

THE RELATIONSHIP BETWEEN THE USE OF VARIOUS TEACHING MATERIALS AND AIDS AND THEIR EFFECTIVENESS IN LEARNING

—THE DOMINANT TENDENCY OF THE LEARNING
(OR RECOGNITION) OF PARTICULAR FORM OF
INFORMATION THROUGH RECEPTORS—

Sadato MORIMASA*

The use of various kinds of teaching materials and aids as media of learning, and their relationship to the effectiveness in learning were examined through several experimental lessons. In our overall examination, the following have been noticed as general tendencies: In the lessons through the textbook, language was learned precisely and easily; an improvement was shown in the grasp and memorization of the ideas and theories explained in words—Symbolic Grasp. In the lessons in which slides and OHP's were used, the grasp and memory through images—Iconic Grasp—were improved. In the lessons conducted through the observation of objects, a notable tendency was shown in the grasp and memorization of the contents of the lesson concretely, substantively, in their actual state, and as a whole—Concrete Grasp. In the lessons through practice, the grasp and memory through operation—Enactive Grasp—were improved.

The tendencies shown above—the “tendencies of the contents or qualities of the information contained in the teaching materials and aids—Media of Learning—to be learned (or recognized) easily,” we call the “dominant tendency of the learning (or recognition) of particular form of information (stimulus) through receptors.”

In this paper, I would like to make a report of the results of our experiments in these researches.

From among the achievements obtained in the experimental lessons so far conducted, this writer would like to make an overall report on what he calls “the dominant tendency of the learning (or recognition) of particular form of information through receptors” by way of study of the relationship between the use of various kinds of teaching materials and aids and the effectiveness in learning, and of the learning psychology and the process of recognition concerning it.

A. Achievement of the Experiments

Experiment 1 Achievement of the experimental lessons with the vacuum cleaner ¹⁾²⁾

1. The lessons through the textbook

The results of the analysis of the answers to the question “What is the setup of the vacuum cleaner?,” were as shown in Table 1. Those who gave “the remo[te-]con[trolled] switch” (the correct answer) in their answers amounted to 18 in the group which learned the lesson through the textbook (T) (43 girls), overwhelming 6 cases in the group which

* Laboratory of Industrial Arts Education, Faculty of Education, Shimane University, Matsue, Japan.

Table 1. The relationship between the use of various kinds of teaching materials and aids and their effectiveness in learning
 —Achievement of the experimental lessons with the vacuum cleaner—
 Problem : What is the setup of the vacuum cleaner?

Groups (by teaching materials & aids)		T	O
		9th grade 43 girls	9th grade 41 girls
Answers			
Fan	Fan	29	15
	Special fan	10	22
	Special fan in the shape of the water-mill	0	2
Dust bag	Dust bag	27	24
	Dust bag (made of the cloth or paper with air-permeability)	1	4
	Others	10	12
Discharge opening	Discharge opening	2	3
	Rear opening	0	1
	Rear loophole	0	1
	Others	1	1
Hose	Hose	28	25
	Hose which can be bent freely	0	1
	Others	7	0
Cord	Cord	0	7
	Cord which can be automatically rolled in	0	1
	Cord which has the mark to show the limit of its extension	0	1
Switch	Switch	3	3
	Remo [te-] con [trolled] switch	18	6
	Remo [te] control	0	10
	Others	3	6

Notes : T : The textbook, O : Objects

learned through objects (O) (41 girls) (As a result of the χ^2 test, a significant difference was noticed at the 5% level. $\chi^2=7.62 > 3.84_{0.05}$). On the other hand, those who gave "the remo[te]control" (an incomplete answer) in their answers were none in the group which learned through the textbook, but as many as 10 in the group which learned through objects ($\chi^2=11.9$). As was shown here, in the learning through the textbook, we noticed the tendency that the students memorized language precisely.

