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# CHALLENGES OF TEACHERS TO INTEGRATE ESD DESIGN ACTIVITIES IN TECHNOLOGY EDUCATION IN JAPANESE PUBLIC JUNIOR HIGH SCHOOLS

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## ABSTRACT

The study aims to clarify teachers' challenges in Technology Education (TE) when implementing Education for Sustainable Development (ESD) design activities into the curriculum in Japanese public junior high schools. The current research is conducted as a case study. The main participants of this study were four TE teachers currently teaching in public junior high schools in Nara City, Japan. A questionnaire survey for TE teachers and a field survey were conducted. According to the findings, the main barriers faced by teachers are a low understanding of ESD and design, low motivation to implement ESD design activities, insufficient teaching materials, and limited teaching time, which prevent TE teachers from integrating ESD design activities into the curriculum as new learning content. A suggestion proposed is that the current TE curriculum can be redesigned through project-based learning (PBL) to regroup and integrate all the learning contents into ESD design activities. Therefore, this study provided a possible new framework for redesigning a new TE curriculum.

*Keywords: Design learning, design activities, education of sustainable development, sustainability, technology education*

## 1 INTRODUCTION

In the 21<sup>st</sup> Century, many environmental, economic, and social problems threaten sustainable development. At the 2002 World Summit on Sustainable Development, Japan put forward the concept of ESD. ESD requires learners to find and solve issues related to sustainability to achieve sustainable development goals (SDGs) [1]. In Japan, the MEXT (Ministry of Education, Culture, Sports, Science, and Technology) has put ESD into the latest national syllabus, including TE. Currently, few TE teachers have integrated ESD into the curriculum. One of the reasons is that many do not know how ESD can be integrated into the TE curriculum [2]. One of the ways to integrate ESD into the TE curriculum is through product design-related activities [3]. This study refers to such product design-related activities as ESD design activities. ESD design activities require learners to find, think and solve real-world issues related to sustainability through the design thinking process, especially the issues related to SDGs. Through ESD design activities, students can improve their awareness of sustainable development.

TE can be associated with Design and Technology (D&T) and Design Education, offered as a subject in the school curriculum in some countries, such as Singapore, England and Australia [4]. In these countries, students learn technical knowledge and skills and apply them to product design solutions. In Japan, TE as a form of general education is mainly conducted in junior high schools, focusing on technical knowledge and skills, with almost no elements of design learning activities, compared to overseas [5]. The latest national syllabus in Japanese secondary education now requires teaching design thinking in TE to improve students' problem-solving skills [6].

The current research is conducted as a case study. The main participants of this study were four TE teachers who are currently teaching in public junior high schools in Nara. This study aims to clarify TE teachers' challenges when implementing ESD design activities in the TE curriculum. The value of this study will provide insights for TE teachers in Japanese public junior high schools to explore how ESD can be implemented in TE curriculum through product design-related activities.

## 2 LITERATURE REVIEWS

UNESCO (United Nations Educational, Scientific and Cultural Organization) shows that ESD is not simply an extension of environmental education but a catalyst for change and a way of addressing the changes in values and behaviours required for a sustainable future [7]. It involves learning how to make decisions to balance and integrate the long-term future of the economy, environment, and society [8]. ESD aims to cultivate one's qualifications and abilities as the founder of a sustainable society by requiring learners to treat global issues as their problems and take action to solve them [9].

TE is a learner-centred and interdisciplinary subject that provides students the opportunity to actively think, find and solve open-ended problems [10][11]. In some countries, such as Europe, North America, and Australia where ESD has been developing in TE through product design-related activities from elementary to higher education, which can be viewed as ESD design activities. Based on the available literature, the key characteristics of ESD design activities in TE may be presented as follow:

- Design problems are open-ended problems, being set within a social-economic-environmental framework, tending to focus on solving environmental problems [12].
- The theme of design activities in each country's TE focuses on different dimensions of sustainability because policies and development priorities differ from country to country [13].
- Besides developing the cognitive dimension of learning, the development of social and psychomotor skills, as well as effective attributes, such as the responsibility of sustainable development, tolerance, and teamwork skills are emphasized [14][15].
- Participatory learning and higher-order thinking skills are promoted, such as critical thinking, creative thinking, and problem-solving skills [16][17]. Also, students can develop the ability to plan, execute and evaluate [18].
- Eco-design principles are used, emphasizing the utilization of low-cost, long-term using, renewable sustainable technology to design sustainable products and services [19].
- Caring for cultural diversity. Traditional technologies are important components. The connection between sustainable development with regional social and culture is considered [20].

