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A 5-Month Comparative Study of Japanese Input Speed by Keyboard of Elementary School Children Learning with 1:1 Devices for the First Time

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Abstract

This study involved a 5-month investigation of Japanese input skills by keyboard of elementary school children learning with 1:1 devices for the first time. Participants were from two classes of elementary schools. The Class X was 4th grade, and the Class Y was 6th grade. The input speed improved in 3rd, 4th, and 5th months compared to 2nd month after the start of utilization. The input speed while copying by looking at the text increased as the months went by. However, the results suggest that the speed of input while thinking by reading the text does not necessarily improve in the same way. We divided the survey results into two groups based on input speed by keyboard. In the upper group, 6th graders were higher than 4th graders, although there was no significant difference. In the lower group, 6th graders were significantly lower than 4th graders in 3rd, 4th, and 5th months. Therefore, it is necessary to pay particular attention to supporting the acquisition of Japanese input skills by keyboard, especially for children in the lower group.

Keywords: 1:1 devices, information and communication technology operation skills, Japanese input skills by keyboard, information literacy

1 Purpose of This Study

In Japan, a new elementary school curriculum was launched in April 2020. This curriculum includes information literacy in the attributes and abilities that form the basis of learning [1]. 1:1 devices were provided to all elementary and junior high school students under the "GIGA (Global and Innovation Gateway for All) school concept" by the Ministry of Education, Culture, Sports, Science and Technology (MEXT) at the end of FY2020 [2]. Starting in April 2021,

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learning activities utilizing 1:1 devices will be implemented in elementary and junior high schools all over Japan.

Reference [3] states that we need to incorporate technology and connection making into learning in a digital society where the lifespan of knowledge is shortening, and we cannot learn everything through experience alone. Connectivism, which deals with learning that occurs not only within oneself but also outside (in organizations and databases), is learning in the age of the "GIGA school concept" where each student has an information terminal access to knowledge and networks inside and outside the classroom. Reference [4] states that the knowledge of the digital age is content and skills. The skills needed in such an era include "communication skills," "the ability to learn independently," "thinking skills," and "digital skills." The content and skills are similar to those listed in the content and skills of school curriculums in Japan. Although this reference mentioned higher education, it is an urgent issue for elementary and junior high schools to acquire the basics of "digital skills," especially after the introduction of 1:1 devices.

Reference [5] states that "one major issue when they do such learning activities is that there are big individual differences in Japanese keyboarding skills" (p. 754) for learning to use computers. Children with high Japanese input skills by keyboard can quickly finish entering the results of their studies and can devote more time to improving the quality of the content. While, children with insufficient Japanese input skills by keyboard spend a lot of time simply entering the results of their studies and have no time for gaining a good understanding of the content itself, which is the main object. With high keyboarding skills, children can spend less time typing and devote more time to learning. Reference [3] concluded that "in elementary schools, children's keyboarding skills affect the quality of learning." In Japan, Japanese input skills by keyboard are considered to be a fundamental requirement of information and communication technology (ICT) literacy.

1:1 devices were provided to all elementary school children under the "GIGA school concept." Many children learned using these devices for the first time in a classroom environment. Participants in this study were elementary school children with no experience of learning with 1:1 devices. Moreover, the teachers in the classes had no experience regarding teaching lessons that children learn with 1:1 devices. We investigated the acquisition status of ICT operation skills of these children using 1:1 devices. This study was conducted prior to classroom environment introduced by the "GIGA(Global and Innovation Gateway for All) school concept" [4]. Study participants were children in 4th and 6th grade classes. This study evaluated the Japanese input skills by keyboard of these elementary school children. Additionally, the basic 1:1 device operation and application operation skills of these children were investigated and analyzed. Results of this study found that the Japanese keyboard input speed significantly increased 2nd, 3rd, and 4th months after the children starting using the 1:1 devices. It was confirmed that the difference was narrowed, although the speed of input while copying by looking at the text was faster than the speed of input while thinking by reading the text. Although the grades and teachers differed, there was no significant difference between the classes, suggesting the effect of introducing 1:1 devices environment was independent of the grade or teacher. There was no significant difference in the results for each class. Therefore, in this study, each class is divided into the upper and lower groups of the same number of children according to the input speed. Then this study provides a detailed analysis of each of the upper and lower groups.

In this study, the data of the 5th month was added to the 4-month survey conducted in the previous study [7], and the data was reanalyzed and revised/corrected.

2 Japanese Input Skills by Keyboard

2.1 Input Skills by Keyboard

First, what kind of skills are input skills by keyboard? According to references [8] and [9], input skills by keyboard consist of three facets; "perceptual-motor, sensory-motor and conceptual-motor skills." Input skills are considered as "a perceptual-motor skill, since learners are transferring text from a book or notes and must plan the layout of the document, while with the use of their fingers (perceptual-motor skills) they are keying in the information on the keyboard." From another perspective, the skills are seen as a "sensory-motor skill, since, on the keyboard, learners must learn where the keys are situated while they type in data." In addition, input skills function as "a conceptual-motor skill, because learners must formulate sentences while they type."