2. The lessons through the object

In the group which learned through objects, the following tendencies were noticed : (1) There were students who answered, taking the "fan" as the "special fan in the shape of a water mill," the "hose" as the "hose which can be bent freely," or the "discharge opening" as the "rear opening," or as the "rear loophole." That is to say, in the learning through objects, we noticed the tendency that the students got concrete and substantive grasp. (2) There were quite a few students who answered, taking the "dust bag" as the "dust bag (made of the cloth or paper with air-permeability)." (3) There were 7 students who, in their answers, gave "cord" about which no explanation had been given in the lesson, quite a number ($\chi^2=8.01$) (in the other groups no cases of this answer). As was shown here in the lessons through objects, we noticed the tendency that the students grasped the contents of the lesson objectively and as a whole. (4) There were students who answered, taking the "cord" as the "cord which can be automatically rolled in," or as the "cord which has the mark to show the limit of its extension." That is to say, in the lessons through objects, we noticed the tendency that the students grasped the contents of the lesson by including even the related mechanical and functional matters. (See Bibliography 1 and 2 for the detailed descriptions.)

Experiment 2 Achievement of the experimental lessons with the fluorescent lamp ³⁾

1. The lessons through the textbook

The results of the students' answers to the question "Explain the setup of the fluorescent lamp and the materials used in it," were as shown in Table 2. Concerning the "pin" and the "base" of the fluorescent lamp, most of the students (30 out of 48 in one class, and 38 out of 48 in another) in the lessons through the textbook gave correct answers. [Against these, in the lessons through the visual aids, 3 out of 23 students ($\chi^2=15.29$), 4 out of 23 ($\chi^2=24.56$) respectively ; and in the lessons through objects, none of 24 students respectively in both cases]. As was shown here, in the lessons through the textbook we noticed the tendency that the students memorized language precisely and easily.

2. The lessons through objects

In the lessons through objects (O), we noticed the students who, in their answers, gave the electrode (filament) as the "tungsten in the shape of a coil." That is to say, in the lessons through objects, we noticed the tendency that the students grasped the content objectively and substantively. (See Bibliography 3 for the detailed descriptions.)

Experiment 3 Achievement of the experimental lesson with the fuel apparatus of the gaso-
line engine. ⁽¹⁾

a. The results of the analysis of the answers to the question "Explain the setup and working of the float chamber," were as shown in Table 3. The cases of the answers were as follows : "The float moves up and down according to the quantity of the fuel," "it keeps the level of the fuel at a certain height," or "it has the float-arm" was 34, 19 and 10 (in addition, 17 cases of illustrated answers) respectively. These are quite a number as compared with the 26 cases ($\chi^2=3.39$) (2 cases), 1 case ($\chi^2=20.93$), no case ($\chi^2=11.13$)

Table 2. The relationship between the use of various kinds of teaching materials and aids and their effectiveness in learning
—Achievement of the experimental lessons with the fluorescent lamp—
Problem : Explain the setup of the fluorescent lamp and the materials used in it.

Groups (by teaching materials & aids) Answers	T	V	O
	9th grade 48 boys	9th grade 23 boys	9th grade 24 boys
Pin	30	3	0
Pin (illustrated without designation)	6	1	8
Base	38	4	0
Base (illustrated without designation)	3	0	1
Electrode	23	5	7
Electrode (illustrated without designation)	6	9	4
Pole [for electricity]	0	0	1
Filament	17	0	6
Filament (Electrode)	2	0	2
Tungsten	0	0	11
Tungsten in the shape of a coil	0	0	1

Notes : T : Textbook, V : Visual aids (the fluorescent lamp' slides, etc., O : Objects

Table 3. The relationship between the use of various kind of teaching materials and aids and their effectiveness in teaching
—Achievement of the experimental lessons on the fuel apparatus of the gasoline engine—

Problem 1. Explain the setup and working of the float chamber.

Groups (by teaching materials & aids) Answers	O	OHP
	9th grade 40 boys	9th grade 41 boys
The float is in the float chamber	17(15)	17(28)
According to the quantity of the fuel the float floats and sinks (moves up and down).	26(2)	34(0)
The opening & closing of the float-needle valve and the valve base	2(0)	6(12)
The flat needle valve opens and closes.	34(6)	22(4)
The fuel flows in or stops flowing.	22	25
It keeps the level of the fuel at a certain height.	1	19
It arranges the height of the fuel.	11	10
The float lid is in it.	0(0)	2(7)
The float arm is in it.	0(0)	10(17)
The float chamber air-hole is in it.	0(0)	3(12)
The packing is in it.	2	0
It is a removeable bag-nut.	2	0
It is a removeable parallel pin.	6	0

