Lesson Development with the 'Dyson Engineering Box' as a Global Teaching Material in Japanese Technology Education

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Abstract

The James Dyson Foundation (JDF) is dedicated to encouraging young people pursuing technology and engineering education. One of the activity of the JDF supports technology education. One of the ways in which the JDF supports technology education is through the lending of the "Dyson Engineering Box (DEB). DEB is a reverse engineering kit that familiarizes students with the design process of the Dyson vacuum cleaner model by disassembling the model. In the United Kingdom and Japan, technology education lessons using DEB as a teaching material have been conducted. The teachers who intend to borrow the DEB receive documents and data for explaining from the JDF for making a lesson plan. This study purposed to develop and propose technology education lessons using DEB in the Japanese context. We conducted planning and practice of lessons using DEB, results and discussion are based on learning evaluation. From an international perspective, we consider the common teaching materials of the Dyson Engineering Box used in other countries, such as the United Kingdom.

Keywords

Team1: Technology Education Lesson; Team 2: Common Teaching Materials; Team 3: Disassembling Model.

Introduction

The James Dyson Foundation (JDF) was founded in the United Kingdom (UK) in 2002 (www.jamesdysonfoundation.co.uk). Since then, the JDF has supported students and young engineers who are learning and studying. Educational support includes lending teaching materials, conducting workshops, holding international conventions, and donating to universities and scholarships (www.jamesdysonfoundation.co.uk. This effort is spreading in the European Union (EU), the United States of America (USA), and Australia.

Activity began in Japan in 2006. Since then, the JDF has held lectures and workshops for university students, and it offers workshops and teaching materials to secondary educators (www.dyson.co.jp). One of the teaching materials is the 'Dyson Engineering Box' (DEB), which is lent out mainly in the UK, USA, and Japan.

In this study, we aimed to develop and propose lesson plans for Japanese technology education using the 'cyclone vacuum cleaner model' as a teaching material included in the DEB. We also considered the possibility that this model could be a teaching material for technology education globally.

Teaching material: The Dyson Engineering Box

Dyson Engineering Box (DEB)

The DEB is a leased teaching material. Students disassemble a Dyson machine and learn how the machine works. The DEB can be leased for free based on a schoolteacher's application.

About the Dyson vacuum cleaner model

The Dyson vacuum cleaner model (VCM) is useful as a teaching material for disassembling and reassembling a product. The shape and size are the same as those of the actual product, but electrical wiring has been removed in consideration of safety.

Students can understand the technology used in products by using the VCM (www.jamesdysonfoundation.co.uk). Teachers can borrow materials from the Dyson Foundation for three to four weeks.

Examples of technology classes using the VCM

The Teacher's Pack attached to the VCM explains how to use the technology in class. The JDF has issued separate Teacher's Packs in three countries: the UK, USA, and Japan. We considered the purpose and intention for using the VCM at the junior high school stage in each country. A comparison of Teacher's Packs is presented in Table 1.

Content/Country	UK	USA	JAPAN
How to use the VCM and ask relevant questions	○	○	○
Learning objectives	○	○	×
Lesson plans	○	○	×
Evaluation criteria	×	×	×
Sample worksheet	×	×	×

Table 1: Comparison of Teacher's Packs by country

It is necessary to provide lesson plans and learning objectives for Japanese teachers, as well as for those in the UK and USA. In addition, it is important to establish evaluation criteria to assess student learning and teaching tools; for example, worksheets would serve this purpose.

Develop and propose lessons plans

Framework of lesson plans

The VCM relates to the content unit for Japanese technology education 'technology of energy conversion'. In consideration of the Japanese Courses of Study(Japanese Ministry of Education, Culture, Sports, Science and Technology 2017), we refer to the UK and

USA lesson plans and examine their frameworks of 'Starter', 'Main' and 'Wrap-up'.

Lesson plan for disassembling a cyclone vacuum cleaner

Lesson plan for disassembling a cyclone vacuum cleaner is shown in Table 2.