Yatagawa and Kurishima showed that only 4% of the junior high schools in Japan develop ESD well, most of which are ASPnet (UNESCO Associated Schools Project Network) or university-affiliated junior high schools [21]. In public junior high schools, ESD has yet to be actively implemented. In TE, more than 80% of teachers are motivated to integrate ESD into the curriculum, but they have met lots of problems cause that ESD did not develop well in TE, such as 1) teachers have no deep understanding of ESD; 2) lack of appropriate ways; 3) lesson time is not enough; 4) lack of effective evaluation methods. The main teaching objective of TE in Japanese junior high schools is to cultivate technological literacy, focusing on learning basic technical knowledge and skills. Currently, in Japan, "Design" in TE focuses more on production-making than real-world problem-solving [22].

## 3 RESEARCH METHODOLOGY

In this study, the main research question is as follow.

- What barriers do TE teachers face that prevent them from conducting ESD design activities in the existing TE curriculum?

The current study was conducted as a case study. In this case study approach, quantitative and qualitative data were collected and used. The main participants of this study were four TE teachers teaching in public junior high schools in Nara. The considerations for selecting the four teachers were based on the followings: 1) most junior high schools in Japan are public junior high schools, thus the issues faced by the four teachers may resonate with teachers in other public schools; 2) the four TE teachers are motivated to integrate ESD design activities into existing TE lessons. The four TE teachers have different numbers of years of teaching experience. Refer to Table 1.

*Table 1. Teaching experience of the four participating TE teachers*

Participants	Teacher A	Teacher B	Teacher C	Teacher D
Years of teaching experience	About 10 years	About 8 years	About 1 years	Less than 1 years

The study objects came from questionnaire surveys done by the teachers. The questionnaire consisted of 12 open-ended questions to clarify whether teachers have done anything related to ESD design activities. Teachers who have conducted ESD design activities in their lessons are required to answer

Q2 to Q8. Q2 to Q8 mainly clarifies 5 areas: 1) the curriculum arrangement of ESD design activities; 2) educational objectives and student outcomes; 3) assessment methods; 4) problems teachers faced, and 5) expected student outcomes. Teachers who have not carried out ESD design activities would answer Q9 to Q12. Q9 to Q12 mainly clarify 3 areas: 1) the reasons for not doing ESD design activities; 2) the approaches they may take to solve the problems faced; 3) the expected educational objective and student outcomes of ESD design activities. Refer to Figure 1. The open-ended questions are analysed by first reading and reviewing the data. Then, the responses are categorized and interpreted to look for links and differences in teachers' perceptions. To supplement the questionnaire survey, a field survey was conducted. Permission for the field survey was given by teachers A, B, and C. The main purpose is to clarify further the type of teaching and learning activities, learning environment, and issues related to ESD design activities that may not be surfaced in the questionnaire survey.

