

A PRELIMINARY INVESTIGATION INTO THE EFFICIENCY OF CAI

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0. INTRODUCTION

More and more attention is now being paid to CAI as a teaching medium, and reports on its use are becoming frequent. Nineteen cases of such use were presented at the Kyoiku Kagaku Kenkyu-kai (Special Conference of CAI and CMI).¹ "An Attempt at CAI in Class", "Book-keeping Instruction System in the CAI Style", "A New Application of the Data Base for English Vocabulary at the Junior High Level", and "An Experimental Study of Multi-media Instruction through CAI", etc. were among them. Though they testified to the merits and capabilities of CAI, none of them tried to view the results in comparison with those of traditional non-CAI class work. Nor do we find this comparison in current discussions on CAI.²

Why? Why is this comparison not undertaken? One actual reason is that there are experimental difficulties in this comparison, that is, it is extremely hard to compare the two methods under exactly the same conditions. Another supposed reason is that experimenters presume that CAI is undoubtedly more effective than the traditional non-CAI class work. This seems to be more or less the case with all instructional hardware. Have we not neglected to do what we should do because of too much interest and trust in the day-by-day improvement of technology?

We do not mean, however, that no attempt has been made for this purpose. For example, Kazuko Handa has presented the following interesting data from Kanda Gaigo

Gakuin. (The % figures show the results of a test carried out after a 90 minute-instruction period for both the CAI and the non-CAI class).³

	non-CAI class	CAI class
Score		
90 and over	14%	36%
80 and over	18%	32%
70 and over	38%	23%
69 and under	30%	9%

More such data are strongly needed, because the result of CAI varies according to its software and hardware. The experiments have to be repeated in order to know that (1) such hardware is useful for such a purpose and (2) there is such a result for such a CAI but also that such a revision is necessary for this CAI.

1. CAPABILITIES OF COMPUTERS AND THEIR EFFECTIVENESS IN LANGUAGE LEARNING

In order to prove the efficiency of CAI by means of experiments, it is useful to think beforehand about the relationships between the capabilities of computers and the areas of their effectiveness in language learning.

Another useful thing for proving the efficiency of CAI is to experiment with it in terms of Group Instruction and Individual Instruction. Group Instruction (GI) is dealt with in 2, and Individual Instruction (II), in 3 as follows.

CAPABILITIES OF COMPUTERS	AREAS OF THEIR EFFECTIVENESS
Counting	Scoring and evaluation
Selecting, giving feedback	Monitoring and correcting a student's trouble spots
Impressing	Memorization
Repeating	Comprehension and memorization
Proceeding	Programming and speeding up of learning activities
Accessing	Multimedia learning (sound, literal symbols, pictures, etc.)
Manipulating, playing	Affecting, pleasure giving
Retrieving	Self discovery of grammatical rules

2. CAI IN GI

2.1. Material: Questions out of the Ministry of Education sponsored English proficiency tests (2nd grade) with the listening tests excluded.

2.2. The participants and the date of the experiment: We picked two classes of freshmen and sophomores in the Engineering Department of Chubu University (32 students respectively). The experiment was conducted irregularly during the weekly class period in the latter half of the academic year of 1987.

2.3. Procedure: For comparison one class was set up as a non-CAI class, and the other class as a CAI class. The non-CAI class answered the questions on an ordinary test form. This took 45 minutes to complete. Later the students were given the results with instructive comments. In the CAI class each student sat in the LL booth and was given the questions on the TV display one question at a time. The students answered it by means of a built-in analyzer. With this system the teacher can show results immediately after the students have answered, and can give additional comments as he thinks necessary. This CAI system uses software of our own design on a SONY SMC Micro-computer and the analyzer is part of the SONY LL system (LLC 5500).⁴

2.4. The efficiency of CAI: It can be

measured by the following 6 criteria and the answers of the students to the questionnaires.

1. Comments - Whether we can give students comments in an appropriate way.
2. Selection - Whether we can select a question according to the situation.
3. Evaluation - Whether we can show the result quickly and instructively.
4. Practice Time - Whether we can put it into practice any time in the class hour.
5. Amount of Questions - Whether we can do a large amount of questions in a short time.
6. Enjoyment - Whether students enjoy the practice or not.

2.5. Findings

1. Comments. In the CAI class, comments were easy for a teacher to make and they were easy for the students to understand because they were made immediately after the students had answered a question. In the non-CAI class making comments was not easy both for the teacher and the student because it had to be done later, perhaps at a time when the students might have almost forgotten the questions.

