Grasping the Actual Situation of Student's Viewpoints on the Improvement of Manufactured Products and User Perspective in Material Processing Learning

Hisashi NAKAHARA, Oita University
Correspondence: nakaharah@oita-u.ac.jp
Keita SERA, Nara University of Education
Tetsuya UENOSONO, Hirosaki University
Atsuhiro KATSUMOTO, Hokkaido University of Education
Jun MORIYAMA, Hyogo University of Teacher Education

ABSTRACT

This study aims to comprehend the actual situation in materials and processing technology learning in junior high school regarding viewpoints on improving what has been produced and students' user perception after learning. The survey subjects were 833 junior high school students (8th-9th grade) in Japan. The results showed that about half of the students needed a user-oriented viewpoint of improvement after learning material processing. When the obtained free descriptions were functionally classified, three categories (self/family, specific user, all users) were established from the viewpoint of user perception. Specifically, most students with a user perspective focused on 'specific user'. The viewpoints to improve the products were classified into eight categories: 'safety', 'functionality', 'durability', and others regarding the improvement of products. In addition, the number of statements regarding the improvement of products was higher among the students who made the products freely. This indicates that students tend to develop their viewpoints of improvement and refinement through producing and using the products they have conceived and designed.

Key Words: Material and Processing Technology Learning, User Perception, Viewpoints on the Improvement of Products

1. INTRODUCTION

This study aims to comprehend the actual situation in materials and processing technology learning in junior high school (from now on referred to as 'materials processing learning') regarding viewpoints on improving what has been produced and user perception that students have after learning.

Curriculum guidelines indicate that learning to use views and ideas that are unique to technology, such as 'To understand the phenomena in daily life and society from the viewpoint of their relation to technology and to optimize technology by focusing on social demands, safety, environmental load, economic efficiency, etc' , in junior high school technology education (The Ministry of Education, Culture, Sports, Science and Technology, 2017a). Furthermore, in that study, 'To find problems related to technology in daily life and society and to set issues' indicates that the scope of the problem to be solved as technology education is the entire society, including industry, etc., as well as everyday life around us (The Ministry of Education, Culture, Sports, Science and Technology, 2017b). It is also indicated as 'To attempt to devise and create technology appropriately and with integrity'. It positions the importance of an attitude of trying to devise and create technology to build a better life and a sustainable society, not only by trying to realize personal wishes but also by being aware of the user's and creator's standpoints. From the above, it can be said that it is essential to cultivate an attitude of ingenuity and creativity with a view to the demands of society through the production, utilization, and evaluation of subject matter in learning activities such as the production and cultivation of manufacturing, etc.

In this context, The Japan Society of Technology Education, Japan's largest academic research organization for technology education, published 'The New Framework of Technology and Engineering Education for Creating a Next Generation Learning'(2022). In this recommendation, it is essential that the problem-finding and solving process of students developed in the classroom is isomorphic to the process of solving technical problems such as production, development, and invention developed in society and that the elements to be included in the problem finding and solving process should be in line with the engineering design process in society. The triple-loop model of the technical problem-finding and solving process is presented as a concept that embodies such an engineering design process. This is a loop that leads to the 'Social scientific needs exploration loop' and 'Experimental science seeds exploration loop', with sufficient learning and its results leading to the 'Creation of optimal deliverables loop' , and back and forth between the loops as appropriate. As a result, 'Cognitive Science' and 'Design Science' bridge in terms of the application of their findings and methods. In addition, it is essential for the 'Technological problem-finding and problem-solving process in line with the developmental stages of students' to situate the 'Problem finding and solving process using the triple-loop model' in the school curriculum. Expressly, it is noted that it is essential to cultivate the ability to identify and solve technical problems in line with the triple-loop model with elements such as user assumptions, needs identification, and seed exploration as developmentally appropriate technical activities are developed.

