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Student Insights on Product Improvement and User Perspectives in Japanese Junior High Technology Education

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Abstract

This study investigates junior high school students' perspectives on improving manufactured products and their perceptions as users after participating in materials processing technology learning in Japan. Guided by recent changes in Japanese curriculum guidelines emphasizing real-world application, we conducted a web-based survey collecting 721 valid responses from 833 students. The survey explored students' enjoyment of and satisfaction with materials processing learning, as well as their intentions regarding future technology-related careers. Our findings reveal high engagement in practical tasks, with 91.7% of students expressing positive attitudes towards making things. However, only 41.5% viewed their experiences as positively impacting future career aspirations. When prompted to describe product improvements, students frequently focused on safety (45.2%) and functionality (34.4%), while often neglecting environmental and economic factors. Differences emerged between those who described user-oriented improvements and those who did not, suggesting that descriptive reflection may enhance safety awareness and other practical concerns. This study contributes to the ongoing discourse on technology education by highlighting the need for curricular advancements that better link technological learning with future career opportunities. It also underscores the importance of fostering a comprehensive design approach that includes societal and environmental considerations.

Keywords

Technology Education, Design and Making things, User perspectives, Viewpoints on the Improvement of Products

Introduction

Technology education plays a crucial role in preparing students for the challenges of an increasingly technological world. In Japan, recent curriculum changes have sought to align classroom learning more closely with real-world technical challenges, reflecting a global trend towards more practical and applied technology education (Ritz & Fan, 2015). This study aims to explore junior high school students' perspectives on improving manufactured products and their perceptions as users after participating in materials processing technology learning.

The significance of this study lies in its integration of theoretical knowledge with practical applications, which is vital for students to understand and influence technology's evolving role in society. As Williams (2009) argues, technological literacy is a key component of modern democracy, requiring a broader and more inclusive approach to technology education. In Japan, this shift is reflected in the Ministry of Education, Culture, Sports, Science, and Technology's curriculum guidelines, which emphasize reflective, critical, and innovative education in technology (Ministry of Education, Culture, Sports, Science, and Technology, 2017a; 2017b).

Internationally, there has been a growing emphasis on integrating engineering and technology more comprehensively into broader curricula. For example, the Next Generation Science Standards (NGSS) in the United States encourage an interdisciplinary approach, blending engineering practices with core scientific concepts to address real-world problems (NGSS, 2013). Similarly, the European Commission's educational directives emphasize incorporating sustainability and societal needs within the framework of technology education (European Commission, 2020). Ritz and Fan's (2015) comprehensive review of STEM and technology education across different countries highlights the global trend towards integrating these fields. They note that while approaches vary, there is a common thread of emphasizing practical, hands-on learning experiences that connect classroom knowledge to real-world applications.

Despite these robust frameworks, significant challenges persist in effectively applying and integrating these educational goals. Matsuda (2006) highlights the linguistic and cultural complexities in interpreting technology education in Japan, pointing to the need for careful consideration of how concepts are translated and applied in practice. This echoes broader concerns raised by Dakers (2006), who argues for a more nuanced understanding of technological literacy that goes beyond mere technical skills. Barak (2018) discusses the evolution of electronics education, emphasizing the importance of system thinking and programming in modern technology education. This shift towards more complex, integrated approaches to technology presents challenges for both educators and students, particularly in terms of curriculum design and implementation.

Understanding student attitudes and perceptions is crucial for effective technology education. Ardies et al. (2013) developed and validated a survey instrument for measuring students' attitudes towards technology, highlighting the importance of this aspect in educational research. Building on this, Ankiewicz (2019) calls for more rigorous theoretical frameworks in attitude research, emphasizing the need for a deeper understanding of how students perceive and engage with technology. Svenningsson et al. (2018) critically examined the widely used Pupils' Attitudes Towards Technology (PATT) questionnaire, discussing the complexities of interpreting and using attitude measurements in technology education research. Their work underscores the importance of robust methodological approaches in studying student perceptions.

Project-based learning has emerged as a key approach in technology education. Fox-Turnbull (2016) analysed student conversations during technology education activities, providing insights into the development of technological thinking in primary education. This work highlights the importance of hands-on, collaborative learning experiences in fostering technological understanding. Rauscher (2011) examined the types of technological knowledge applied by students in practical tasks, emphasizing the importance of aligning curriculum design and assessment with real-world problem-solving. This aligns with the growing emphasis on user-centered design in technology education, as discussed by Khunyakari et al. (2009) in their work on design-based curricula for diverse student populations.

The role of teachers in implementing effective technology education cannot be overstated. Chikasanda et al. (2013) proposed a professional development model for technology teachers, emphasizing the need to enhance technological pedagogical knowledge and practices. This is particularly relevant in the context of rapidly evolving technological landscapes and educational paradigms. Martin (2017) analysed policy documents related to primary technology education in England, discussing the challenges of preparing teachers for technology education. This work highlights the importance of aligning teacher education with the evolving goals and methods of technology education.