Notes : The numbers in the brackets represent the numbers of those who gave the answers in illustrations only.

respectively, in the lessons through objects. As was shown in these cases, in the lessons through the OHP we noticed the tendency that the change which in reality went through the process of time, and that which could hardly be observed through the objects could be grasped and memorized well.

b. The results of the analysis of the answers to the question "Explain the setup and working of the carburetor chamber," were as shown in Table 4. In the lessons through the OHP, we saw 125 cases of the answers by illustration only (the ratio of these answers to the total number of the answers, 182 cases, is 68.7%), 20 cases of the answers by illustration and designation (11.0%), 5 cases of the answers by illustration and explanatory words (6.7%), 6 cases of the answers by illustration, designation and explanatory words (3.3%), and 26 cases of the answers by the explanatory words only (14.3%). That is to say, we saw a great number of the answers by illustration only, which was much greater than the 65 cases (49.6%) in the lessons through objects. As was shown here, in the lessons through the OHP (TP is the formalized illustrations), we noticed the tendency that the students gave more answers by illustration. And in that expression by illustration was as in TP used in the OHP, given in formalized ways, and many of them were in good order in regard to the locations and shapes of it. As was shown here, in the lessons through the OHP, we noticed the tendency that the students got a good illustrative grasp, but a poor grasp or memorization of the names, explanations, the concept presented in language.

2. The lessons through objects

a. In Table 3 (1) In the group which learned through objects (40 students), concerning the fact that "the floatneedle valve opens and closes alternately," the answers in words were 34, those by illustration were 6, almost all the students giving the answers. Here we noticed the tendency to get a better grasp and memorization of what could be observed well. (2) The answers by illustration were fewer than the same answers in the lessons through the OHP. And those illustrations were in most cases given in sketches, and quite a few of them were inaccurate or showed wrong memories on the part of the students. It seems that the observation of the objective things in the lessons through objects does not necessarily lead the students to the ability to express by illustration. (3) In the group which practised the assembling and disassembling, we noticed, in their answers, the contents grasped through the manipulation, such as the "the packin[g]exists," "the bag-shaped nut which can be removed," and "the parallel pin which can be removed." (4) As was shown here, even in the same lessons through objects, differences were noticed between the lessons through observation of objects and that through manipulation of the objects.

b. In Table 4, in the lessons through objects, the answers by illustration only were 65 cases (the ratio of this answer to the total answers of 131 in this group was 49.6%), which were fewer than those in the lessons through the OHP, but quite a number. And the answers by illustration were mostly given in sketches. Most of them were incorrect regarding the location and shape of each part.

Experiment 4 Achievement of the experimental lessons in the dwarfing culture of the chrysanthemum with B-Nine

1. The lessons through the textbook and mimeographed materials

The results of the tests on the principle of the dwarfing culture with one of the retardants B-Nine (n-dimethylamino succinami acid) were as shown in Table 5. In the group

Table 4. The relationship between the use of various kinds of teaching materials and aids and their effectiveness in learning
 —Achievement of the experimental lessons on the fuel apparatus of the gasoline engine—
 Problem 2. Explain the setup and working of the carburettor chamber.

Groups (by teaching materials & aids)	Items in the answers	Forms of the answers	Main jet system						Low-speed jet system				Total number of cases (%)		
			a. Air-valve	b. Throttle valve	c. Venturi part	d. Main nozzle	e. Main jet	f. Main air-flow opening	g. Low-speed opening	h. Racing opening	i. Low-speed jet	j. Low-speed air-inflow opening		Total	
Object 9th grade (40 boys)	A Illustration only		4	11	14	10	1	—	40	13	12	—	—	25	65(49.6)
	B Illustration & designation		3	1	3	3	2	1	13	3	4	—	—	7	20(15.3)
	C Illustration & explanatory words		1	1	1	2	—	2	7	1	—	—	—	1	8(6.1)
	D Illustration, designation & explanatory words		2	—	—	4	—	—	6	—	—	1	1	2	8(6.1)
	E Explanatory words only		2	4	5	9	3	3	26	1	1	1	1	4	30(22.9)
	Total		12	17	23	28	6	6	92	18	17	2	2	39	131(100)
OHP 9th grade (41 boys)	A Illustration only		9	18	20	12	8	12	79	14	16	6	10	46	125(68.7)
	B Illustration & designation		5	1	2	5	3	1	17	—	1	1	1	3	20(11.0)
	C Illustration & explanatory words		—	1	1	2	—	1	5	—	—	—	—	—	5(2.7)
	D Illustration, designation & explanatory words		—	1	1	3	—	1	6	—	—	—	—	—	6(3.3)
	E Explanatory words only		2	—	2	5	6	1	16	4	3	3	—	10	26(14.3)
	Total		16	21	26	27	17	16	123	18	20	10	11	59	182(100)