Next, when is the best age to be taught input skills by keyboard? Regarding this question, the literature [10] as a review article states that studies have suggested no magic number for the best grade level in elementary school. For example, [11] found that 1st and 2nd graders could learn the skills whereas Fleming taught them to 3rd graders [10]. Reference [12], however, indicated that "formal keyboarding should not begin until the fifth or sixth grade." Although previous studies have differing views on what graders should be taught input skills, [11] states that "it is a skill that needs to be addressed in the elementary curriculum at some point." Considering that this skill is a motor skill, the researcher also asserts the significance of having a keyboard for every student in the classroom as it trains their fingers to be able to respond correctly and quickly.

2.2 Japanese Input by Keyboard

Japanese sentences are composed of "Kanji" and "Kana." Users cannot directly input Japanese sentences by typing the alphabet with the keyboard. According to [3], the common method of Japanese input using a QWERTY keyboard is "Roman alphabet typing." In Roman alphabet typing method, combinations of Roman alphabetic characters representing kana characters are entered using a QWERTY keyboard. First, the user thinks about the Roman alphabet notation of the kanji and kana to input (for example, "仮名を" is converted to "KANAWO") and type Roman alphabet by keyboard (for example, "K, A, N, A, W, O"). Next, a front-end processor automatically converts these characters to hiragana (for example, "KANAWO" is converted to "かなを"), then highlight them. In the third step, the user must press the conversion key to convert to kanji and kana (for example, "かなを" is converted to "仮名を"). However, when converting to kanji and kana, one pronunciation often corresponds to multiple kanji. Thus, the user must select and confirm the appropriate kanji from several potential candidates presented by the front-end processor. In other words, for Japanese input by keyboard, it is necessary to be able to remember the Roman alphabet notation and type with the QWERTY keyboard and select the appropriate kanji for confirmation before conversion to kanji and kana. The process of Japanese input by QWERTY keyboard becomes automatic once it is learned, but practicing is required in the early learning stages.

2.3 The Actual Situation of Japanese Input Skills by Keyboard

Reference [13] observed "Regarding of the effect of the amount of learning to improve the speed of keyboarding, 5th and 6th graders were able to improve their typing speed with fewer amount of learning comparing to 3rd and 4th graders. However, 3rd and 4th improved their keyboarding skills as well as 5th and 6th graders expect Katakana." However, this was observed when it was standard to provide 1:1 computers in one computer room per elementary school. Additionally, [14] conducted a survey to evaluate Japanese input skills by keyboard, software operation skills, and information literacy for junior high schools that have introduced 1:1 devices in the classroom. Japanese input skills by keyboard can be improved by using 1:1 devices. However, if 1:1 devices are used only during lesson, the improvement is limited. [13]; notably, it is possible to further improve these skills through basic practice and the independent use outside of lesson.

2.4 Comparison of English Input Skills and Japanese Input Skills by Keyboard

In other countries such as the United States, surveys of English input by keyboard have been conducted in elementary schools for some time. As an example, [15] provided keyboard input practice using two different teaching methods. One was a teacher-led method, and the other was a software-led method. After the teaching, the average typing speed of the 3rd, 4th, and 5th grade groups was measured; the average speeds of the teacher-led method were 5.1, 6.5, and 8.4 words per minute, respectively, which was achieved in 12 weeks. The average speed of the software-led method was 6.4, 7.8, and 9.8 words per minute, respectively, which was achieved in 21 weeks. However, these results are word input speeds in English and cannot be simply compared with Japanese input requiring conversion and confirmation.

3 Research Method

3.1 Target and the Timing of Survey

The 1:1 devices used in this survey were Chromebooks (Acer Chromebook 11 C732 LTE model) that conform to the specifications of the GIGA school concept. We provided a Chromebook to each child in the study. The children used these devices for five months (i.e., from Sep. 2020 to Jan. 2021).

Table 1 details the surveyed schools, classes, children, and teachers. We targeted two schools with principals and boards of education who permitted the use of the 1:1 devices in specific classes. One of the classes included in this survey was selected because the children had no prior experience learning in 1:1 devices environment. Also, the teacher had no experience teaching in 1:1 devices environment.

Table 1: Overview of Schools, Classes, Children, and Teachers in This Study

	Class X	*Class Y*
School (number of classes)	A Prefecture, B City Elementary School (33 Classes)	C Prefecture, D City Elementary School (17 Classes)
Children	4th grade, 32 children	6th grade, 35 children
ICT utilization in the class before the introduction of 1:1 devices	Occasionally used shared iPad at school, and using a shared tablet PC at School freely almost every day	Searched on the internet and created slides several times using the shared tablet PC at school
Years of teaching experience	8	6
Years of teacher experience educating using ICT	5	0
Previous frequency of ICT use in the classroom	Daily	A few times each month
Years of ICT use in the classroom	8	0
Years of experience teaching Japanese input skills	7	0

3.2 Survey Outline

When children use 1:1 devices as tools for recording text, the following two scenarios are possible. In the first scenario, the children copy and input what they see into the 1:1 device. This scenario is the same as when children copy what they see on a blackboard into a notebook. In the second scenario, children enter their thoughts and feelings into the 1:1 device. This scenario is the same as when the children write a composition and so on. Therefore, we prepared two situations of Japanese input by keyboard in this survey. In the first situation, the children input a specific text as they see (hereafter referred to as "copied input"). In the second situation, the children read a question and input what they know, think, and feel (hereafter referred to as "thinking input").