De Vries (2016) provides a comprehensive overview of the philosophy of technology for educators, emphasizing the importance of philosophical understanding in technology education. This work contributes to a deeper, more nuanced approach to teaching technology that goes beyond mere technical skills. Hallström and Gyberg (2011) argue for the importance of including the history of technology in education, suggesting ways to integrate historical perspectives into technology curricula. This historical context can provide students with a richer understanding of technological development and its societal impacts.

Buckley et al. (2019) explored the use of spatial reasoning strategies in geometric problem solving, highlighting the importance of developing these skills in technology education. Their work suggests that spatial reasoning abilities play a crucial role in students' capacity to engage with complex technological problems.

Comparative studies provide valuable insights into different approaches to technology education. Autio and Soobik (2017) compared technology education in Finland and Estonia, analysing students' technological knowledge and reasoning skills. Such studies highlight both commonalities and differences in educational approaches across different cultural contexts. Koski and de Vries (2013) investigated young students' understanding of technological systems, providing implications for curriculum design in primary technology education. Their work emphasizes the importance of developing systemic thinking skills from an early age.

In Japan, the introduction of the 'triple-loop model' by the Japan Society of Technology Education in 2022 represents a substantial advancement toward aligning classroom problem-solving activities with real-world technical challenges (Japan Society of Technology Education, 2022). This model, which includes the 'Social scientific needs exploration loop,' 'Experimental science seeds exploration loop,' and 'Creation of optimal deliverables loop,' fosters a dynamic, iterative learning process (figure 1).

While previous research has examined technology education in various contexts, there is a lack of studies focusing specifically on how different production methods in materials processing learning influence Japanese junior high school students' perceptions of user needs and product improvements. This study aims to fill this gap by exploring the viewpoints of improvement and user perceptions that students develop through materials processing learning. We focus on the initial experiences of junior high school students, conducting post-study surveys to assess how different production subjects influence their understanding of user needs and product improvements.

The research questions guiding this study are:

1. How do junior high school students perceive user needs and product improvements after engaging in materials processing learning?
2. What impact do different project types (free design, choice kit, unified kit) have on students' understanding of user-centered design principles?
3. How do students' experiences in materials processing learning relate to their attitudes towards technology and future career considerations?

By addressing these questions, this study aims to contribute to the ongoing discourse on technology education reform, providing empirical evidence to inform curriculum design and teaching practices in Japan and beyond.

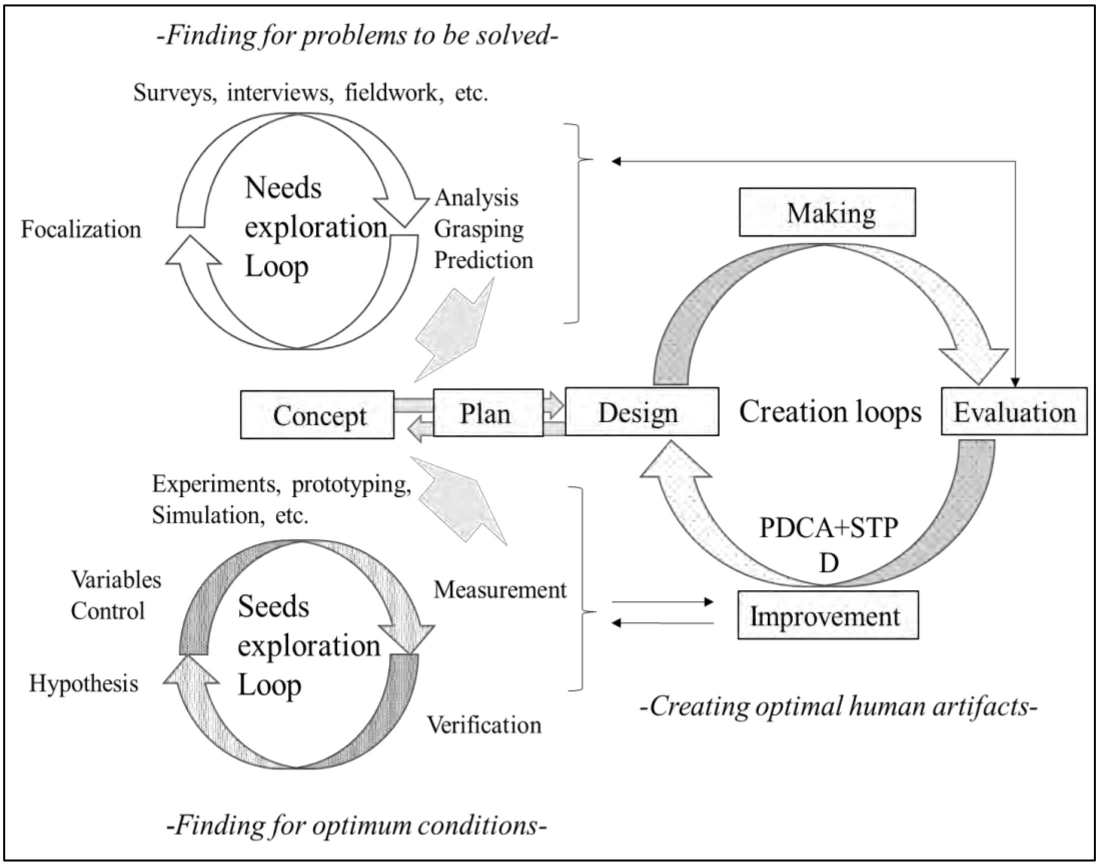

Figure 1: The triple-loop model of the technical problem-finding and solving process, The Japan Society of Technology Education (2022).