Table 5. The relationship between the use of various kinds of teaching materials and aids and their effectiveness in learning
—Achievement of the experimental lessons on the “dwarfing culture of the chrysanthemum with B-Nine”—

Groups (by teaching materials & aids Answers	T+P	T+P+O	T+P+S	T+P+O+S
	9th grade 24 boys	9th grade 24 boys	9th grade 23 boys	9th grade 24 boys
1) Nature of the dwarfing promotion retardant B-Nine No harmful action is done to the differentiation of the flower buds, and leaves does not slow the growth shortens the stalk & lower the height of the plant Total	15 9 18 42	11 6 18 35	12 6 21 39	15 10 22 47
2) Principle of the dwarfing the cell division of the growth point at the top is repressed. the extension of the part inbetween the joints of the stalk is repressed. It checks the metabolism of the growth substance in the body. Total	8 8 5 21	6 6 3 15	2 3 2 7	4 5 2 11
3) The best concentration of B-Nine 1/250 (0.4% solution) is generally used.	11	16	8	18
4) Proper time & frequency of the B-Nine spray standard spray time is 10-14 days after nipping the top. when one spray is given : set the aim on the 30 days before the flowering. when two sprays are given : set the aims on the 60 & 30days after the flowering. Total	11 13 14 38	11 9 10 30	3 3 3 9	13 19 19 51

5) The spray-amount of B-Nine 10-12cc per bawl (15cm)	7	7	5	15
6) How to make the chemical solution Add the spreader and solve in the lukewarm water.	7	3	2	13
7) Suggestions for the spray (Items omitted) Total	85	82	38	105
Sum Total	211	188	108	260

which learned through the textbook and mimeographed material (24 students), the answers covered 21 factors greater than 15 factors ($\chi^2=4.00$) covered in the answers of the group which learned through the textbook and mimeographed material plus objects (24 students), and 11 factors ($\chi^2=9.38$) covered in the answers of the group which learned through the textbook, mimeographed material and objects plus slides (24 students). That is to say, we noticed the tendency that in the lessons through the textbook and mimeographed material, the students got a better grasp and memorization of the theories.

2. The lessons through slides

In the results of the consciousness survey of the group which learned through the textbook, mimeographed material plus slides (23 students), we noticed the learning through slides (10 cases), the learning through mimeographed material (6 cases), the learning through pictures (4 cases) and others mentioned as the reasons for easy understanding. Among them the items mentioned as the reasons for easy understanding through slides were 4 cases of the dwarfing effect of B-Nine, and 3 cases of the growth-difference from the density of B-Nine. We can tell that the slides will make the grasp of the morphological comparison easier.

Experiment 5 Achievement of the lessons with the circuit tester ⁽⁵⁾

1. The lessons through the textbook and the OHP

As was shown in Table 6, in regard to the reading of the dial plate, the groups which learned the lesson through the textbook and the OHP showed better achievements than the groups which learned through the textbook plus the practice in the measurement of the resistance with the circuit tester.

2. The lessons through the textbook and the practice in the measurement of the resistance with the circuit tester

The results of the tests of the actual measurements with the circuit tester were as shown in Table 6. The group which learned through the textbook and practice in measurement with the circuit tester (23 students) showed better achievements than the group which learned through the textbook and OHP (22 students): fewer students who were incompetent to measure the resistance (3 : 11, $\chi^2=7.14$), more A [excellent] students (11 : 4, $\chi^2=4.45$) and less C [passable] students (3 : 9, $\chi^2=4.46$) in their attitude of measurement, etc. (See Bibliography 5 for the detailed descriptions.)