3.3 Survey Method

The question texts were created from 4th and 5th grade textbooks that were not adopted in the surveyed schools. The same questions were used in both classes. The first level of the Japanese word processor test is level 4. At level 4, the range of question texts that measure accuracy and speed range from 400 to 500 characters and the percentage of kanji is 23%–26%. The question texts both of the copied input and thinking input followed these questions.

For each of the copied and thinking inputs, we asked children to input as the text of Google Docs for 10 minutes after confirming the question text at once with 1:1 devices. The remaining time was displayed on the monitor in front of the classroom, and when all the questions were input as the copied input, the children themselves recorded the remaining time. The thinking input of 10 minutes included thinking time.

First, we obtained the text shared in the cloud. Next, we decided that "one character is reduced for one input error." based on the test standard of the Japanese word processor test at level 4. Then we calculated the characters per minute (CPM) (i.e., how many characters can be entered in one minute). When the child finished inputting the complete set of question text as copied input early, the CPM was calculated after subtracting the remaining recorded time from the 10 minutes.

The survey was conducted monthly in Oct., Nov., Dec. 2020, and Jan. 2021. The first survey in Oct. was the 2nd month after the introduction of 1:1 devices in the classroom. Each of the four surveys used a different set of questions.

Further, the survey was completed with five assessments because Class Y 6th grade was unable to secure time for the survey before graduation.

Table II shows the grades, subjects, and contents of the textbooks referred to when creating the questions. Figure 1 is an example of a problem.

Table 2: Grade, Subject, and Content of the Questions

	Copied Input			***Thinking Input***		
	Grade	Subject	Content	Grade	Subject	Content
2nd month	5th grade	Japanese	Global warming	4th grade	Science	How to see the moon
3rd month	4th grade	Music	Your voice	5th grade	Japanese	Dialect
4th month	4th grade	Japanese	Proposal to the town	4th grade	Japanese	Keyboard input
5th month	5th grade	Science	Weather information	5th grade	Japanese	Newspaper

3.4 Analysis

In both the copied and thinking inputs, the input speed increased during 2nd month through 4th month, but the main effects of the class and the interactions related to the class were not statistically significant. However, since the standard deviation (*SD*) of the CPM was 14.5 for the thinking input in the Class Y for the 4th month, we decided to divide each class into an upper group and a lower group based on a child's input speed and performance analysis.

3.5 Interview

A semi-structured interview was conducted with each classroom teacher to find out what kind of instruction and learning activities are provided for Japanese input by keyboard.

The interviews were conducted using Google Forms and the direct message function of Slack, a communication tool.

First, the first author used the questionnaire function of Google Forms to present the methods of teaching Japanese input using the keyboard, such as romaji and home position, and the use of practice websites as well as asked whether these methods were used. The homeroom teachers were asked to respond to these questions. We also asked them to freely describe other methods they used in the form.

After reviewing the form answers, we asked additional questions in Slack's direct message, if necessary.

4 Results

4.1 Overall Results

In the four surveys, we could obtain quality data in both the copied and thinking inputs for 28 children in Class X and 25 children in Class Y. Thus, a total of 53 children participated in the survey.

Table 3 shows the CPM mean and *SD* of each class and overall.

Table 3: The CPM Mean and *SD* in Each class and Overall

		Copied Input				Thinking Input			
		2nd mo.	3rd mo.	4th mo.	5th mo.	2nd mo.	3rd mo.	4th mo.	5th mo.
Class X	M	22.7	27.4	30.1	38.9	18.3	25.8	30.9	32.6
$n = 28$	*SD*	5.4	6.5	6.2	8.4	5.4	6.5	7.2	9.5
Class Y	M	24.6	27	33	34.7	18.7	24.5	30	27.9
$n = 25$	*SD*	9.9	9.9	10.9	10.4	9.2	10.7	14.5	16.2
Overall	M	23.6	27.2	31.5	36.9	18.5	25.2	30.5	30.4
$N = 53$	*SD*	7.9	8.3	8.8	9.7	7.5	8.8	11.3	13.3

Figure 1 (a) shows the trend of the overall means, and Figures 1 (b) and (c) show the trend of the means of Class X and Class Y, respectively.