Survey Method

Justification for Survey Approach

This study employed a survey method to collect data on students' perspectives and attitudes towards materials processing learning. A survey approach was chosen for several reasons:

1. Breadth of data collection: Surveys allow for gathering information from a large number of participants efficiently, providing a broad overview of student experiences and attitudes (Creswell & Creswell, 2018).

2. Standardization: The use of a structured questionnaire ensures that all participants respond to the same set of questions, facilitating comparisons across different groups and production types (Fowler, 2013).
3. Quantifiability: Survey data can be easily quantified and analysed statistically, allowing for the identification of patterns and trends in student responses (de Vaus, 2013).
4. Compatibility with previous research: Many studies in technology education have used survey methods (e.g., Ardies et al., 2013; Svenningsson et al., 2018), allowing for potential comparisons with existing literature.

Participants and Sampling

The study involved 833 junior high school students (8th-9th grade) in Japan. After excluding incomplete or irregular responses, 721 valid responses were obtained (valid response rate: 86.6%). Participants were recruited from multiple schools to ensure a diverse sample and enhance the generalizability of findings.

Table 1. Surveyed production and number of subjects.

Type of production subject	Description	Target
free production	Free to design and produce own products. There are limitations on the size of materials used (e.g., laminated pine wood, L1800mm, W300mm, H15mm).	4 junior high schools, 366 students
choice kit	Choose from about ten different designs to fabricate. For example, choose from magazine racks, tissue boxes, accessory boxes, etc. There are limitations on the size of materials used (e.g., laminated pine wood, L1200mm, W150mm, H15mm).	2 junior high schools, 253 students
unified kit	Produce a designed book stand. The wood is vertically laid and requires little fabrication time. The size of the material is only just large enough to fabricate.	one junior high school, 102 students

Types of Production Subjects

To address the reviewers' concerns about clarity, we explicitly define the three types of production subjects involved in this study (Table 1):

1. Free design production (n = 366): Students were allowed to design and produce their own products, with limitations only on the size of materials used (e.g., laminated pine wood, L1800mm, W300mm, H15mm).
2. Choice kit (n = 253): Students chose from approximately ten different pre-designed options (e.g., magazine racks, tissue boxes, accessory boxes) to fabricate. Material limitations were similar to the free design group.
3. Unified kit (n = 102): All students in this group produced a designed book stand. The wood was vertically laid and required minimal fabrication time.

These different production types were included to investigate how varying levels of design freedom and structure might influence students' perceptions and learning outcomes. The free design production allows for maximum creativity, the choice kit offers a balance between guidance and choice, while the unified kit provides a highly structured experience. This range of approaches enables us to examine how different levels of autonomy in the design process affect students' understanding and attitudes.

Survey Instrument

The survey was conducted using a web-based tool (Google Form) to facilitate data collection and reduce data entry errors. The questionnaire consisted of two main parts:

1. Items assessing consciousness and learning experiences in 'material-processing learning':
   "I like making things" ('like making things')
   "I like the technology classes" ('like technology classes')
   "I like to think about concepts and design" ('like concept and design')
   "I am satisfied with my production in technology classes" ('satisfied with my production')
   "I would like to have a career in the future related to what I learned in my technology classes" ('career in the future')

2. These items were rated on a 4-point Likert scale: 4 (strongly agree), 3 (agree), 2 (somewhat disagree), and 1 (strongly disagree). An open-ended question assessing viewpoints and user perceptions of manufactured product improvement:
   "If you were a developer of a material processing product and wanted to improve the product you have made, for whom and in what areas would you improve it? Please describe freely without considering your skill level."

Data Collection Procedure

The survey was administered in April 2022 during regular technology classes by the students' technology teachers. This timing was chosen to capture students' perceptions shortly after completing their materials processing projects. Teachers were provided with standardized instructions to ensure consistent administration across different classrooms and schools.

Data Analysis Methods

To address the reviewers' concerns about the lack of detail on analysis methods, we provide a more comprehensive explanation of our analytical approach:

1. Quantitative Analysis:
   Descriptive statistics (frequencies, means, standard deviations) were calculated for the Likert-scale items.
   One-way analysis of variance (ANOVA) was conducted to compare responses across the three production types, with post-hoc Bonferroni tests for multiple comparisons.
   Chi-square tests were used to analyse the association between production type and categorical variables derived from the open-ended responses.
2. Qualitative Analysis of Open-Ended Responses:
   Responses to the open-ended question were analysed using a thematic content analysis approach (Braun & Clarke, 2006).
   Two researchers independently coded a subset of responses to develop an initial coding framework.
   The entire dataset was then coded using this framework, with regular meetings to resolve any discrepancies and refine the coding scheme.

