Introducing CAD Instruction at High School Level - A Japanese Experience

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Abstract

A drawing test and questionnaire survey on CAD (which is taken in this paper as computer-aided drafting) proficiency and training were carried out with 250 students of Mechanical Engineering program at Sanyo High School. The performace outcomes of the students were evaluated to understand the present status of CAD instruction and to consider the appropriate subsequent learning instruction. Based on the results of the study conducted, 50 % of the students have come to understand and 70 % became interested in learning CAD. Some students who at first disliked the traditional manual drafting turned out to advocate CAD and CAD preference is more influenced by the traditional drafting experience rather than by keyboard skills.

1.Introduction

Towards the end of 1970 CAD has been especially prevailing as the main tool in the field of the automotive, aircraft, architecture and electricity. Presently, it is not too daring to say that CAD has considerably replaced traditional manual drafting. In light of this technological advancement, CAD systems have been gradually putting into use even in high-school level. Considering the fast technological change and our future prospects, the CAD system in education has been introduced at Sanyo High School. It has been incorporated in the Mechanical Engineering course as a practical subject since April 1994. In order to practically evaluate the present status of the CAD instruction and to consider the appropriate subsequent learning instruction, CAD drawing test and questionnaire survey was carried out with 250 students enrolled in the school year 1994 to 1998.

2.Students survey

Table 1 shows an adopted CAD system which comprises a NEC PC-9821 AP2/U2, a CADPAC Station 2 EX, and associated software. Nine units were installed, eight for students and one for the teacher. One group is composed of eight students, thus, one unit is allocated for every student. The time allotted to this subject is six-week period, two hours per week. Within twelve hours, operating procedures were taught and helped students to arouse interest in learning CAD. A training guide was utilized to begin with as thought to be the most effective and efficient approach where appropriate draw-

Hardware	Supplier	Type	Unit
CPU	NEC	PC-9821AP2/U2	9
CRT(17inch)	NEC	PC-KM172	9
memory	I O DATA	AP34-4M	9
hard disk(540MB)	ICM	INTER-540AN	9
display(37inch)	MITUBISHI	XC-3752C	1
pen plotter	MUTOH	XP-511(A1)	1
laser plotter	MUTOH	RL-503(A3)	1

Hardware	Supplier	Type	Unit
CADPAC-Station2EX	D A INTEGRA	EDUCATIONAL	9
MS-DOS	NEC	Ver.3.30	9

Table 1 CAD System

ing samples were selected and completed according to the listed procedures. Moreover, a man-to-man based instruction was given so as to balance various students' degree of understanding the operation. The instruction was given with accompanying supplemental and recovery explanations of procedures.

At the final stage of the training, the drawing test was conducted in fourty minutes to each student in order to objectively assess the learning he acquired of CAD. The drawing adopted for the test was the same as the one used during the training, because it seemed to be appropriate as a test subject based on the training contents and working time. The grade points of the test were given based on the mistakes made on their drawings. For every wrong element, three points were deducted. The total number of elements in the drawing test is 102.

In addition, questionnaire survey on CAD proficiency and training was carried out individually to evaluate students' understanding, interest, intention, attitude and working time. Results of questionnaire survey and individual drawing test are summarized in Table 2 and Table 3 (appendix) respectively. "Basic operation" of item 4 means capable of selecting and operating commands in creating point, line, circle, rectangle and others, processing (round-corner, trim, delete, reproduce, copy, move, enlarge and the like), dimensioning, writing comments, plotting and filing upon making fundamental drawings like the drawing samples. The "overall operation" of item 3 means to operate additional commands in reference with the operation manuals. Fig.1 (appendix) is another expression of the survey results based on each item on Table 2.

3.Learning level

Each question in the questionnaire regarding the students' learning level of CAD refers to items no.1 - 4 of Table 2 and is graphically represented in Fig.1. "CAD in general" (item 1), "merits of CAD" (item 2) and "basic operation" (item 4) were understood by 88%, 89%, and 86% of the students, respectively. However, the "overall operations" in item 3 was understood by 82% of the students. This is probably due to a short period of working time. The graph on Fig.2 shows positive answers on the left and negative answers on the right for each of the questionnaire items. With this result, it is clear that 204 - 221 of 250 students, roughly 80% have gained satisfactory knowledge of CAD.

Fig.3 shows the relationship between the drawing test (grade) and the survey (understanding) to the students. The results were objectively assessed their learning of CAD. The upper part is plotted for the positive answers and the lower part for the negative answers in terms of questions vs grade points.