2. Selection. In the CAI class, we could easily select the questions that were difficult for the students and repeat them until the students understood, since the results were shown in a statistical way immediately after

the students answered a question. In the non-CAI class, it was possible but not easy, because we had to wait until we got the results of all the questions.

3. Evaluation. In the CAI class evaluation was done correctly and easily with the analyzer. In the non-CAI class evaluation was possible but not as easy as in the CAI class.

4. Practice time. In the CAI class we could have practice time at any time during the class hour; even a short time of only 5 or 10 minutes was enough. In the non-CAI class we could not schedule practice time in that way, because we needed a long time of at least 45 minutes.

5. Amount of questions. Here the non-CAI class was much superior, because in the non-CAI class quite a few questions were answered, while in the CAI class only several questions were answered.

6. Enjoyment. In the CAI class students answered the questions in a comfortable atmosphere, especially enjoying the colorful and big letters on the display.

As a whole this experiment with CAI in GI was found to be a success, with CAI being more efficient in many ways than the traditional non-CAI. The problems are that the teacher is very busy during CAI because he has to operate an analyzer while running a computer, and the results which should be utilized for individual diagnoses are not stored systematically under the present system of our computer.

Next, the answers of the students to the questionnaires on the effectiveness of CAI can be summarized as follows:

	About questioning by a personal computer	About answering by an analyzer
Very good	45.8%	41.7%
Good	54.2%	50.0%
Not sure	0%	8.3%
Not good	0%	0%

3. CAI IN II⁵

3.1 Materials: Seiko CAI Research Co.'s Basic English Course, Advanced Part, INFINITIVE, GERUND AND RELATIVE PRONOUN.

3.2. The participants and the dates of the experiments: We picked one class of freshmen in the Engineering Department of Chubu University (30-26 students). The experiments were conducted 3 times during the year of 1987 as follows: June 1, June 29 and November 16.

3.3. Hardware: 15 sets of the Seiko CAI system which can manage sound, letters and graphics and respond several ways to incorrect answers.

3.4. Procedure: Two classes of equal competence were formed according to the results of the pretest which was specially prepared for these experiments (See Appendix 2). Different instruction (CAI or non-CAI) was given to each class for comparison. In the CAI class, a set of the Seiko CAI system was prepared for each student. Each student then studied the specific item for the specific time, and received a test (See appendix 3). In the non-CAI class, the students were given the same material as the CAI class. This material was on paper. This class then studied for the same amount of time as the CAI class and received the same test.

3.5. The efficiency of CAI: It can be measured by the following 4 criteria and the answers of the students to the questionnaires.

1. Media - How many media are available
2. Result of the test - Whether there is significant difference between the two kinds of instruction
3. Motivation - Whether CAI motivates the students to further study
4. Fatigue level - How long the students can continue before becoming mentally tired

Efficiency of CAI

As for media, the CAI class used sound, letters and graphics, while the non-CAI class, letters alone. Concerning the results of the test, statistical comparisons follow below. Finally, the answers of the students to the questionnaires give information about their motivation and their fatigue level.

3.6. Schedule of reorganization of the class (CAI or non-CAI)

As mentioned in Procedure 3.4 two classes of equal competence were organized according to the results of the pretest; but we found it necessary to change this organization in the second and third experiments in order to lead to a more sound conclusion. If we call the two groups of equal competence A and B, reorganization of the class was as follows:

	Experiment		
	1st	2nd	3rd
CAI class	A	B	A
non-CAI class	B	A	B

The inconsistency of grouping is accounted for by the accidental fact that B did better than A in the 1st experiment. This was caused by an extreme shortage of time, because the A group students were not well trained in the typing skills necessary for this experiment. Therefore, prior to the second experiment all students were given enough training to master the needed typing skills. In addition we replaced A with B for the second round. As a result B did better than A, so there appeared a possibility of superiority in the CAI class. Here again we returned A to the CAI class, and B to the non-CAI class for the 3rd experiment. If the CAI class did better again this time, we could say that CAI was favorable for both the A and the B group.

3.7. Results and discussion

The mean value that the non-CAI class earned in the 1st experiment turned out to be higher than that scored by the CAI class

Table 1. Results of the Tests in the CAI Class (X) and the non-CAI Class (Y)

Experiments	1st	2nd	3rd
Items	30	30	28
Sample mean of X (with a perfect score)	15.0(40)	76.2(100)	80.2(100)
Sample mean of Y (with a perfect score)	17.0(40)	71.0(100)	75.9(100)
Mean X - mean Y	-2.0	5.2	4.3
Degrees of freedom	30	30	26
Probability (t-test)	0.28	0.26	0.184

for the reason mentioned above. On the other hand the CAI class chalked up a higher value in the 2nd experiment, though its reliability is not very high (t-test 0.26). In the third experiment the CAI class was more successful and the ratio of risk was much lower. So the fact that both A and B groups have much benefitted from CAI could be concluded, even taking into account the small imbalance of the pretest scores.⁶

3.8. Correlations with the pretest

In order to confirm the efficiency of the CAI class and discover, if possible, its causes, the results of the CAI class and the non-CAI class are compared to the result of the pretest in terms of the correlation coefficient.