Codes were grouped into broader themes related to user perception and product improvement.

3. Mixed Methods Integration:
   Results from the quantitative and qualitative analyses were integrated to provide a comprehensive understanding of students' perspectives and experiences. Triangulation of quantitative and qualitative data was used to enhance the validity of findings (Creswell & Plano Clark, 2017).

Ethical Considerations

Ethical approval for this study was obtained from [relevant ethics committee]. Informed consent was obtained from all participants and their parents/guardians. Participants were assured of the confidentiality and anonymity of their responses, and they were informed of their right to withdraw from the study at any time without consequence.

Limitations

We acknowledge several limitations of our survey method:

The cross-sectional nature of the study limits our ability to track changes in student perceptions over time.

The self-report nature of the data may be subject to social desirability bias.

The sample, while large, is limited to specific regions in Japan and may not be fully representative of all Japanese junior high school students.

These limitations will be considered when interpreting and discussing the results of the study.

Table 2. Frequency and rate of items for assessing consciousness and learning experiences toward 'material-processing learning'.

		frequency	rate
like making things	Positive	661	91.7%
	Negative	60	8.3%
like technology classes	Positive	661	92.6%
	Negative	60	7.4%
like concept and design	Positive	549	76.1%
	Negative	172	23.9%
satisfied with my production	Positive	600	83.2%
	Negative	121	16.8%
career in the future	Positive	299	41.5%
	Negative	422	58.5%

Results

Student Attitudes and Experiences

Frequencies of acquired answers in Items for assessing consciousness and learning experiences toward 'material-processing learning' were counted to understand subjects' situations (Table 2). A significant majority expressed a positive attitude toward making things (91.7%) and attending technology classes (92.6%). When it comes to the conceptual aspects of technology, such as concept and design, the positive response rate was 76.1%. Regarding satisfaction with personal production, 83.2% of students reported positive feelings. However, only 41.5% view their experiences in technology classes as positively impacting their future careers.

In addition to the overall trend, the data were tabulated by groups regarding the subject matter produced (Table 3). For 'like making things', the overall mean was 3.34 (SD = 0.64). A one-way analysis of variance by production subject showed a significant main effect of subject matter (*F* = 6.82, *p* < .01). Multiple comparisons using Bonferroni revealed significantly higher means for the Group of unified kit (M = 3.56, SD = 0.54) than for the Group of choice kit (M = 3.30, SD = 0.61) and the Group of free production (M = 3.31, SD = 0.68).

Table 3. Means, Standard Deviations, and One-Way Analyses of Variance in assessing consciousness and learning experiences toward 'material-processing learning'.

		Mean	S.D.	ANOVA	Bonferroni
like making things	all	3.34	0.64		
	unified kit	3.56	0.54		unified kit > choice kit **
	choice kit	3.30	0.61	$F_{(2,718)}$= 6.82 **	unified kit > free production **
	free production	3.31	0.68		choice kit free production *n.s.*
like technology classes	all	3.33	0.64		
	unified kit	3.54	0.54		unified kit > choice kit **
	choice kit	3.37	0.57	$F_{(2,718)}$= 9.49 **	unified kit free production *n.s.*
	free production	3.24	0.70		choice kit > free production *
like concept and design	all	2.97	0.77		
	unified kit	3.24	0.63		unified kit > choice kit **
	choice kit	3.04	0.74	$F_{(2,718)}$= 11.69 **	unified kit free production *n.s.*
	free production	2.85	0.80		choice kit > free production *
satisfied with my production	all	3.10	0.69		
	unified kit	3.27	0.63		unified kit choice kit *n.s.*
	choice kit	3.21	0.63	$F_{(2,718)}$= 12.4 **	unified kit > free production **
	free production	2.98	0.73		choice kit > free production **
career in the future	all	2.39	0.77		
	unified kit	2.53	0.80		
	choice kit	2.39	0.74	$F_{(2,718)}$= 2.02 *n.s.*	
	free production	2.36	0.79		

***p<.01*， **p<.05*

The overall mean for 'like technology classes' was 3.33 (SD = 0.64). The main effect of the subject matter was significant (*F* = 9.49, *p* < .01), with significantly higher means in the Group of choice kit (M = 3.37, SD = 0.57) and the Group of unified kit (M = 3.54, SD = 0.54) than in the Group of free production (M = 3.24, SD = 0.70).

For 'like concept and design', the overall mean was 2.97 (SD = 0.77). The main effect of subject matter was significant (*F* = 11.69, *p* < .01), with significantly higher means in the Group of choice kit (M = 3.04, SD = 0.74) and the Group of unified kit (M = 3.24, SD = 0.63) than in the Group of free production (M = 2.85, SD = 0.73).