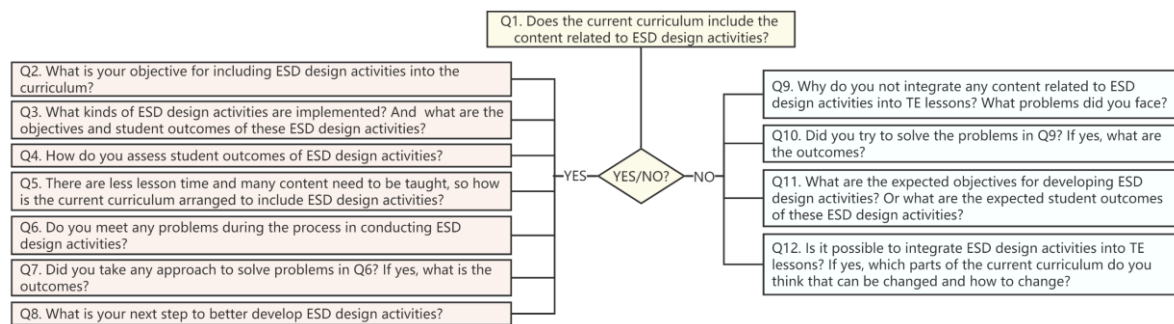


Figure 1. Open-ended questions in the questionnaire survey

This research was implemented in September 2022. Before the questionnaire survey, an explanation session was conducted to explain the different types of product design-related activities that can be conducted in TE to give the teachers a clear idea of what product design-related activities in TE are. At the same time, the definition of ESD design activities was explained. After this session, teachers were given a questionnaire survey to answer. In addition, a field survey was subsequently conducted.

## 4 FINDINGS

The responses to the questionnaire survey can be presented in Table 2. Based on Q1, all TE teachers have not integrated any content related to ESD design activities into TE lessons. As a follow-up to Q1, all teachers answered Q9 to Q12.

Table 2. The teachers' answers in the questionnaire survey

Teachers' answers in the questionnaire survey from Q9 to Q12 (Q1:NO)	
Questions	Consolidated key perspectives based on teachers' responses
Q9. Why do you not integrate any content related to ESD design activities into TE lessons? What problems did you face?	<ul style="list-style-type: none"> <li>• Current teaching materials are not enough for developing ESD design activities</li> <li>• Teachers have low motivation and incentives to do ESD design activities</li> <li>• Students do not have high thinking skills and life experience to solve complex sustainability issues</li> <li>• Teachers do not have deep understanding and teaching experience of ESD and design process</li> </ul>
Q10. Did you try to solve the problems in Q9? If yes, what are the outcomes?	<ul style="list-style-type: none"> <li>• Teaching materials should be improved through Internet and related books</li> <li>• Assessment methods should be changed, putting the assessment related to ESD into rubric</li> <li>• Students' basic knowledge of ESD should be cultivated</li> <li>• Teachers' knowledge and skills about ESD and design thinking should be improved</li> <li>• Students' ability to find and solve problems in daily life can be improved</li> </ul>
Q11. What are the expected objectives for developing ESD design activities? Or what are the expected student outcomes of these ESD design activities?	<ul style="list-style-type: none"> <li>• Students can link the subject of technology education with their life</li> <li>• Students can improve interests, thinking skills and practical ability in solving problems by increasing the difficulty of solving problems</li> <li>• Students can solve problems from more different perspective and ways</li> <li>• TE lessons can be more engaging</li> </ul>
Q12. Is it possible to integrate ESD design activities into TE lessons? If yes, which parts of the current curriculum do you think that can be changed and how to change?	<ul style="list-style-type: none"> <li>• Teacher training of ESD and design should be strengthened</li> <li>• The issues related to ESD is too difficulty for TE students and teachers in junior high schools</li> <li>• The TE lesson time is too limited to integrate ESD design activities</li> <li>• The motivation of TE teachers for doing ESD design activities in Japan should be improved</li> </ul>

There are mainly 3 reasons teachers did not integrate ESD design activities into TE lessons. Firstly, teachers do not have a deep understanding and teaching experience of ESD and the design process. This part of the finding is consistent with previous studies. Secondly, teachers perceived that students do not have high-level thinking skills and life experience to solve complex problems. Thus, teachers are less motivated to implement ESD design activities because they would prefer students to solve concrete

problems related to daily life rather than complex ill-defined problems related to sustainability. One of the teachers also reflected that the current teaching materials are insufficient to support ESD design activities.

Regarding the issues mentioned in Q9, teachers did not take any approaches to solve those issues. But the teachers provided some suggestions. Firstly, teacher training should be strengthened to improve teachers' knowledge of ESD and design. Then, the current assessment method of class activities should be changed. For example, summative assessment is more emphasized at the moment. Thus, the assessment rubric should include formative assessment related to ESD. Additionally, improving students' knowledge of sustainable development and design thinking skills is necessary.