Table 2 Questionnaire Summary

No	Item	Positive	Negative	Unknown/ enough
1	CAD in General	218	32	
2	CAD Merits	221	29	
3	Overall Operation	204	46	
4	Basic Operation	213	37	
5	CAD Easiness	192	57	1
6	CAD Interest	192	58	
7	CAD Preference	179	71	
8	Intention to Continue using CAD	155	95	
9	Keyboard Skills	170	80	
10	Traditional Drafting Preference	62	188	
11	Hope for a Specialist	36	103	111
12	Working Time	91	30	129

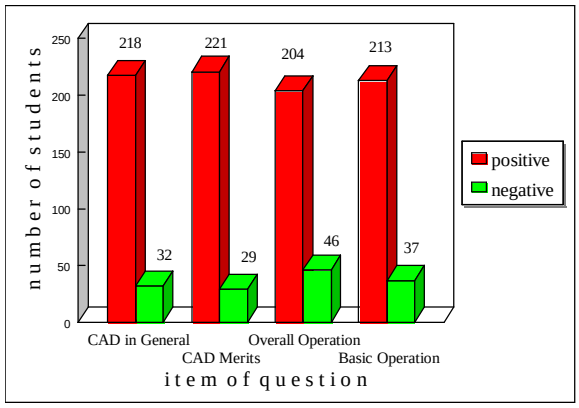


Fig.2 General Understanding

The students' grade points were statistically shown in Table 4. It appeared that there is a good correlation between grading and understanding especially for those students who got grade higher than 82. Since the average grade point of all students is 83, the contents of the drawing test and working time, and the correlation between grade point and understanding, the criterion used on the objective understanding of CAD is assumed to be 82 grade point. Accordingly, by taking a close look at the individual result of the drawing test and survey for questions no.1 - 4 in Table 3, 125 students positively answered all the questions higher than the criterion. Based on the criterion made 50% of the students have sufficient understanding of CAD.

Table 4 Statistical Data of Students' Reponses

Grade		Positive				Negative			
range	mid.pt.	item 1	item 2	item 3	item 4	item 1	item 2	item 3	item 4
30-35	33	4	3	3	1	1	2	2	4
36-40	38	4	6	2	5	3	1	5	2
41-45	43	4	4	4	3	0	0	0	1
46-50	48	4	4	3	3	0	0	1	1
51-55	53	2	2	2	2	1	1	1	1
56-60	58	4	3	5	5	1	2	0	0
61-65	63	8	7	6	9	2	3	4	1
66-70	68	8	7	5	9	2	3	5	1
71-75	73	5	6	5	4	3	2	3	4
76-80	78	22	23	23	22	8	7	7	8
81-85	83	19	19	18	17	1	1	2	3
86-90	88	24	26	24	25	3	1	3	2
91-95	93	43	45	41	43	5	3	7	5
96-100	98	67	66	63	65	2	3	6	4

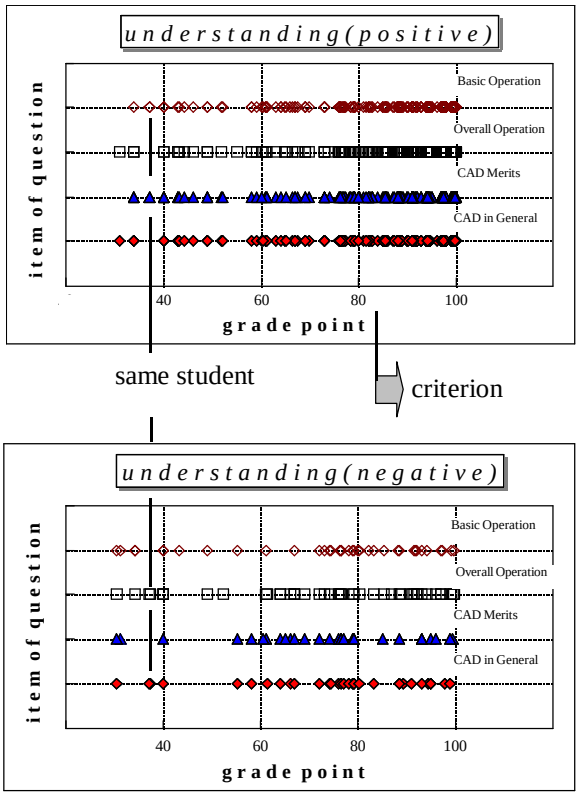


Fig.3 Correlation between grade and Understanding

4. General interest

Questions regarding students' interest refers to items no.5 - 8 of Table 2 and in Fig.1. 77% of the students have replied that CAD "is easy to use", 77% answered CAD is "interesting" and 72% "prefer" CAD. Moreover, 62% of the students replied "they wish to continue CAD practice". Fig.4 shows positive answers on the left and negative answers on the right for each of the above questionnaire items. This result shows that out of 250 students, 155 - 192, roughly 70% became interested in learning CAD.