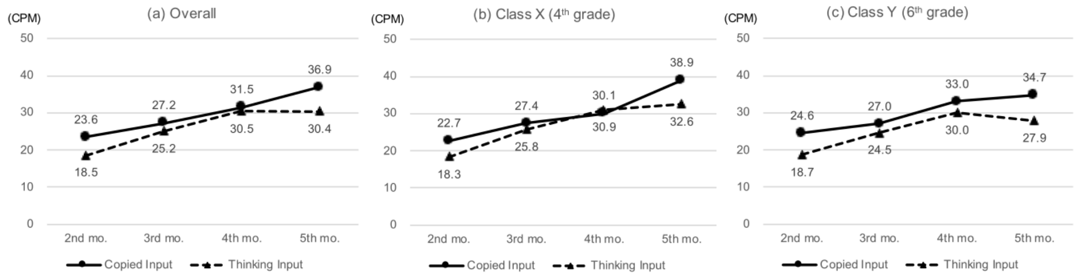

Figure 1: Trend of Means

A three-factor analysis of variance (3-factor ANOVA) was performed for each CPM mean of the 53 copied and thinking inputs. The factors in this analysis were factor A = class, factor B = copied input or thinking input (hereafter referred to as input situation), and factor C = survey timing (hereafter referred to as timing).

The results of the 3-factor ANOVA for Overall were:

Factor A = the main effect of class (F (1,51) = 0.118, p = 0.732, ηp^2 =0.002) was not significant. Factor B = the main effect of input situation (F (1,51) = 25.399, p = 0, ηp^2 = 0.332) was significant. Factor C = the main effect of timing (F (3,153) = 94.444, p = 0, ηp^2 =0.649) was significant.

The first-order interactions class × timing (F (3,153) = 5.256, p = 0.001, ηp^2 = 0.093) and input situation × timing (F (3,153) = 8.38, p = 0, ηp^2 = 0.141) were significant, class × input situation (F (1,51) = 1.215, p = 0.275, ηp^2 = 0.023) was not significant.

The second-order interaction was not significant (F (3,153) = 0.752, p = 0.522, ηp^2 = 0.015).

The results of the simple main effect tests for class × timing: the simple main effect of the class was not significant in any timing (adj ps > 0.261). However, the simple main effect of timing was significant in both Class X (F (3,153) = 68.377, adj p = 0, ηp^2 = 0.573) and Class Y (F (3,153) = 33.309, adj p = 0, ηp^2 = 0.395). As a result of multiple comparison (α = 0.05, two-sided test) using a paired t-test, statistically significant difference was observed in Class X, which was 2nd mo. (mean of 20.5) < 3rd mo. (mean of 26.6), 4th mo. (mean of 30.5), 5th mo. (mean of 30.5), 3rd mo. (mean of 26.6) < 4th mo. (mean of 30.5), 5th mo. (mean of 30.5), and 4th mo. (mean of 30.5) < 5th mo. (mean of 30.5). There was also a statistically significant difference in Class Y, which was 2nd mo. (mean of 21.6) < 3rd mo. (mean of 25.8), 4th mo. (mean of 31.5), 5th mo. (mean of 31.3), 3rd mo. (mean of 25.8), 4th mo. (mean of 31.5), 5th mo. (mean of 31.3), 3rd mo. (mean of 25.8) < 4th mo. (mean of 31.5), and 5th mo. (mean of 31.3); there was no significant difference between 4th mo. and 5th mo.. Figure 2 shows the profile of means in class × timing for the overall.

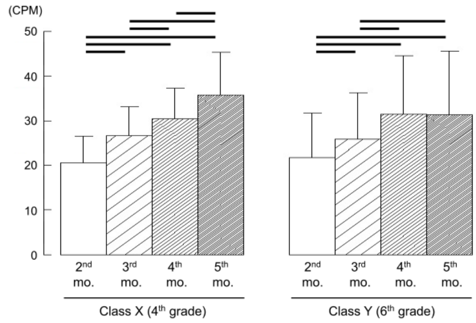

Figure 2: The Profile of Means in the Class × Timing (the Overall).

Next, the results of the simple main effect tests for input situation × timing: the simple main effect of input situation significant in 2nd mo. (F (1,51) = 11.921, adj p = 0.001, $\eta p^2 = 0.19$), and 5th mo. (F (1,51) = 20.042, adj p = 0, $\eta p^2 = 0.282$).

As a result of multiple comparison (α = 0.05, two-sided test) using a paired t-test, there was statistically significant difference in copied input, which in 2nd mo. (mean of 23.6) < 3rd mo. (mean of 27.2), 4th mo. (mean of 31.5), 5th mo. (mean of 36.9), 3rd mo. (mean of 27.2) < 4th mo. (mean of 31.5), 5th mo. (mean of 36.9), and 4th mo. (mean of 31.5) < 5th mo. (mean of 36.9). There was also statistically significant difference in the thinking input, which in 2nd mo. (mean of 18.5) < 3rd mo. (mean of 25.2), 4th mo. (mean of 30.9), 5th mo. (mean of 30.4), 3rd mo. (mean of 25.2), 4th mo. (mean of 30.9), 5th mo. (mean of 30.4), 3rd mo. (mean of 25.2) < 4th mo. (mean of 30.9), and 5th mo. (mean of 30.4); there was no significant difference between 4th mo. and 5th mo.. Figure 3 shows the means profile input situation × timing for the overall.