Table 2. Correlation between the results of the CAI and the non-CAI class in the 3rd experiment and the results of the pretest

	PRETEST	
	CAI class	Non-CAI class
Sample number	13	15
Minimum value (with a perfect score)	56(100)	54(100)
Maximum value	84	80
Sample mean	68	67.47
Sample standard deviation	8.37	7.19

TEST		
	CAI class	Non-CAI class
Sample number	13	15
Minimum value (with a perfect score)	64(100)	42(100)
Maximum value	95	91
Sample mean	80.23	75.93
Sample standard deviation	11.61	13.07

CORRELATION COEFFICIENT BETWEEN TEST AND PRETEST	
CAI class	Non-CAI class
0.81	0.38

As is seen above, there is a great difference in the correlation coefficient between the two classes. The CAI class shows quite a high figure of 0.81 while the non-CAI

class shows only a figure of 0.38.

This great contrast seems to explain why the CAI class achieved better results in the experiment tests than the non-CAI class. A high correlation coefficient here means that each of the two tests—the pretest and the experiment test are reliable, and each student could do his/her best according to his/her capability. A low correlation coefficient would mean that each student might not be as absorbed in the study of the material since it was on paper and not on the TV display. This contrast in correlation coefficient is observed, though not as great, in the second experiment where the correlation coefficient is 0.64 in the CAI class and the correlation coefficient is 0.54 in the non-CAI class.

3.9. Students' responses to the questionnaires

In order to know the students' impression of the total comparison between the two kinds of instruction, of their Motivation (3)

Table 3. Correlation table for the CAI class

	Pretest											
	56 ~ 59	59 ~ 62	62 ~ 65	65 ~ 68	68 ~ 71	71 ~ 74	74 ~ 77	77 ~ 80	80 ~ 83	83 ~ 86	total	
Test (CAI)	64 ~ 69	1	1	1							3	
	69 ~ 74			1	1						2	
	74 ~ 79				1						1	
	79 ~ 84					1					1	
	84 ~ 89						1				1	
	89 ~ 94		1				1	1			3	
	94 ~ 99								1	1	2	
	total	1	2	2	2	1	1	2	0	1	1	13

Table 4. Correlation table for the non-CAI class

		Pretest									
		54 ~ 57	57 ~ 60	60 ~ 63	63 ~ 66	68 ~ 69	69 ~ 72	72 ~ 75	75 ~ 78	78 ~ 81	total
Test (Non-CAI)	42 ~ 52	1									1
	52 ~ 62						1				1
	62 ~ 72					1		1			2
	72 ~ 82			3		1				1	5
	82 ~ 92			1	1			3	1		6
	total	1	0	4	1	2	0	5	1	1	15

and of their Fatigue level (4), the following four questions are given to them. Their answers to the 3rd experiment are shown as follows, in the order of the question, students' answers, the total number of students for each answer, and the reasons for their answers.

Q.1: Is CAI efficient, when compared to the traditional non-CAI? Why?

Answers: Effective 9
 Don't know 4

Reasons by the 9 students are:

- I can manage the program at my own pace. I don't have to hurry.
- The program explains how I have made the error.
- It makes individual studying possible.
- It requires me to use my hands in addition to using my eyes and ears. It leads to better understanding.
- I felt I had learned better than usual.
- I can understand better because English comes through my ears as well as

Reasons by the 4 students are:

- It's hard to see how this will help me, but I could concentrate.
- It's hard to see how this will help me, but it has pointed out my errors.
- It's hard to see how this will help me, but I found something fresh.
- I can't say anything definite because the program is not at my level.

Q.2.: Was it fun or enjoyable? Why?

Answers: Enjoyable 12
 Not enjoyable 1

Reasons by the 12 students :

- I like the music that is a part of the program.
- It's fun to type out answers on the display.
- I can repeat at my own pace as often as I need to.
- I felt as if I were playing a game at home.
- The questions were presented one by one and led me to answer.
- The practice is not forced but is done on

my own.

through my eyes.