Table 6. The relationship between the use of various kinds of teaching materials and aids and their effectiveness in learning
—Achievement of the experimental lessons with the circuit tester—

a. The reading of the dial plate of the circuit tester

Groups (by teaching materials & aids)		W+OHP	T+O
		8th grade 48 boys	8th grade 24 boys
Answers			
Correct Answers	Value (per unit)	16	4
	Absolute value only	6	3
	Total	26	7
Wrong answers		26	17

b. Actual measurement with the circuit tester

Groups (by teaching materials & aids)		T+OHP	T+O	
		8th grade 22 boys	8th grade 23 boys	
Answers				
Plug with a lead	Correct	21	21	
	Wrong, or unable to answer	1	2	
Selection of range	Correct	15	21	
	Wrong, or unable to answer	7	2	
O Ω arrangement	Correct	8	14	
	Wrong, or unable to answer	14	9	
Value of measurement of the resistance	Correct	Value (with unit Ω)	3	5
		Absolute value only	3	7
		Total	6	12
	Wrong	5	8	
	Unable to answer	11	3	

Attitude	A	4	11
	B	9	9
	C	9	3

Notes : T : The textbook, OHP : The overhead projector,
O : Objects.

B. General Study

The overall study of the results given above has led us to notice the following tendencies : The lessons through the textbook let the students to memorize language precisely and easily, also to the better grasp and memorization of the concepts and theories—Symbolic Grasp. The lessons through slides and the OHP will lead the students to a better grasp and memorization of images—Iconic Grasp. The lessons through the observation of objects will lead to the better objective, substantive and total grasp—Concrete Grasp. The lessons through practice will lead the students to a better manipulating grasp and memorization—Enactive Grasp. As was shown in these results, the present writer call “the tendency to learn (or recognize) the contents and qualities corresponding to the information (or stimuli) contained in the teaching materials and aids—media of learning—have” the “dominant tendency of the learning (or recognition) of particular form of information through receptors,” which he would like to investigate further.

If we admit the tendency like this, that is to say, if the tendency toward the distinctive quality of the learning effect of the media of learning (recognition) is great, it can be said from the standpoint of S-S (sign-significate) theory that the learning through the reasonably combined uses of the teaching materials and aids are required.

And from the standpoint of “S-R Theory,” which explains that learning is a combination of stimuli and responses, we think it necessary to elucidate further, for instance, what kinds of teaching materials and aids will make the lesson more reasonable one for the technological learning—enactive grasp.

ACKNOWLEDGMENT

In making this report, I would like to appreciate gratefully those who gave kind cooperation and help to me in my research. This research was conducted on the Japanese Ministry of Education’s grant for the research on science (special study in science education). I would like to express my deepest gratitude for the kindness and good offices extended to me by those who were concerned.

BIBLIOGRAPHY

- 1) Morimasa Group (1972), The Learning Process and Evaluation in Scientific Technology Education. Research Material of the Research on Science, Special Study in Science Education on the Japanese Ministry of Education’s Grant for the Research on Science for 1971, pp. 55–81.
- 2) Morimasa, Sadato & Toshiko Kuga (1972), “The Influence of the Process of Using Teaching Materials and Tools on the Effectiveness in Learning,” Bulletin of Faculty of Education, Shimane University (Educational Science), VI, pp. 165–78.
- 3) Morimasa Group (1971), On the Results Produced on the Effectiveness in Learning by the Differences in Teaching Method in Technological Education. Research Material of the Research on Science, Special Study in Science Education on the Japanese Ministry of Education’s Grant for the Research on Science for 1970, pp. 25–32

- 4) Morimasa Group (1976), Analysis of The Relationship between the Structure of the Contents of the Lesson and the Effectiveness in Learning in the Junior High School Science Lesson. Research Material of the Research on Science, Science Study in Science Education on the Japanese Ministry of Education's Grant for the Research on Science for 1975, pp. 211-32.
- 5) Morimasa Group (1973), The Elucidation of the Abilities And Their Development in Scientific Technology Education—With a View to the Improvement in the Learning Process And Evaluation—. Research Material of the Research on Science, Special Study in Science Education on the Japanese Ministry of Education's Grant for the Research on Science for 1972, pp. 43-44.