservation I thought that I wanted to do even a little bit." Although it was measurement immediately after the class, some answers were thought to have resulted in consciousness of energy conservation by the class, and the effect was seen in consciousness fixing.

Table 5. Contents of the questionnaire

| Item | Answer          | a | b | c |
|------|-----------------|---|---|---|
| 1    | How was today's content? | Easy | Normal | Difficult |
| 2    | Do you think that energy conservation will be done even at home? | Do | Don’t |  |
| 3    | Did you enjoy making a model of your house? | Fun | So so | Not fun |
| 4    | Did you enjoy discussion with the group by looking at the picture in the book? | Fun | So so | Not fun |
| 5    | Did you enjoy searching for energy from the picture? | Easy | Normal | Difficult |
| 6    | Do you think you can do energy conservation? | | | |
| 7    | Was today fun? | Fun | So so | Not fun |
| 8    | Let's write what you thought freely. | | | |

Figure 7. Results of the questionnaire
4.2. Transcript result

Table 6 shows some of the results of the transcription of the voice recorder. Looking at the number of times of speech and contents, speaking was not done much among children but was mainly done between children and person in charge. As a cause of this, it is considered that the child was recruited generally, it was conceivable that someone who did not know existed in the group, and the content was difficult to understand with only the child. If the student is unable to solve the problem, the burden on the instructor will increase and teaching materials will be a difficult to practice. At the reflection meeting after class held with the public hall staff and the adult who participated as support, opinions such as, "There were many children whose hands stopped at model creation, so preparation of sample models was necessary.", "Part of the lecture since it is difficult, ingenuity of how to communicate is necessary." were obtained. Improvement is necessary in the future to make it easy to incorporate in elementary schools.

\begin{table}
\centering
\caption{results of the transcription (Excerpt)}
\begin{tabular}{lll}
\hline
Speaker & Times & Remark contents \\
\hline
Staff 2 & 7 & Great! \\
Niko & 4 & Is it an electrical outlet? \\
Staff 1 & 5 & The electrical outlet is connected to the vacuum cleaner. \\
Jiro & 4 & I got it all. \\
Staff 2 & 8 & Did you have all done? Everyone works quickly. \\
Niko & 5 & Is this too? \\
Staff 1 & 6 & Is this too? What is this? \\
Sanko & 2 & I was finding it the first. \\
Staff 2 & 9 & Sounds good. \\
Sanko & 3 & Then it ended soon. I was finished early. \\
Staff 2 & 10 & Did you find nine? \\
Staff 1 & 7 & There seems to be nine. \\
Jiro & 5 & Nine? \\
Staff 1 & 9 & There is another one. \\
Staff 1 & 4 & How many did you find? \\
Sanko & 11 & I was finished early. \\
\hline
\end{tabular}
\end{table}

5. Conclusion

In this research, with the goal of developing effective energy conservation teaching materials, making teaching materials and practice the study group were carried out making use of the ARCS model and the method of five viewpoints for energy literacy improvement. From the results of the questionnaire it showed the possibility to create teaching materials that children can learn ambitiously and pleasantly by combining element of teaching content and work well in energy education. Also, from the contents of the free description, it was revealed that the class using the teaching materials created this research has an effect on fixing energy conservation awareness of children. However, analysis of the transcription of the data of the voice recorder revealed that the content of this teaching material was not understandable to the child at one time, and that the burden on the teacher became large accordingly. It also has become clear from the opinion obtained at the reflection meeting after class that it is necessary to make improvements by devising ways of communicating the content to make teaching materials easy to incorporate in elementary school.

From this research, knowledge was gained on the points to be improved and on how to create teaching materials that the children could learn ambitiously. In the future, the points to be improved that were obtained this time will be corrected, and it will be necessary to consider the teaching materials that lead to the formation of a medium to long term attitude.
References

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