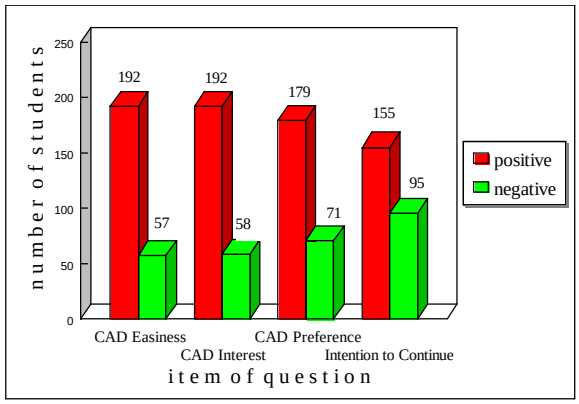


Fig.4 General Interest

5. Attitude and intention

No.9 of Fig.1 shows the influence of keyboard skills on CAD operation. 32% of the students have low typing skills, while 68% of the students have sufficient typing skills. All students have already finished word processing, however, those students who have low keyboard skills are considered to

have insufficient typing skills. No.10 of Fig.1 shows preference to traditional manual drafting as a basic attitude to CAD operation. 25% of the students preferred traditional drafting, whereas, 75% disliked it. Fig.5 shows the relationship among keyboard skills, impressions of CAD operation (basic operation and CAD easiness) and the traditional drafting preference in terms of the number of students. 170 students have sufficient typing skills, 213 students understand basic operation, 192 students feel CAD is easy to use and 179 students prefer CAD. Therefore, it is well understood that the students who have good impressions of CAD operation and have sufficient typing skills tend to adovocate CAD.

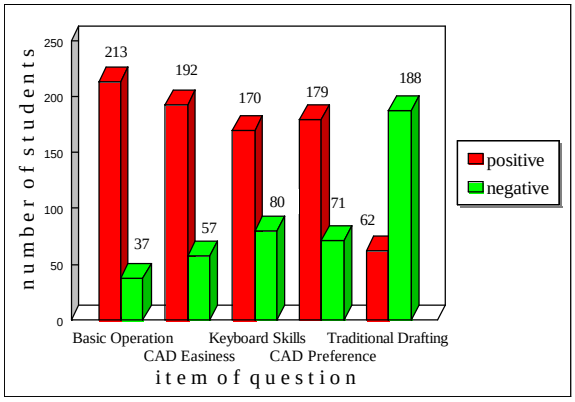


Fig.5 Attitude and Intention

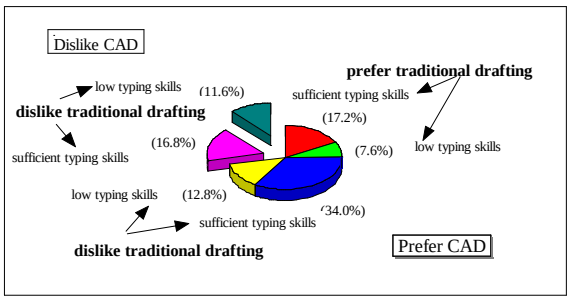
Because the number of students who prefer traditional drafting is 62 and the number of students with CAD preference is 179, 117 out of 188 students, namely 62% who initially disliked the traditional drafting turned out to adovocate CAD. This is a remarkable effect due to CAD practice. No.11 of Fig.1 shows 15% of the students (36 out of 250) hope to continue CAD practice to become specialists in the future. Thus, CAD practice has given them an enlightening effect for their future career.

6.Working time

No.12 of Fig.1 shows students' feeling about the length of working time as in item 12 on Table 2. Total working time was 12 hours. It is shown that 36% of the students feel it was short; 52% feel it was good enough and 12% feel it was long. The total number of students who feel "short" and "good enough", namely 88% have a positive feeling about the total working time. In addition to the previous result, the 62% of the students who wish to continue CAD practice and the 15% who hope to become a specialist suggested to increase the total working time.