Thus, in the technology education curriculum, it is essential to incorporate problem-finding and understands needs by assuming users in carrying out projects through the engineering design process. However, in technology education in Japan, perspectives on understanding user assumptions and needs have yet to be considered necessary. Possible reasons include an emphasis on traditional classroom practices, insufficient class time, uniformity of subject matter, environmental improvement, lack of technological literacy development at the elementary school level, etc. Therefore, in this study, we attempted to understand in an exploratory manner what kind of viewpoints of improvement students may have after the fabrication of the manufactured product and actual utilization of the product in Learning technology education, and what kind of user perception they specifically have in that case. Specifically, we shall focus on material processing learning positioned first in junior high school, conduct a survey of students after the study., and examine how the difference in production subject expresses the description of user and product improvements.

2. SURVEY METHOD

The subjects were 833 junior high school students (8th-9th grade) in Japan. The survey was conducted using a web tool (Google Form). The data were tabulated after excluding those with incomplete or regular responses. 721 valid responses were obtained (valid response rate, 86.6%). The subjects of the survey were of three types: free design production subjects (from now on referred to as ‘free production’), kit subjects who could choose from several productions (from now on referred to as ‘choice kit’), kit subjects whose productions were unified (from now on referred to as ‘unified kit’). Table 1 shows the specific contents.

We prepared the items for assessing students' experiences and consciousness. The prepared questionnaire for the survey had two parts: (1) Items for assessing consciousness and learning experiences in ‘material-processing learning’ and (2) Items for assessing viewpoints and user perceptions of manufactured product improvement.

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

Items for 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’). 4) 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’).

Items for 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.'

The survey was conducted in technology classes by technology teachers in April 2022. Subjects rated their agreement in a survey (1), choosing one of the following four responses: 4, I strongly agree; 3, I agree; 2, I somewhat disagree; and 1, I strongly disagree. In a survey (2), respondents were asked to respond in the form of open-ended questions.

3. RESULTS AND DISCUSSION

Frequencies of acquired answers in Items for assessing consciousness and learning experiences toward 'material-processing learning' were counted to understand subjects' situations (Table 2). As a result, affirmative responses in 'like technology classes' showed the highest rate with 92.6%. On the other hand, affirmative responses in 'career in the future' showed the lowest rate with 41.5%. Next, the mean and S.D. were calculated. In addition to the overall trend, the data were tabulated by groups regarding the subject matter produced (Table 3). In addition, the data for (1) were tabulated for the overall and subject-specific groups. For 'like making things', the overall mean was 3.34 and S.D. was 0.64. A one-way analysis of variance by production subject showed a significant main effect of subject matter. Multiple comparisons using Bonferroni revealed significantly higher means for the Group of unified kit than for the Group of choice kit and the Group of unified kit than for the Group of free production. The overall mean for 'technology classes' was 3.33 and S.D. was 0.64. The main effect of the subject matter was significant, with significantly higher means in the Group of choice kit and the Group of unified kit than in the Group of free production. For 'like concept and design', the overall mean was 2.97 and S.D. was 0.77. The main effect of subject matter was significant, with significantly higher means in the Group of choice kit and the Group of unified kit than in the Group of free production. For 'satisfied with my production', the overall mean was 3.10 and S.D. was 0.69. The main effect of the subject matter was significant, with significantly higher means in the Group of choice kit and the Group of unified kit than in the Group of free production. For 'career in the future', the overall mean was 2.39 and S.D. was 0.77. No significant differences were found in the main effects of the subject matter. These results indicate that the subjects of this survey had a positive view of the manufacturing and technology classes and tended to be highly satisfied with the work produced in the classes. Comparison between groups showed this tendency was extreme in the Group of unified kit.

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%

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*

Next, the free descriptions obtained in question (2) were classified into two categories: those related to user perception and those related to product improvement. The free descriptions obtained were classified into two categories: those related to user perception and those related to product improvement. An example description, 'To make the corners a little more shaved and rounded so that children can use it safely and not get hurt when touching it' was given to the student who made a toilet paper holder as a free production, 'Make it waterproof so that it will not break or get dirty when used in the kitchen for my parents who cook' to the student who made a spice rack as a choice kit, and 'I put various patterns and colours on it so that people of different generations can use it' to the student who made a bookshelf as a unified kit.