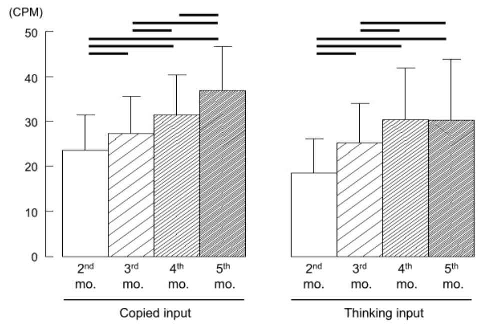

Figure 3: The Profile of Means in Input Situation × Timing (the Overall).

Reference [16] was used to adjust the p-values.

4.2 Grouping Based on Japanese Input Speed

The mean of all CPMs for each child was calculated and divided into two groups based on the input speed. There were 14 children in each group in the Class X. There were 25 children in the Class Y. Twelve of these children were assigned to each group. In the Class Y, one child with a CPM average rank was 13th in the class was excluded.

Table 4 shows the CPM mean, SD, and t-test (between participants) for each of the upper and lower groups of copied input and thinking input at each survey timing.

Table 4: The CPM Mean and *SD* and *T*-Test (between Participants) by the Upper and Lower Input Speed Groups

		2nd mon.		3rd mon.		4th mon.		5th mon.	
		Copied Input	Thinking Input	Copied Input	Thinking Input	Copied Input	Thinking Input	Copied Input	Thinking Input
Upper Group	M	28.3	23	32.7	31	37.9	38	41.1	36.5
$n = 26$	*SD*	7.3	7.7	7.1	7.9	6.6	9.7	8.6	13.5
Lower Group	M	18.9	14.2	21.9	19.5	25	22.9	32.8	24.4
$n = 26$	*SD*	5.4	3.7	5.7	5.4	5.6	7.2	9	10.4
	t	5.11	5.15	5.94	6.04	7.42	5.47	3.32	3.54
		**	**	**	**	**	**	**	**

**: $p < 0.01$

There was a significant difference at the 1% level between the upper group and the lower group in the CPM for each survey problem of copied input and thinking input at each survey event. Therefore, it is considered that all of the survey problems were appropriate.

Next, a three-factor analysis of variance was performed for each of the upper and lower groups. The factors in this analysis were factor A = class, factor B = input situation, and factor C = timing.

4.3 Upper Group Results

Table 5 shows the CPM mean and *SD* in the upper group.

Table 5: The CPM Mean and *SD* (the Upper Group)

		Copied Input				Thinking Input			
		2nd mo.	3rd mo.	4th mo.	5th mo.	2nd mo.	3rd mo.	4th mo.	5th mo.
Class X	M	25.8	31.1	34.7	41.7	21.8	30.3	35.0	34.3
$n = 14$	*SD*	5.0	5.4	5.1	9.4	4.9	5.2	4.9	10.7
Class Y	M	31.9	34.5	42.2	41.8	25.0	32.3	40.8	37.5
$n = 12$	*SD*	7.8	8.3	5.6	5.9	9.6	9.7	12.7	17.1
Overall	M	28.6	32.6	38.1	41.7	23.3	31.2	37.7	35.8
$N = 26$	*SD*	7.1	7.1	6.5	8.0	7.6	7.7	9.8	14.1

The results of the three-factor analysis of variance for the upper group were:

Factor A = the main effect of class (F (1,24) = 2.181, p = 0.152, ηp^2 = 0.083) was not significant. Factor B = the main effect of input situation (F (1,24) = 6.584, p = 0.017, ηp^2 = 0.215) was significant. Factor C = the main effect of timing (F (3,72) = 54.147, p = 0, ηp^2 = 0.693) was significant.

For first-order interactions, input situation × timing (F (3,72) = 3.787, p = 0.014, ηp^2 = 0.136) was significant. Class × input situation (F (1,24) = 0.071, p = 0.792, ηp^2 = 0.003) and class × timing (F (2,48) = 3.204, p = 0.049, ηp^2 = 0.118) were not significant.

The second-order interaction was not significant (F (3,72) = 0.941, p = 0.425, ηp^2 =0.038).

As a result of the simple main effect test, the simple main effect of input situation was 2nd mo. (*F* (1,24) = 4.422, adj $p = 0.069$, $\eta p^2 = 0.156$) and 5th mo. (*F* (1,24) =5.043, adj $p = 0.068$, $\eta p^2 = 0.174$). The copied input (mean of 28.6) > thinking input (mean of 23.3) in the 2nd mo. and copied input (mean of 41.7) > thinking input (mean of 35.8) in 5th mo..