For 'satisfied with my production', the overall mean was 3.10 (SD = 0.69). The main effect of the subject matter was significant (*F* = 12.40, p < .01), with significantly higher means in the Group of choice kit (M = 3.21, SD = 0.63) and the Group of unified kit (M = 3.27, SD = 0.63) than in the Group of free production (M = 2.98, SD = 0.73).

For 'career in the future', the overall mean was 2.39 (SD = 0.77). No significant differences were found in the main effects of the subject matter (F = 2.02, p = .53).

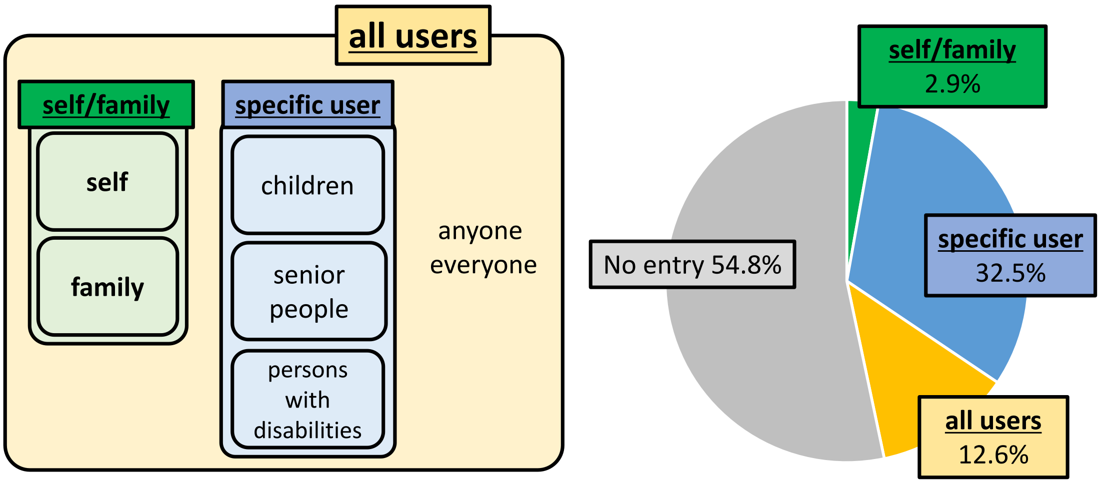

Figure 2. Distribution of User Consideration Categories in Student Projects

User Perception Analysis

When the data were tabulated, 364 descriptions (multiple responses: 326 respondents, 45.2% response rate) regarding user perception were received (Figure 2). Three categories were established from the viewpoint of user perception: 'self/family', 'specific user', and 'all users'.

Table 4 presents the frequency of responses and chi-square results of user perception across the three production types. The analysis indicated that most students (32.5%) considered specific users when completing their projects. This was consistently observed across all modalities: free production (34.7%), choice kit (28.9%), and unified kit (33.3%). When considering all users, the frequency was notably lower at 12.6% overall, with a slight variation across modalities but no significant difference (χ2 = 1.57, ns). The consideration for self or family was minimal across modalities, with the total frequency being 2.9%. Notably, no instances were recorded in the unified kit group, but the difference across groups was not statistically significant.

Table 4. Frequency of responses and chi-square results of user perception

	All (N=721)		free production (n=366)		choice kit (n=253)		unified kit (n=102)		Comparison between groups	
	frequency	rate	frequency	rate	frequency	rate	frequency	rate		
self/family	21	2.9%	14	3.8%	7	2.8%	0	0.0%		*n.s.*
specific users	234	32.5%	127	34.7%	73	28.9%	34	33.3%	$\chi^2_{(2)}$= 2.37	*n.s.*
all users	91	12.6%	48	13.1%	34	13.4%	9	8.8%	$\chi^2_{(2)}$= 1.57	*n.s.*
Total number of statements	346	48.0%	189	51.6%	114	45.1%	43	42.2%		
Total Number of Writers	326	45.2%	179	48.9%	109	43.1%	38	37.3%	$\chi^2_{(2)}$= 5.09	*n.s.*

Fisher exact test was used for those with 0 in the observed frequencies

Engagement, as measured by the total number of statements produced, was highest in the free production modality at 51.6% (189 statements) and lowest in the unified kit at 42.2% (43 statements). The rate of students' engagement, as indicated by the number of writers, followed a similar pattern, with free production having the highest engagement rate at 48.9% (179 writers) and the unified kit the lowest at 37.3% (38 writers), although no significant differences were found (χ2 = 5.09, ns).

Table 5. Category types and examples of descriptions

category	Example of description
Safety	Rounded edges with no sharp edges to prevent children from hurting themselves.
Functionality	More compartments to hold different things.
Durability	Make it sturdy so that it will not break even if it falls.
Convenience	Make it light so that it can be carried and moved easily, even by those who are not strong.
Quality	Varnish the surface to improve the feel, as a rough surface is not good.
Aesthetics	Create a variety of colors to improve the appearance of the product.
Environmental	Use environmentally friendly materials.
Economy	Consider the materials to be used to reduce the cost.