Objective: Think about the engineering idea behind the design of the vacuum cleaner through the disassembly of products

	Learning activities	Teacher's instructions	Points of instruction
Starter 10 min.	1. Understand the idea behind and the technology of a cyclone vacuum cleaner.	・Describe the conventional paper pack vacuum cleaner. ・Instruct students to notice what was developed to solve the problems of paper pack vacuum cleaners.	・Clean with a real vacuum cleaner. ✓ Use worksheet 1.
Main1 15 min.	2. Think about the air flowing into the vacuum cleaner and the flow of dust sucked into it, ・Disassemble the cyclone parts of the cleaner model. ・Disassemble the body parts of the cleaner model.	・Instruct students to investigate how cyclone technology is used. ・Instruct students to examine the structure to collect invisible trash. ・Instruct students to consider the flow of air inside the body parts. ・Instruct students to confirm the flow of air from the filter to the outside.	・Pay attention to air flow and dust movement in cyclone technology. ✓ Use worksheet 2. ・Consider how visible and invisible dust is accumulated. ✓ Use worksheet 2.
Main 2 10 min.	3. Consider the specifications of the product from the disassembled parts. ・Think of the functions of disassembled parts.	・Ask the some questions. ・Instruct students to think about the product design while observing the parts.	・Pay attention to the function of and ingenuity behind each part. ✓ Use worksheet 3.
Wrap-up 15 min.	4. Consider the idea behind a cyclone vacuum cleaner. ・Reassemble disassembled parts. ・Check the specifications of the cyclone vacuum cleaner. ・Evaluate the product from various viewpoints.	・Instruct students to use the worksheet and write opinions about product design. ・Confirm that products are being developed based on aspects such as appearance, cost, customers, the environment, safety, size, function, and materials.	・Evaluate according to the description on the worksheet whether the lesson objective can be achieved. ✓ Use worksheet 3.

Table 2: Lesson Plan for disassembling a cyclone vacuum cleaner

Class worksheets

Worksheets 1, 2, 3, and 4 follow the processes presented in the lessons.

In worksheet 1, students describe the problem of a paper pack vacuum cleaner, such as the decrease in suction force and the need to replace the paper pack. The teacher advises students that Dyson's vacuum cleaner is designed with cyclone technology to solve these problems.

Regarding worksheet 2, the teacher instructs students to consider the flow of air through the vacuum cleaner's disassembly and observe the movement of dust. Teachers direct students to notice how dust accumulates in the upper parts and under the cyclone parts.

Regarding worksheet 3, the teacher instructs students to think about the specifications of the products from parts that they have disassembled (See Table 5).

Concerning worksheet 4, the teacher instructs students to contemplate the ideas behind the product design from various viewpoints through the disassembly learning activity. The description here becomes a learning evaluation.

Results of learning evaluation

The evaluation standards based on the criteria are shown in Table 4. Overall, 38 students (63%) evaluated criterion A; 14 students (24%) evaluated criterion B; and 8 students (13%) evaluated criterion C.

Criterion / Standard	Notice that products are being developed from various viewpoints to solve problems found in daily life and society.
A	To consider that the product is designed based on the viewpoints of society, the environment, and the economy, along with concrete usage purpose and design conditions.
B	To think that the product is designed based on the viewpoints of society, the environment, and the economy, etc.
C	Can't think evaluated criterion B

Table 4: Evaluation criteria and standards

Conclusion

In this study, we proposed a technology education class using the cyclone vacuum cleaner included in the DEB provided by the JDF. We compared contents of the Teacher's Packs provided in the UK, USA, and Japan; additionally, we considered the learning framework in the context of Japanese technology education. Based on the learning framework, we prepared lesson plans, worksheets, and evaluation criteria. From the result of learning evaluation, it is necessary to modify and improve the lessons and worksheets to ensure an awareness of product design through product disassembly.

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