First, (1) the viewpoint of 'for whom' was classified as 'user perception', and (2) the viewpoint of 'what parts should be improved' was tabulated as 'viewpoint regarding improvement of manufactured products'. As a result, in the case of the description above, 'To make the corners a little more shaved and rounded so that children can use it safely and not get hurt when touching it', it was classified as (1) specific users and (2) safety. Similarly, in the case of the statement, 'Make it waterproof so that it will not break or get dirty when used in the kitchen for my parents who cook', we classified the statement into (1) self/family and (2) functionality. In the case of the statement, 'I put various patterns and colours on it so that people of different generations can use it', it was classified into (1) all users and (2) aesthetics.

When the data were tabulated in the above order, 364 descriptions (multiple responses: 326 respondents, 45.2% response rate) were received regarding user perception. When the obtained free descriptions were functionally classified, three categories were established from the viewpoint of user perception. The first was descriptions that focused on the lifestyle of family members, including oneself, and attempted to respond to the living environment and individual characteristics (from now on referred to as 'self/family'). The second category was descriptions that focused on needs arising from psychological and physical characteristics derived from age groups, personality and physical characteristics derived from individuals, lifestyles, preferences, occupations, social roles, etc. (from now on referred to as 'specific user'). Lastly, the descriptions considered users in an all-encompassing manner, such as universal design (from now on referred to as 'all users'). The response rates were compared among the groups, and no significant differences were found (Table 4).

There were 956 statements (multiple responses; all valid responses) regarding fabrication product improvement. The free descriptions were classified functionally in the same way as user perception and were classified into eight categories: Safety, Durability, Functionality, and others. Table 5 shows the categories and examples of the descriptions. Overall, the 'Safety' category received the highest responses, followed by 'Durability' and 'Functionality' (Table 6). A comparison between the groups of production subjects showed significant differences in response rates in 'Functionality' and 'Quality' improvement categories. Comparisons were also made by dividing the groups into those that described the user perspective and those that did not (Table 7). As a result, significant differences in response rates were found in the categories of 'Safety', 'Durability', 'Convenience', and 'Aesthetics'. These results indicate that students' perceptions of users tend to focus on specific needs. In addition, it was found that the viewpoints on the improvement of the manufactured products varied depending on the subject matter of the product.

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

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.

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

4. CONCLUSIONS AND FUTURE ISSUES

In this study, the following findings were obtained from an open-ended survey of students' viewpoints on improving manufactured products and their perceptions of users after learning materials processing in the technology education.

About half of the students needed a user-oriented viewpoint of improvement after learning material processing. On the other hand, most of the students who had a user perspective focused on 'specific users,' or in other words, on usability. Moreover, no differences were found when the production subjects compared the user perceptions. From these facts, it can be pointed out that, as in free production, it is not possible to assume a variety of users because conceptual and design activities are performed, but the importance of appropriately positioning learning about the demands of society and learning to identify problems by envisioning users and understanding their needs can be pointed out. The viewpoints to improve the products, such as 'safety', 'functionality' and 'durability' were formed regarding the improvement of the products. In addition, the number of statements regarding the improvement of products was higher among the students who made the products freely. This indicates that students tend to develop their viewpoints of improvement and refinement through producing and using the products they have conceived and designed. Furthermore, the subjects differed in their viewpoints on product improvement. Specifically, it is considered essential to learn more about 'functionality' and 'quality' in the case of a unified kit and 'safety' in the case of a choice kit.

However, since this survey did not allow for comparisons of the same sample size regarding grades and production contents, more detailed surveys are needed. In addition, detailed analysis (e.g., text mining) will be conducted, and surveys will continue to be conducted to understand the actual situation in other learning contents.

5. REFERENCES

The Ministry of Education, Culture, Sports, Science and Technology (2017a). *Junior High School Teaching Guide*, https://www.mext.go.jp/content/20230120-mxt_kyoiku02-100002604_02.pdf (Japanese)

The 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*, https://www.mext.go.jp/component/a_menu/education/micro_detail/__icsFiles/afieldfile/2019/03/18/1387018_009.pdf (Japanese)

The Japan Society of Technology Education (2022). *The New Framework of Technology and Engineering Education for Creating a Next Generation Learning*. https://www.jste.jp/main/data/New_Fw2021.pdf (Japanese)

Further Guidance Academic Writer Tutorial: Basics of Seventh Edition APA Style - Overview