Product Improvement Analysis

There were 956 statements (multiple responses; all valid responses) regarding fabrication product improvement. The free descriptions were classified into eight categories: Safety, Durability, Functionality, Convenience, Quality, Aesthetics, Environmental, and Economy (Table 5).

Across all modalities, students most frequently considered safety (45.2%) and functionality (34.4%) (Table 6). Safety was the highest concern in the unified kit modality (52.0%), while functionality was significantly more considered in the free production modality (40.4%) than in the unified kit modality (18.6%) ($\chi 2 = 17.79$, $p < .01$).

Durability and convenience were considered relatively consistently across all modalities, with no significant differences found. However, there were notable disparities in the rate at which students considered quality and aesthetics. Quality was most considered in the free production modality (10.7%) and not considered in the unified kit modality.

Aesthetics were considered to a lesser extent than functional aspects like safety and functionality, which may suggest that practical concerns are paramount in students' minds during the design process. Environmental factors and economy were least considered by students, with only 0.4% and 0.3% consideration rates respectively.

Comparisons were also made by dividing the groups into those that described the user perspective and those that did not (Table 7). The Group with descriptions showed a higher frequency of considering safety (56.1%) than the Group without descriptions (36.5%) ($\chi 2 = 27.91$, $p < .01$). Durability was considered more frequently in the Group without descriptions (28.4%) than those with descriptions (16.0%) ($\chi 2 = 15.64$, $p < .01$). Convenience was a more prevalent concern for those who provided a description (22.1%) than those who did not (10.1%) ($\chi 2 = 19.47$, $p < .001$).

Aesthetics were more often considered by students who did not provide a description (9.1%) compared to those who did (4.0%) ($\chi 2 = 7.41$, $p < .01$). No significant differences were found in considering functionality, quality, environmental aspects, and economic factors, indicating a consistent approach to these elements regardless of description.

Table 6. Frequency of responses and chi-square results of analysis of categories related to viewpoint regarding improvement of manufactured products (comparison between the groups of production subjects)

	All (N=721)		free production (n=366)		choice kit (n=253)		unified kit (n=102)		Comparison between groups	
	frequency	rate	frequency	rate	frequency	rate	frequency	rate		
Safety	326	45.2%	168	45.9%	105	41.5%	53	52.0%	$\chi^2_{(2)}$= 3.35	*n.s.*
Functionality	248	34.4%	148	40.4%	81	32.0%	19	18.6%	$\chi^2_{(2)}$= 17.79	**
Durability	164	22.7%	83	22.7%	56	22.1%	25	24.5%	$\chi^2_{(2)}$= 0.24	*n.s.*
Convenience	112	15.5%	52	14.2%	40	15.8%	20	19.6%	$\chi^2_{(2)}$= 1.80	*n.s.*
Quality	53	7.4%	39	10.7%	14	5.5%	0	0.0%		**
Aesthetics	49	6.8%	29	7.9%	17	6.7%	3	2.9%	$\chi^2_{(2)}$= 3.13	*n.s.*
Environmental	3	0.4%	1	0.3%	0	0.0%	2	2.0%		*n.s.*
Economy	2	0.3%	2	0.5%	0	0.0%	0	0.0%		*n.s.*
	957	132.7%	522	142.6%	313	123.7%	122	119.6%		

**p<.01 Fisher exact test was used for those with 0 in the observed frequencies

Table 7. Frequency of responses and chi-square results of analysis of categories related to viewpoint regarding improvement of manufactured products (Group with description or no)

	All (N=721)		Group with description (n=326)		Group with no description (n=395)		Comparison between groups	
	frequency	rate	frequency	rate	frequency	rate		
Safety	326	45.2%	183	56.1%	144	36.5%	$\chi^2_{(1)}$= 27.91	**
Functionality	248	34.4%	114	35.0%	134	33.9%	$\chi^2_{(1)}$= 0.09	*n.s.*
Durability	164	22.7%	52	16.0%	112	28.4%	$\chi^2_{(1)}$= 15.64	**
Convenience	112	15.5%	72	22.1%	40	10.1%	$\chi^2_{(1)}$= 19.47	**
Quality	53	7.4%	19	5.8%	34	8.6%	$\chi^2_{(1)}$= 2.03	*n.s.*
Aesthetics	49	6.8%	13	4.0%	36	9.1%	$\chi^2_{(1)}$= 7.41	**
Environmental	3	0.4%	1	0.3%	2	0.5%	$\chi^2_{(1)}$= 0.17	*n.s.*
Economy	2	0.3%	2	0.6%	0	0.0%		*n.s.*
	957	132.7%	456	139.9%	502	127.1%		

**p<.01 Fisher exact test was used for those with 0 in the observed frequencies

Discussion

Student Attitudes and Experiences

The high positive responses for making things and attending technology classes suggest a strong interest in hands-on activities and the educational experiences provided in these areas. This enthusiasm for practical engagement indicates the effectiveness of the current academic approach in fostering a connection between students and technology.