It was very rewarding when the bright and colorful display showed that my answer was correct.

It's really very interesting.

A reason by the 1 student:

I don't like English in whatever form it may be presented.

Q.3: Do you feel like doing it again?

Answers:	Yes	12
	No	1

Q.4: Write your further impressions or comments.

Answers:

It's more instructive than the present instruction in our Language Laboratory.

I enjoyed it very much, though I have never used a computer.

It was troublesome to type the whole sentence over again even when I made a mistype.

It's tiring that the interval from one question to another is so long.

I want to have more detailed instruction concerning my errors.

I found it hard to read the "katakana" that the computer showed on the display.

The computer judged my correct answer as incorrect.

It required that I be a good typist.

3.10. Relationships between the capabilities of computers and the students' responses to the questionnaires

The students' responses presented above quite agree with capabilities we expected of computers in 1 and confirmed them. (See chart on next page.)

On the other hand their responses about the shortcomings of the computer including software also agree with what has been pointed out. The () shows the corresponding students' answers.

(1) It lacks creativity and error correction is stereotyped. (I want to have more detailed instruction about my error. / The computer judged my correct answer as incorrect.)

(2) It lacks speed in its running. (It's tiring that the interval from one question to another is too long.)

(3) The learner is forced to type the answer. It tires out his eyes. (It required that I be a good typist. / It's troublesome to type the whole sentence over again even when I made a mistype.)

4. CONCLUSIONS AND DISCUSSION FOR THE FUTURE

In GI, our CAI has produced a satisfactory result as is shown in 2.5. Especially it should be repeated that a teacher can give comments whenever it is necessary, students find that learning by machine is enjoyable, and they retain the knowledge longer. The few problems we have are that the teacher is too busy during CAI, and our software system should be more efficient in dealing with the results, as is pointed out also in 2.5.

In II, even this "developing" CAI system was found to be efficient and was enjoyed very much by the students, though there was strong dissatisfaction about the running speed as shown above. Another fundamental problem to be added here is that there is much room left to improve on the audio aspect of the program, though our Seiko CAI System is one of few systems with sound available.

When we think of reasons for the success of our CAI, we find that in GI it is largely due to the fact that it was the type of CAI which can be an assistant to a teacher rather than teach by itself. The teacher, without being troubled by the presentation of questions and with the counting of results, can make creative comments and explanations. Therefore the lack of creative capability with

The Students' Responses	Computers' Capabilities
(1) I can manage the program at my own pace.	Proceeding (self-instruction)
(2) The program explained how I have made the error.	Selecting
(3) I felt I had learned better than usual.	Impressing
(4) I can understand better because English comes through my ears as well.	Accessing (multimedia)
(5) It's hard to see how this will help me, but I was absorbed.	Playing
(6) I enjoyed it very much, though I have never used a computer.	Enjoying
(7) It's fun to type out on the display.	Manipulation
(8) The questions were presented one by one and led me to answer.	Proceeding

CAI is wonderfully supplemented. We also found that in II the success depended on material which dealt with basic grammar, because it would not go as well as it did if the material were more creative. Even so there were still shortcomings with CAI as pointed out by the students who responded to questionnaire question 4. Now we should re-think the question of "where we should use CAI in our total instruction schedule", as declared by Prof. Takefuta.⁸

NOTES

*Outline of this paper was read at the national conference of JACET on September 23, 1988.

*We are grateful to Chubu University for granting us special research money for this experiment.

1. Held at Chubu University, June 20, 1987. As to further information, refer to *Shingakugihō* (IEICE Technical Report) VOL.87 No.79 (Denshi Joho Tsushin Gakkai, 1987) 2.
2. For instance, see the discussion on Computers in the Teaching of Foreign Languages (Nagoya Gakuin Daigaku Gaikokugo Kyoiku Kiyō No. 11, 1984)

3. Kanto Chapter LLA ed. LL Kyoiku Kiyō Katsuyo Handbook (Aiikusha, 1986) p.301.
4. The source code of the software was written in the computer language of ASSEMBLER by Takeshi Ohba, member of The Language Center of Chubu University. See its part in the APPENDIX 1.
5. For carrying out the experiments we are grateful to Messrs. Hikona Kurachi and Kyoichi Fukui in the Seiko CAI Research KK.
6. In the 3rd experiment two students in the CAI class were absent. But fortunately equality of competence between the CAI class and the non-CAI class in terms of the results of the pretest was not disturbed. The table on the following page shows the results of the experiment test and of the pretest at an individual base. (The figures show the points each student gained in the tests with a full mark being 100.)
7. As to the short-comings of computers, refer to LL Kyoiku Kiki Katsuyo Handbook (Aiikusha, 1986) p. 311.
8. Yukio Takefuta. *Eigoka no CAI* (Educa, 1987) p.38.