The simple main effect of input situation × timing was timing in copied input (*F* (3,72) = 25.243, adj $p = 0$, $\eta p^2 = 0.513$), and in thinking input (*F* (3,72) = 31.707, adj $p = 0$, $\eta p^2 = 0.569$ which are significant. As a result of multiple comparison ($\alpha = 0.05$, two-sided test) using a paired *t*-test, statistically significant difference was observed in copied input, which was 2nd mo. (mean of 28.6) < 3rd mo. (mean of 32.6), 4th mo. (mean of 38.1), 5th mo. (mean of 41.7), 3rd mo. (mean of 32.6) < 4th mo. (mean of 38.1), 5th mo. (mean of 41.7), and 4th mo. (mean of 38.1) < 5th mo. (mean of 41.7). There was also a statistically significant difference in thinking input, which was 2nd mo. (mean of 23.3) < 3rd mo. (mean of 31.2), 4th mo. (mean of 37.7), 5th mo. (mean of 35.8), 3rd mo. (mean of 31.2) < 4th mo. (mean of 37.7), and 5th mo. (mean of 35.8). Figure 4 shows the profile of the means in input situation × timing for the upper group.

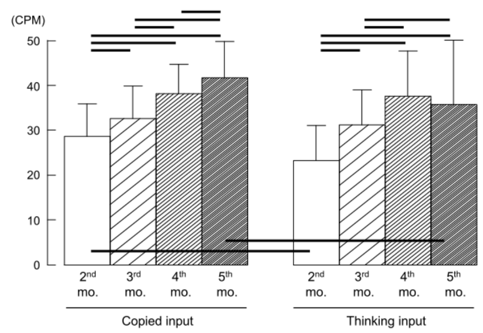

Figure 4: The Profile of Means in Input Situation × Timing (the Upper Group).

Reference [16] was used to adjust the *p*-values.

4.4 Lower Group Results

Table 6 shows the CPM mean and *SD* in the lower group.

Table 6**:** The CPM Mean and *SD* (the Lower Group)

		Copied Input				Thinking Input			
		2nd mo.	3rd mo.	4th mo.	5th mo.	2nd mo.	3rd mo.	4th mo.	5th mo.
Class X	M	19.5	23.8	25.6	36.2	14.8	21.3	26.9	30.8
n = 14	SD	3.9	5.3	3.1	7.8	3.3	4.2	6.8	7.8
Class Y	M	17.2	19.6	23.5	27.3	13.1	17.4	20.0	17.7
n = 12	SD	5.8	5.1	6.3	9.2	3.3	5.4	7.3	7.7
Overall	M	18.4	21.9	24.6	32.1	14.0	19.5	23.7	24.8
N = 26	SD	5.0	5.6	4.9	8.9	3.4	5.2	7.8	10.1

The results of three-factor analysis of variance for the lower group were:

Factor A = the main effect of class (*F* (1,24) = 11.466, p = 0.002, $\eta p^2 = 0.323$) was significant. Factor B = the main effect of input situation (*F* (1,24) = 25.159, p = 0, $\eta p^2 = 0.512$) was significant. Factor C = the main effect of timing (F (3,72) = 42.955, p = 0, ηp^2 = 0.641) was significant.

The first-order interactions class × timing (F (3,72) = 6.374, p = 0, ηp^2=0.21) and class × input situation (F (1,24) = 1.788, p = 0.193, ηp^2 = 0.069) and input situation × timing (F (2,48) = 2.304, p = 0.11, ηp^2 = 0.088) were significant, class × input situation (F (1,24) = 1.788, p = 0.193, ηp^2 = 0.069) was not significant. The second-order interaction was not significant (F (3,72) = 1.617, p = 0.192, ηp^2 = 0.063).

A simple main effect test (α = 0.15) was performed for the first-order interactions. The simple main effects of class were significant in 3rd mo. (F (1,24) = 6.314, adj p = 0.028, ηp^2 = 0.208), 4th mo. (F (1,24) = 4.233, adj p = 0.06, ηp^2 = 0.15), and 5th mo. (F (1,24) = 15.435, adj p = 0.001, ηp^2 =0.391). Class X (mean of 22.5) > Class Y (mean of 18.5) in 3rd mo., Class X (mean of 26.2) > Class Y (mean of 21.8) in 4th mo., and Class X (mean of 33.5) > Class Y (mean of 22.5) in 5th mo..

The simple main effect of timing in Class X (F (3,72) = 42.959, adj p = 0, ηp^2 = 0.642) and Class Y (F (3,72) = 8.983, adj p = 0, ηp^2 = 0.272) were significant. As a result of multiple comparison (α = 0.05, two-sided test) using a paired t-test, timing was significant for the Class X in 2nd mo. (mean of 17.2) < 3rd mo. (mean of 22.5), 4th mo. (mean of 26.2), 5th mo. (mean of 33.5), 3rd mo. (mean of 22.5) < 4th mo. (mean of 26.2), 5th mo. (mean of 33.5), and 4th mo. (mean of 26.2) < 5th mo. (mean of 33.5). Timing was also significant for the Class Y 2nd mo. (mean of 15.1) < 3rd mo. (mean of 18.5), 4th mo. (mean of 21.8), 5th mo. (mean of 22.5), 3rd mo. (mean of 18.5) < 4th mo. (mean of 21.8), and 5th mo. (mean of 22.5).