However, the lower positive response rate for concept and design aspects suggests possible challenges in the more abstract elements of technology education, highlighting an area that may benefit from revised teaching strategies or enhanced curricular focus.

The structured approach, provided by unified kits, appears to resonate well with students, offering a level of guidance and clarity that might be absent in more open-ended tasks. The lower enjoyment scores in free production indicate a need for more support or instruction in the initial design phases of materials processing.

Despite structured kits leading to higher enjoyment and satisfaction in-class activities, this did not translate into a significantly increased interest in pursuing a related career in the future. This disparity suggests that while students are engaged and find value in the educational process, there is a disconnect between their academic experiences and their perceptions of technology-related careers.

User Perception and Product Improvement

The findings indicate a tendency for students to focus on specific users during materials processing tasks, which aligns with the user-centric goals of contemporary design education. However, the minimal consideration for self/family and all users suggests the need for educational strategies that encourage students to adopt a more inclusive perspective during the design process.

The higher engagement levels in free production tasks indicated that when students are given more autonomy, they are more likely to produce more statements about their work. However, this does not necessarily translate into a broader user consideration, as the frequency of considering all users was not the highest in the free production modality.

The significant difference in consideration of functionality between free production and unified kit modalities may indicate that the freedom afforded by the former allows students to explore a broader range of functional possibilities. The need for more focus on quality in the unified kit modality points to a potential area of improvement in structured educational settings.

The minimal consideration of environmental and economic factors highlights an educational opportunity to foster a more holistic understanding of product design. Integrating these considerations into project guidelines and assessment criteria could encourage students to think more critically about the broader impacts of their design choices.

The impact of descriptive engagement on prioritizing design considerations is noteworthy. Students who provided user-oriented descriptions showed a higher frequency of considering safety issues, suggesting that reflective practices may enhance awareness of key design factors. However, the tendency to overlook certain aspects like durability when providing descriptions suggests a need for prompts or checklists to address all relevant design considerations.

Conclusion and Future Issues

This study examined Japanese junior high school students' perspectives on product improvement and user perceptions in materials processing education. Our findings reveal generally positive attitudes towards materials processing learning, with students particularly enjoying hands-on activities. However, we observed a notable disconnect between students' enjoyment of technology classes and their interest in pursuing technology-related careers. This echoes findings by Ankiewicz (2019), who noted a similar gap between attitudes and career aspirations in technology education, highlighting a persistent issue in the field.

Interestingly, structured approaches such as choice kits and unified kits were associated with higher levels of student satisfaction compared to free production methods. In terms of user-centred thinking, about half of the students demonstrated user-oriented perspectives when considering product improvements. Students prioritized safety, functionality, and durability in their improvement considerations, but rarely took into account environmental or economic factors.

These findings have several implications for technology education curricula. There is a need to balance structured and open-ended design experiences, enhance the connection between classroom activities and real-world applications, and explicitly incorporate user-cantered design principles. This aligns with Williams' (2009) emphasis on technological literacy for real-world problem-solving, suggesting that curricula should foster a more comprehensive understanding of technology's role in society.

While this research provides valuable insights, it is important to acknowledge its limitations. The cross-sectional design of the study captures student perspectives at a single point in time, limiting our ability to track changes in attitudes and understanding over the course of their education. Additionally, the study's focus on specific regions of Japan may limit the generalizability of findings to other cultural or educational contexts. The reliance on self-reported survey responses may be subject to social desirability bias or limited by students' ability to articulate their thoughts and experiences. Furthermore, the study's concentration on junior high school students means that findings may not be applicable to other educational levels. Lastly, the study did not extensively investigate external factors, such as family background or prior experiences, that might influence students' perspectives and career interests.

Considering these limitations and our findings, several promising directions for future research emerge. Future studies should employ longitudinal designs to track how students' perspectives and skills in technology education evolve over time, providing insights into the long-term impacts of different educational approaches. Expanding the study to different cultural contexts could offer broader insights into the effectiveness of various approaches to technology education and help identify best practices. In-depth qualitative research exploring the reasons behind the disconnect between class enjoyment and career interest through interviews or focus groups could inform more effective career guidance strategies.

Developing and testing curriculum interventions to address the identified gaps in students' thinking could significantly enhance technology education. This approach is supported by the work of Chikasanda et al. (2013), who proposed a professional development model for technology teachers, emphasizing the need to enhance technological pedagogical knowledge and practices. Future studies should also explore how factors such as family background, socioeconomic status, and exposure to technology outside of school influence students' perspectives and career interests in technology.

To gain a more comprehensive understanding of students' experiences and thought processes in technology education, future research could benefit from mixed methods approaches, combining quantitative surveys with qualitative methods like observations and interviews. Additionally, research into innovative assessment techniques that can effectively evaluate students' development of user-centred thinking and holistic design considerations is needed.

In conclusion, while students show positive engagement with materials processing learning, there is room for improvement in fostering holistic, user-centred design thinking and connecting classroom experiences to future careers. By addressing these issues through thoughtful curriculum development and further research that takes into account the limitations of the current study, we can enhance technology education and better prepare students for the complex technological challenges they will face in the future.