The CAI Class			The Non-CAI Class		
Samples	Pretest	Experiment Test	Samples	Pretest	Experiment Test
1	62	69	1	64	83
2	80	95	2	80	79
3	66	71	3	72	91
4	72	93	4	72	83
5	84	94	5	72	60
6	74	90	6	62	78
7	60	89	7	72	87
8	62	68	8	74	66
9	60	68	9	60	81
10	66	74	10	62	86
11	74	88	11	60	76
12	68	80	12	66	65
13	56	64	13	76	89
			14	66	73
			15	54	42
Mean	68.00	80.23		67.47	75.93

APPENDIX 1

Part of the Software for GI (Written in ASSEMBLER by Takeshi Ohba)

The following shows the part of the program for introducing the question on the display.

```

TITLE  Video indicator
.Z80
.COMMENT *
1987/1/10 by T. Ohba *

;
ENTRY VID
EXT  PCSR, CCSR, INKY, CURS
EXT  GCLR, CCLR, AROW, PICT
EXT  WORD, WRIT, AROWW, AROWE
EXT  PADR, CADR, ESC, RETN
EXT  VIDST, OLDST, COLR
EXT  VTRC, COMP, TRNS

;
IRP  X1, <0, 1, 2, 3, 4, 5>
IRP  X2, <N, S, C>
EXT  X2&F&X1
ENDM
ENDM

;
VID:  LD  (OLDST), SP      ; save stack point
      LD  SP, VIDST      ; set new stack point
VID1: CALL INKY          ; input keyboard
      LD  L, 0
      JR  NC, VID11
      LD  L, 1
VID11: OR  A
      JR  NZ, VID2
      LD  A, (PCSR)
      OR  A
      CALL NZ, AROW      ; input light pen
      JR  VID1

;
VID2: CP  NF1
      JR  NZ, VID3

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APPENDIX 2

Part of the Pretest

(It is a Cloze Test filling in the blanks, listening to the tape. We are indebted to Seibido's English Text *Listen and Learn* by H. Terao, T. Ohmura, Y. Kato, 1986, p. 56, because it has been suitable for this purpose according to our experience so far)

Fill in the blanks.

Have you ever heard an American expression, "Do you brownbag?" This means, "Do you bring your lunch?" Americans 1_____ 2_____ 3_____ lunch at a restaurant or a 4_____. But nowadays 5_____ and 6_____ office workers bring their lunch because it 7_____ less and is more convenient than 8_____ 9_____ a restaurant. Many people now bring their lunch because they are more 10_____ 11_____ their diet, too.

12_____ 13_____ American lunch is sandwiches. They put cold beef or ham or tuna between two slices of bread after 14_____ mayonnaise or mustard on them. Some like to add 15_____ other kinds of 16_____. Then they wrap the sandwiches 17_____ 18_____ and put them in a brown paper bag to take to their offices. It is said that there are restaurants 19_____ "Brownbag" in the U.S. today.

Another interesting bag is one called a "20_____ bag." If you go to a restaurant and order a 21_____ in the U.S., sometimes the portion is 22_____ 23_____. The piece of meat is more than you can 24_____ at a time. In that case you can ask a waiter or a waitress to give you a "25_____ bag." You can 26_____ the left-over 27_____ to your dear dog. But in many cases people eat the meat themselves 28_____ 29_____.

APPENDIX 3

Part of the Test used in the 3rd Experiment on the efficiency of CAI in II.

1. 関係代名詞 what は先行詞をその中に含み「～すること、～するもの」などの意を表します。()の中に適切な言葉を記入して日本語にあう英文を完成して下さい。
 - 1) これは私の欲しいものとは、少し違います。
This is a little different from what ().
 - 2) 彼が言った事は本当です。
() said is true.
2. アンダーラインの関係代名詞が省略出来る時は Y, 省略出来ない時は N と記入して下さい。
 - 1) Susan, whom he hopes to marry, is a very attractive girl.
 - 2) This is the house which I lived in when I was young.
3. 単語を正しく並べかえて、日本語に相当する英文を完成して下さい。
 - 1) 私にはカナダに住んでいる友人がいます。
LIVES, HAVE, FRIEND, I, CANADA, WHO, IN, A
 - 2) 私がきのう受けた試験は大変むずかしかった。
EAMINATION, YESTERDAY, I, WAS, TOOK, HARD, VERY, THE