As a result of the simple main effect test, the simple main effect of class × input status at the 4th mo. was significant (F (1,24) = 5.104, adj p = 0.077, ηp^2 = 0.175). The simple/simple main effect of the class was significant in thinking input (F (1,24) = 8.974, MSE = 48.343, adj p = 0.02), and Class X (mean of 27.3) > Class Y (mean of 19.1). Multiple comparisons (α = 0.05, two-sided test) using paired t-test were performed for simple/simple main effects of three or more levels that showed significance. Consequently, for the Class X the results were 2nd mo. (mean of 18.7) < 3rd mo. (mean of 23.2) and 2nd mo. (mean of 18.7) < 4th mo. (mean of 25.3) in copied input, 2nd mo. (mean of 14.6) < 3rd mo. (mean of 21.8) < 4th mo. (mean of 27.3) in thinking input. The comparison results for the Class Y were 2nd mo. (mean of 13.1) < 3rd mo. (mean of 16.9) and 2nd mo. (mean of 13.1) < 4th mo. (mean of 19.1) in thinking input. Figure 5 shows the profile of the means in class × timing for the lower group.

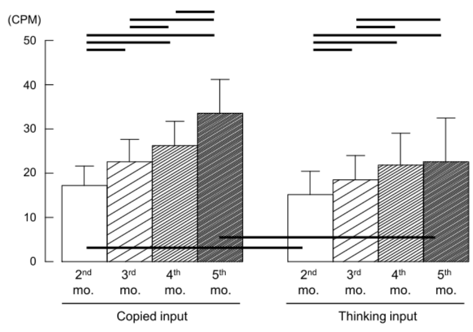

Figure 5: The Profile of Means in Input Situation × Timing (the Upper Group).

The simple main effect of input situation in input situation × timing was significant in 2nd mo. (F (1,24) = 8.319, adj p = 0.012, ηp^2 = 0.257), and 5th mo. (F (3,72) = 31.707, adj p = 0, ηp^2 = 0.569). As a result of multiple comparison (α = 0.05, two-sided test) using a paired t-test, statistically significant difference was observed in copied input, which was 2nd mo. (mean of 18.4) < 3rd mo. (mean of 21.8), 4th mo. (mean of 24.6), 5th mo. (mean of 32.1), 3rd mo. (mean of 21.8) < 4th mo. (mean of 24.6), 5th mo. (mean of 32.1), and 4th mo. (mean of 24.6) < 5th mo. (mean of 32.1). There was also a statistically significant difference in thinking input, which was 2nd mo. (mean of 14.0) < 3rd mo. (mean of 19.5), 4th mo. (mean of 23.7), 5th mo. (mean of 24.8), 3rd mo. (mean of 19.5) < 4th mo. (mean of 23.7), 5th mo. (mean of 24.8), and 4th mo. (mean of 23.7) < 5th mo. (mean of 24.8). Figure 6 shows the profile of the mean in input situation × timing for the lower group.

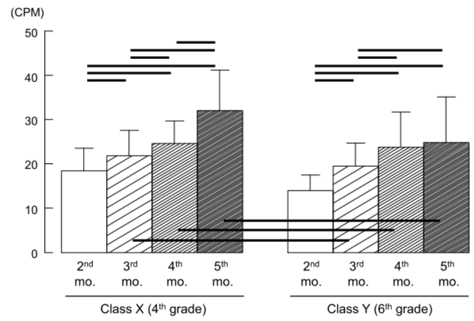

Figure 6: The Profile of Means in Class × Timing (the Lower Group).

Reference [16] was used to adjust the p-values.

4.5 Interview Results

Semi-structured interviews were conducted with the classroom teachers of each class. The following is a list of the identified teaching and learning activities related to Japanese input by keyboard.

Both classes

Romaji: deciding to look at the Romaji Chart when inputting, checking how to input syllabary and side sounds, and teaching when asked.

Home position: teaching how to put and move fingers as well as model video shows.

Conversion/confirmation: teaching switching with half-width/full-width keys and converting with function keys

Website: setting practice time in class time, letting children practice in gaps such as after activity, rest time, allowing them to practice at home, grasping the learning situation of each child, praising the child who is trying, praising the hard-working child in front of everyone, encouraging the child who does not improve easily, showing the learning status of each child in front of everyone, and showing the learning status of the other class.

Class X only

Romaji: distributing the Romaji Chart as well as giving homework and tests.

Home position: distributing prints with key positions and letting practice by printing.

Conversion/confirmation: instructing to input and then convert after inputting to some extent.

Website: instructing the child who does not improve, giving individual instruction to the child who does not improve, and letting children try again when finished.
Other: touch-type training and copied input of the book when children can touch type.

Class Y only
Romaji: instructing how to enter small letters, such as "LA" and "XA."
Home position: doing and showing how to put and move fingers.
Website: recording learning status, practice as homework.

5 Consideration

For the three-factor analysis of variance, the overall results were compared with the results of each of the upper and lower groups.

5.1 Copied Input and Thinking Input

Overall, the input speed significantly improved compared to the beginning of using the 1:1 device. The reason why Class X as 4^{th} grade and Class Y as 6^{th} grade improved to the same extent is probably the effect of practicing with the 1:1 device and utilizing it for learning.