The teachers think it is possible to do ESD design activities in the current TE lessons. Most of them believe that the key objective of ESD design activities is to improve students' problem-solving skills and learn to solve problems from different perspectives and ways. Also, some teachers think students can improve their critical thinking skills. In addition, they hope students can be more interested in TE and better link TE with their daily life through ESD design activities.

To further understand teachers' teaching conditions, a field survey was conducted. During the field survey, we can understand that teachers have limited teaching time. Each TE class is 50 minutes, and the total teaching time for 3 years program is 87.5 hours. Due to the limited teaching time, implementing ESD design activities as new content into current TE lessons will increase TE teachers' workload.

## 5 DISCUSSIONS AND LIMITATIONS

From this case study, the feedback from the TE teachers provided several implications for redeveloping the current TE curriculum to implement ESD design activities. Firstly, it is difficult to integrate ESD into the TE curriculum as new learning content because of the limited teaching time.

The current TE curriculum has four main learning contents: A. Materials and their processing, B. Nurturing living things, C. Energy conversion, and D. Information processing [23]. In most cases, TE teachers teach these contents sequentially. The learning objectives of these contents can be divided into 3 categories: 1) Basic knowledge and skills of technology; 2) Thinking, judging, and expressing about solving real-world problems; 3) Proactive, interactive, and deep learning of promoting sustainable development through technology. Refer to Figure 2.

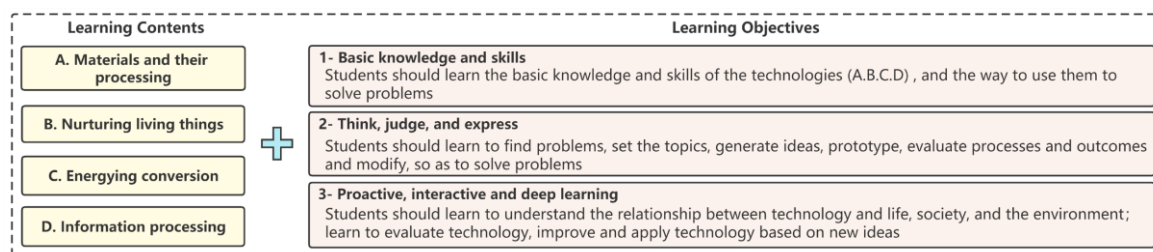


Figure 2. The learning contents and objectives of technology education

As such, instead of teaching the learning contents of TE separately, all the learning contents may be regrouped and integrated into ESD design activities. Complex sustainability issues can be the themes used in ESD design activities. Students can be taught how to use the design thinking process to solve these complex sustainability issues. Through the design thinking process, students can learn to narrow down complex sustainability issues to a specific problem related to their own experience to solve.

To regroup the learning contents and teach the design thinking process, the current TE curriculum may be redesigned through PBL, which means ESD design activities can be structured as design projects based on the PBL approach. A framework for ESD design projects can be proposed. Refer to Figure 3. By redesigning the current TE curriculum, different learning contents of TE can be integrated into a series of ESD design projects. The necessary knowledge and skills will be integrated into projects to help students find design solutions. The design process starts with identifying design problems related to sustainability, idea generation, development of ideas, and testing and evaluating prototypes. The number of design cycles of the design process that can be done will depend on the lesson time teachers have for the projects. Therefore, if the design problem cannot be solved completely after the test and evaluation, teachers can ask students to update the problem and continue the design process. Students can also end the design process with a reflection after the test and evaluation in the first design cycle.



In addition, the curriculum can be designed with a scaffolded approach. Refer to Figure 4. In the scaffolded approach, the projects can be designed by the level of difficulty. In the first year, students can solve problems related to their daily life with a concrete objective. In the second year, projects can broaden the scope and complexity of finding and solving problems. In the third year, students can learn to solve ill-defined problems where they need to narrow down complex problems to a specific problem by themselves. Several learning objectives can be achieved through ESD design activities, and students' design thinking skills will be strengthened in stages.