7.Primary factors for CAD preference

There are two primary factors for CAD preference: typing skill and traditional drafting preference. Fig.6 summarizes CAD preference in terms of these parameters. From these results,
(1)71 students (28%) dislike CAD. All of them at first disliked traditional drafting. 29 out of the 71 students (12%) have insufficient typing skills.
(2)179 students (72%) prefer CAD, whereas 62 students (25%) initially preferred traditional drafting and the remaining 117 students (47%) at first disliked it. 43 out of the 62 students (17%) have sufficient typing skills and the remaining students (8%) have insufficient skills. 85 out of the 117 students (34%) have sufficient typing skills, while the re-



CAD	Traditional drafting	Typing skills: sufficient	Typing skills: low	Total	
prefer	prefer	43	19	62	
	dislike	85	32	117	179
dislike	prefer	0	0	0	
	dislike	42	29	71	71
Total		170	80	250	250

Fig.6 CAD Preference and Primary Factors

maining 32 students (13%) have inadequate typing skills.
The above shows that some students who at first disliked traditional drafting turned out to advocate CAD because it is interesting and that students' CAD preference is more influenced by traditional drafting experience rather than by keyboard skills.

8.Conclusion

Presented below are the highlights of results of the drawing test and the survey.
(1) 50 % of the students understood CAD.
(2) 70 % of the students became interested in learning CAD.
(3) All of the students who preferred traditional drafting switched to CAD.
(4) Some students who initially disliked traditional drafting have come to prefer CAD.
(5) CAD preference is more influenced by students' background on traditional drafting rather than by keyboard skills.

Bibliography

1. Mitunari, T. Personal computer CAD. Sangyotosho, 1992.
2. Kawaguchi, Y. et al. Promotion for personal computer CAD drawing. Ohmusha, 1994.
3. CAD engineer first grade authorized test book. Japan Personal Computer Software Association, 1994.

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Appendix

Table 3 Result of Individual Drawing Test and Questionnaire investigation

Student	Grade	Positive answer for each item number												Negative answer for each item number												Others			Meet
No	point	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	5	11	12	criterion
1	82	1	1	1	1		1	1	1				1					1				1	1				1		1
2	97	1	1		1	1	1	1	1	1		1				1							1					1	
3	97	1	1	1	1	1	1	1	1													1	1	1	1				1
4	82	1	1	1	1	1			1				1						1	1		1	1	1					1
5	88	1	1	1	1	1							1						1	1	1	1	1				1		1
6	97	1	1	1	1	1	1	1	1													1	1	1	1				1
7	31	1		1						1					1		1	1	1	1	1		1	1				1	
8	82	1	1	1	1	1	1	1	1	1	1	1	1																1
9	66				1	1	1	1	1		1	1	1	1	1	1						1							
10	97	1	1	1	1	1	1	1	1		1											1					1	1	1
11	76				1	1								1	1	1			1	1	1	1	1	1	1				
12	88	1	1	1	1	1	1	1	1		1		1									1					1		1
13	67				1	1	1	1	1		1		1	1	1	1						1					1		
14	76	1	1				1	1		1						1	1				1		1	1	1	1			
15	61	1	1	1	1					1								1	1	1	1		1	1				1	
16	85	1	1	1	1													1	1	1	1	1	1	1				1	1
17	97	1	1	1	1	1	1	1													1	1	1	1				1	1
18	100	1	1	1	1		1	1	1		1	1						1				1						1	1
19	85	1	1		1	1	1	1	1							1						1	1	1				1	
20	94	1	1	1	1	1	1	1	1	1													1		1		1		1
232	94	1	1	1	1		1	1	1				1					1				1	1				1		1
233	91	1	1	1	1		1		1									1		1		1	1				1	1	1
234	100	1	1	1	1	1	1	1	1													1	1				1	1	1
235	100	1	1	1	1	1	1	1	1			1										1	1					1	1
236	100	1	1	1	1	1	1	1	1				1									1	1				1		1
237	97	1	1	1	1	1	1	1	1													1	1				1	1	1
238	97	1	1	1	1	1	1	1	1	1													1				1	1	1
239	88	1	1	1	1	1	1	1	1		1		1									1					1		1
240	94	1	1	1	1	1	1	1	1			1	1									1	1						1
241	100	1	1	1	1	1	1	1	1													1	1				1	1	1
242	100	1	1	1	1	1	1	1	1		1											1					1	1	1
243	100	1	1	1	1	1	1	1	1	1			1										1				1		1
244	100	1	1	1	1	1	1	1	1				1									1	1				1		1
245	100	1	1	1	1	1	1	1	1		1	1	1									1							1
246	100	1	1	1	1	1	1	1	1				1									1	1				1		1
247	34	1	1	1		1	1	1	1	1	1		1				1										1		
248	40				1	1	1			1				1	1	1				1	1		1	1				1	
249	40	1	1			1	1	1	1	1			1			1	1						1				1		
250	80	1	1	1		1	1	1	1			1					1					1	1					1	
Total		218	221	204	213	192	192	179	155	170	62	36	91	32	29	46	37	57	58	71	95	80	188	103	30	1	111	129	125
Ave.	83																												