References

Ankiewicz, P. (2019). Perceptions and attitudes of pupils towards technology: In search of a rigorous theoretical framework. *International Journal of Technology and Design Education, 29*(1), 37-56.

Ardies, J., De Maeyer, S., & Gijbels, D. (2013). Reconstructing the pupils' attitude towards technology-survey. *Design and Technology Education: An International Journal, 18*(1), 8-19.

Autio, O., & Soobik, M. (2017). Technological knowledge and reasoning in Finnish and Estonian technology education. *International Journal of Technology and Design Education, 27*(4), 637-654.

Barak, M. (2018). Teaching electronics: From building circuits to system thinking and programming. In M. J. de Vries (Ed.), *Handbook of Technology Education* (pp. 337-360). Springer.

Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology, 3*(2), 77-101.

Buckley, J., Seery, N., & Canty, D. (2019). Investigating the use of spatial reasoning strategies in geometric problem solving. *International Journal of Technology and Design Education, 29*(2), 341-362.

Chikasanda, V. K. M., Otrel-Cass, K., Williams, J., & Jones, A. (2013). Enhancing teachers' technological pedagogical knowledge and practices: A professional development model for technology teachers in Malawi. *International Journal of Technology and Design Education, 23*(3), 597-622.

Creswell, J. W., & Creswell, J. D. (2018). *Research design: Qualitative, quantitative, and mixed methods approaches* (5th ed.). Sage Publications.

Creswell, J. W., & Plano Clark, V. L. (2017). *Designing and conducting mixed methods research* (3rd ed.). Sage Publications.

Dakers, J. R. (2006). *Defining technological literacy: Towards an epistemological framework*. Palgrave Macmillan.

de Vaus, D. (2013). *Surveys in social research* (6th ed.). Routledge.

de Vries, M. J. (2016). *Teaching about technology: An introduction to the philosophy of technology for non-philosophers*. Springer.

European Commission. (2020). Recommendations for technology education in the European Union. https://education.ec.europa.eu/

Fowler, F. J. (2013). *Survey research methods* (5th ed.). Sage Publications.

Fox-Turnbull, W. (2016). The nature of primary students' conversation in technology education. *International Journal of Technology and Design Education, 26*(1), 21-41.

Hallström, J., & Gyberg, P. (2011). Technology in the rear-view mirror: How to better incorporate the history of technology into technology education. *International Journal of Technology and Design Education, 21*(1), 3-17.

Japan Society of Technology Education. (2022). *The New Framework of Technology and Engineering Education for Creating a Next Generation Learning*. Retrieved from https://www.jste.jp/main/data/New_Fw2021.pdf [accessed 06/09/2024]

Khunyakari, R., Natarajan, C., & Chunawala, S. (2009). Expounding a design-based tribal technology education curriculum. In A. Jones & M. de Vries (Eds.), *International Handbook of Research and Development in Technology Education* (pp. 105-114). Sense Publishers.

Koski, M. I., & de Vries, M. J. (2013). An exploratory study on how primary pupils approach systems. *International Journal of Technology and Design Education, 23*(4), 835-848.

Martin, M. (2017). Preparing teachers to teach design and technology in the primary school: A textual analysis of key policy documents in England. In M. J. de Vries (Ed.), *Handbook of Technology Education* (pp. 617-632). Springer.

Matsuda, T. (2006). The Japanese word "Gijutsu": Should it mean "skills" or "technology"? *International Journal of Technology and Design Education, 16*(3), 307-316.

Ministry of Education, Culture, Sports, Science and Technology. (2017a). *Junior High School Teaching Guide*. [translated from Japanese.] Retrieved from https://www.mext.go.jp/content/20230120-mxt_kyoiku02-100002604_02.pdf [accessed 06/09/2024]

Ministry of Education, Culture, Sports, Science and Technology (2017b). *Commentary on Junior High School Teaching Guidance for the technology education and home economics education course*. [translated from Japanese.] Retrieved from https://www.mext.go.jp/component/a_menu/education/micro_detail/__icsFiles/afieldfile/2019/03/18/1387018_009.pdf [accessed 06/09/2024]

Next Generation Science Standards (2013). https://www.nextgenscience.org/

Rauscher, W. (2011). The technological knowledge used by technology education students in capability tasks. *International Journal of Technology and Design Education, 21*(3), 291-305.

Ritz, J. M., & Fan, S. C. (2015). STEM and technology education: International state-of-the-art. *International Journal of Technology and Design Education, 25*(4), 429-451.

Svenningsson, J., Hultén, M., & Hallström, J. (2018). Understanding attitude measurement: Exploring meaning and use of the PATT short questionnaire. *International Journal of Technology and Design Education, 28*(1), 67-83.

Williams, P. J. (2009). Technological literacy: A multiliteracies approach for democracy. *International Journal of Technology and Design Education, 19*(3), 237-254.