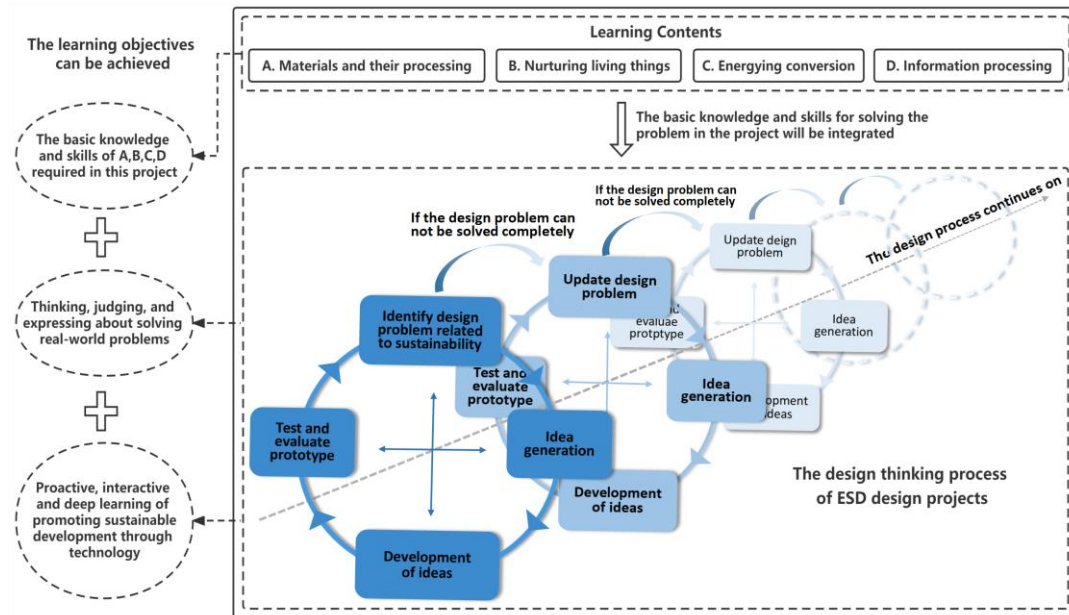


Figure 3. The framework for planning ESD design projects in TE

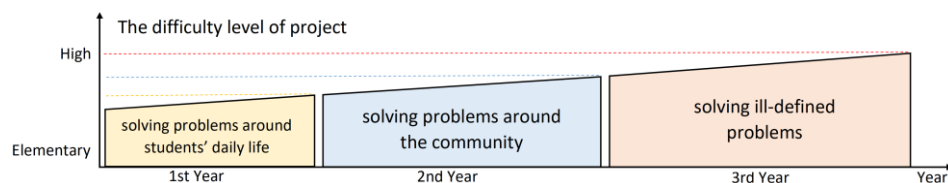


Figure 4. The difficulty level of ESD design projects can be scaffolded in the respective year of study

The framework suggested above mainly regroups and integrates all learning contents into ESD design projects. As such, the learning contents of TE may not increase much in limited teaching time. The teachers' workload may also not increase much.

Although the Japanese national syllabus requires developing ESD design activities in the TE curriculum, most schools did not do it well due to the lack of strategies. The framework for planning ESD design projects suggested in this study addresses part of the needs for the lack of strategies to implement ESD design activities in TE. The current framework (Figure 3 and 4) may bridge the gap between the national policy of developing ESD and school implementation of ESD design activities. But more research in studying best practices is required to find more available strategies.

The limitation of this study is that the feedback comes mainly from four TE teachers in Nara City. As this is just the initial stage of the study, further clarification will be required for future research to determine if most TE teachers in Japanese public junior high schools provide similar perspectives. Besides, the suggestion of this study is just a theoretical concept that has not been implemented in schools. The next step of this study will do a trial to implement this project plan in the actual schools.

## 6 CONCLUSIONS

The study aims to clarify the TE teachers' challenges in Japanese public junior high schools when implementing ESD design activities. Currently, the main barriers faced by TE teachers to implement ESD design activities are due to a low understanding of ESD and design, low motivation to implement ESD design activities, insufficient teaching materials, and limited teaching time. This study suggested a framework for TE teachers to redesign the current TE curriculum by regrouping and integrating

different learning contents of TE into ESD design projects. The framework for planning ESD design projects suggest in this study is only one of the possibilities for implementing ESD design activities into TE. More research is required to study best practices to implement ESD design activities into TE.

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