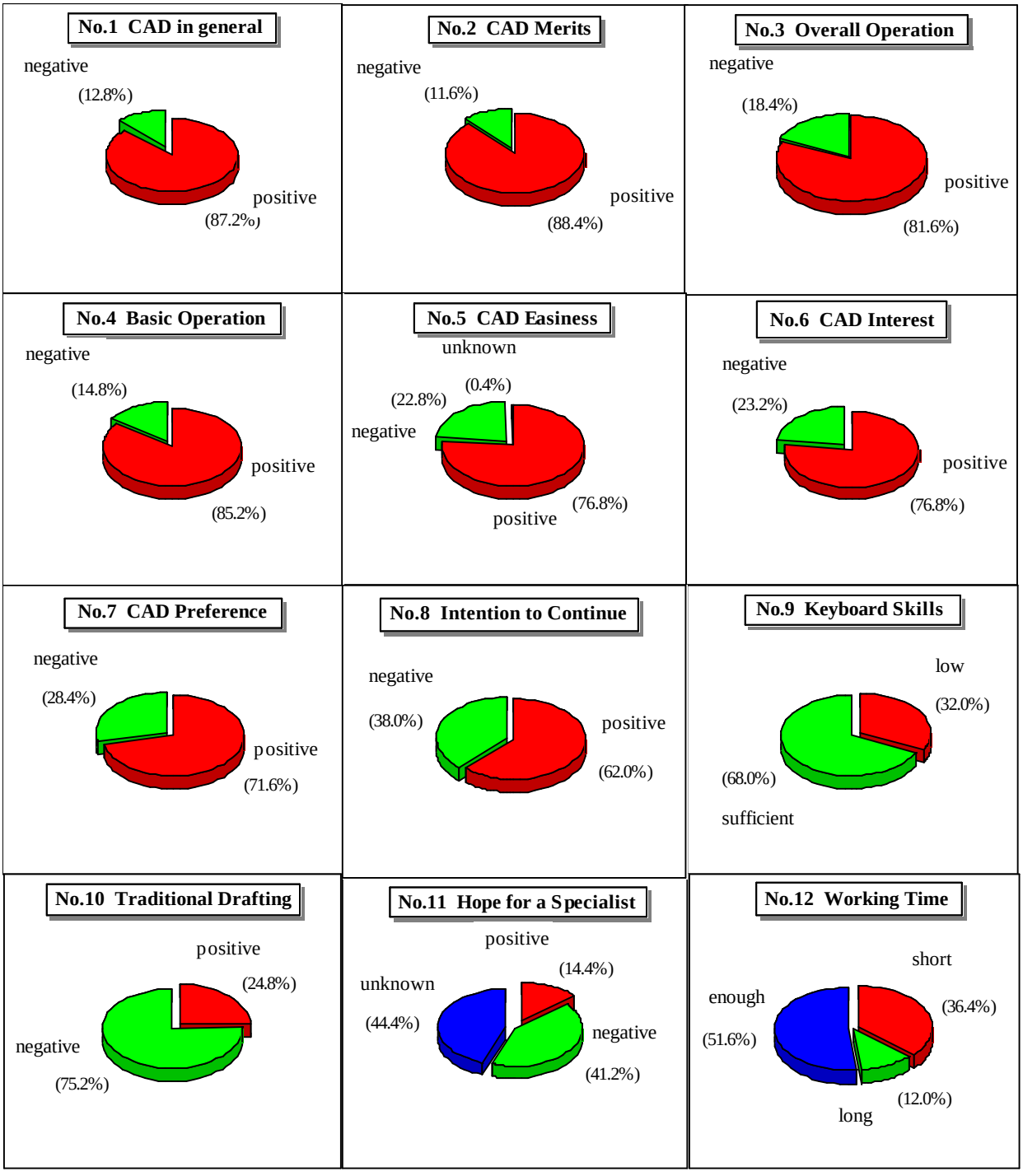

Fig.1 Summary of the Students' Responses on the Questionnaire