For copied input, the CPM increased from 2^{nd} mo. to 5^{th} mo. for both Class X (4^{th} grade) and Class Y (6^{th} grade), indicating an increase in input speed. However, the increase from 4th to 5th mo. for 6th grade was not statistically significant.

Overall, the main effect of the class was not significant. However, in the upper group, the mean of the 6^{th} grade significantly exceeded the mean of the 4^{th} grade during the 2^{nd} and 4^{th} months. However, in the lower group, the mean of the 6^{th} grade fell significantly below the mean of the 4^{th} grade in the 3^{rd} and 4^{th} months.

The speed of thinking input increased from the 2^{nd} to 4^{th} month. 4^{th} graders also improved in the 5^{th} month, but this improvement was not statistically significant. 6^{th} graders were slower in the 5^{th} month, although the difference was not statistically significant.

For the copied and thinking inputs, there was a significant difference between copied and thinking inputs in the 2^{nd} month, but the difference disappeared at the 3^{rd} and 4^{th} months but reappeared in the 5^{th} month. Why did the speed of copied input improve over time, whereas the speed of thinking input in the 5^{th} month did not improve much?

Moreover, in thinking input, children begin by confirming the question, thinking about their impressions of the content and what they know about it, and then inputting Japanese by keyboard. It is suggested that the speed of thinking input slows down when it takes a long time to think, depending on the question text.

The thinking input questions were also prepared by the first author with reference to textbooks for the 4^{th} and 5^{th} grades. After preparation, three of the authors who have experience as elementary school teachers checked the questions to confirm the questions were not difficult for the target children. However, we suspect that some of the children may have taken longer to think about the "How to see the moon" question in the 2^{nd} month and the "Newspaper" question in the

5th month than the “Dialect” question in the 3rd month and “Keyboard input” question in the 4th month due to their past experiences.

The speed of copied input improved over time. The speed of thinking input also improved compared to when children started using 1:1 devices, but unlike the copied input, it did not necessarily improve with time. To increase the speed of thinking input, we think that another training to practice “thinking” is necessary.

5.2 Upper and Lower Groups

Overall, the main effect of the class was not significant. In the upper group, there was no statistically significant difference, but the mean for the 6th graders was higher than the mean for the 4th graders. By contrast, the main effect of the class was significant for the lower group. The first-order interaction of timing was also significant for the lower group, with the 6th graders below 4th graders in the 3rd, 4th, and 5th months. Why were the 6th graders lower than the 4th graders in the lower group?

According to the interviews, the only instruction given by the 4th grade classroom teacher were homework and tests on romaji, instruction on conversion and confirmation, and tutoring for children who were not making progress on the Web site and touch-type training.

For Japanese input by keyboard, it is necessary to be able to convert kana to Roman alphabetic characters, and type using a QWERTY keyboard to select kanji and confirm the appropriate one [3]. As mentioned in the interview, the instructions provided are considered to have contributed to the improvement of the Japanese input speed by keyboard of the 4th graders. In the upper grades, the content of the class and the activities at school outside of study increase. Thus, it is difficult to spend a lot of time learning and practicing Japanese input by keyboard.

From the analysis results, the lower group of 6th graders also improved their input speed, especially in the thinking input; however, there was a significant difference from the lower group of the 4th graders in the 3rd, 4th, and 5th months, and the difference was increased. The difference has become larger owing to the accumulation of small stumbling blocks in various steps, such as Roman alphabetic characters, touch typing, conversion to kana-kanji, confirmation, and thinking.

The results of this study are not limited to a particular grade level but suggest that if special attention is not paid when the equipment is introduced and initial instruction is given, the difference in input speed may increase over time.

Reference [17] proposes that initial instruction on Japanese input by keyboard begins in 3rd grade when children start studying Roman alphabetic characters in the Japanese language. Our survey supports the necessity of acquiring the Japanese input skills by keyboard in the earlier grades.

6 Summary

This study involved a 5-month investigation of Japanese input skills by keyboard of elementary school children learning with 1:1 devices for the first time in a classroom environment. 1:1 devices were provided to two classes: the Class X was 4th grade, and the Class Y was 6th grade. The input speed was improved in 3rd, 4th, and 5th months compared to 2nd month after the start of utilization. The speed of input while copying by looking at the text increased as the months went by. However, the results of the study suggest the speed of input while thinking by reading the text does not necessarily improve in the same way. We divided the survey results into two groups based on input speed by keyboard. In the upper group, the 6th graders were higher than the 4th graders, although there was no significant difference. In the lower group, 6th graders were significantly lower than 4th graders in 3rd, 4th, and 5th months. Therefore, it is necessary to pay particular attention to supporting the acquisition of Japanese input skills by keyboard, especially for children in the lower group.

However, this study analyzed a survey that only targeted two classes. The upper and lower groups had even fewer targets. Future work may further examine whether similar conclusions can be obtained for other groups of children. Furthermore, we want to conduct a survey to obtain children's feedback after their experience of Japanese input using 1:1 devices. Moreover, we would like to conduct research on the acquisition of skills necessary for thinking and using devices and networks as well as input by keyboard.

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