A CLASS EXPERIMENT IN LEARNING

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In presenting to classes in Educational Psychology the facts about learning, the effects of practice and transfer of training it seems highly desirable to adopt a method which will furnish to the students evidence of an objective nature. The limited time at the disposal of the lecturer in the ordinary introductory course in this field precludes the possibility of adapting the typical experiments in learning to fit the occasion. The studies of Bryan and Harter, Swift, Book, and others have dealt with the learning of telegraphy, typewriting, or some other subject matter which required lengthy practice extending sometimes over months. In a previous article by one of the present writers a preliminary statement of the problem was made and suggestions were offered for experiments which seemed to meet the requirements of the situation.¹ Several years later there was published a more elaborate scheme for carrying out a class experiment in learning.² This experiment did not prove entirely satisfactory, but it has since been modified, after trial in a number of classes, and it now seems to serve its purpose excellently. It is the object of this paper to report the methods and results of the experiment as given in its final form.

The class in Educational Psychology was divided arbitrarily according to the seating arrangements into two groups of approximately equal size. On the first day of the experiment all members of the class were given three tests, hereafter designated as the Test Series. The first of these is called the Digit Letter Substitution Test. Sheets of paper were distributed, each containing at the top circles in which were inserted the numbers from 1 to 26. Each circle also contained one of the letters of the alphabet, the distribution being a random one. Under the code were printed a number of sentences, and the task consisted in translating letters into digits for a period of 5 minutes. As shown in Fig. 1 the arrangement of the sheet permits of rapid scoring. The subjects were told to work for accuracy rather

¹ Dearborn, W. F.: Experiments in Learning. *Journal of Educational Psychology*, Vol. I, pp. 373-384.

² Dearborn, W. F., and Brewer, John M.: Methods and Results of a Class Experiment in Learning. *Journal of Educational Psychology*, Vol. IX, No. 2, Feb., 1918, pp. 63-82.

in the wind. The boys also	5	13	9	14	11	12	5	13	17	9	14	11	7	7	24	25	16	19	1	
spin tops, and they play	19	23	5	13	9	1	23	19	25	13	17	9	14	11	24	23	16	25	24	
"seesaw," and jump the rope.	19	11	11	19	25	12	25	13	17	18	21	8	23	9	14	11	20	1	23	11
Boys in Korea are fond of	7	1	24	19	5	13	6	1	20	11	25	25	20	11	4	1	13	17	1	4
fishing Nearly every																				
boy has a fishing rod and																				
goes fishing whenever																				
he can. Sometimes the																				

[FIG. 1.—Sample of digit-letter substitution test.

than speed, and to correct mistakes, and no account was taken of the errors in making up the scores.¹

The second test is designated as the Complex Dotting Test. For

2	8	1	2	1	1	2	3	2	2
..	...	.	...	.	.	..	...	.	..
1	1	3	1	3	1	2	3	3	2
.	.	..	.	...	.	..	...	...	..
3	2	3	2	2	1	3	1	2	3
..	..	..	..	..	.	..	.	..	..
1	3	2	3	1	1	2	1	3	1
.	...	..	..	..	.	..	.	...	.
2	1	3	2	1	3	2	3	3	2
..	.	...	..	.	...	..	...	...	..
1	3	2	1	3	1	2	2	1	1
.	...	..	.	...	..	..	..	.	.

FIG. 2.—Sample of dotting test.

¹ In one of the previous experiments the curve of errors was plotted, and it was shown that the errors might be disregarded.

this test sheets of paper are ruled into half-inch squares, each of which contains either the number 1, 2 or 3 (See Fig. 2). The numbers are distributed at random throughout the 150 squares on the sheet. The task is to put in each square as rapidly as possible the number of dots called for by the number in that square. One minute is allowed, and the score is the number of squares completed.

Test 3 is a modification of the code test of the Stanford-Binet Scale.¹ This code is reproduced in Fig. 3, and Fig. 4 shows part of a test sheet. Five minutes are allowed for this test, and the score is the number of letters translated. As in the other tests, no allowance is made for errors.

After these tests had been given the class was practiced for 10 minutes in the substitution of shorthand symbols for about a hundred of the most common words and word phrases in the English language. These symbols were printed on a key, a copy of which was given to each subject (Fig. 5). The material in which the substitutions were made was furnished by double spacing a book which was being printed at the University Press at the time and striking off sufficient copies on inexpensive paper. Figure 6 shows a section of this practice material in which the symbols have been substituted.

A	D	G	J	M	P
B	E	H	K	N	Q				
C	F	I	L	O	R				

FIG. 3.—Code for code substitution test.

And now leaving these life (28)	אם עתה נעזב את החיים
failures, as I may call them, (28)	כישלונות, כפי שאני יכול לקרוא להם
I will ask why there are so (21)	אני אשאל למה יש כ"כ הרבה
many failures at the (17)	כ"כ הרבה כישלונות ב
university. First, (15)	האוניברסיטה. ראשית,
among the causes of (16)	בין הגורמים של
failure, I should be (15)	כישלון, אני צריך להיות
inclined to place neglect (22)	נכונות לשים לב

FIG. 4.—Sample of code substitution test.

¹ This code test seems to have first been described by Healy and Fernald in *Psychological Review Monographs*, Test No. XI, Vol. XIII, No. 2.

a, an	do.	his, is	it will	the	will be
after	do not	how, out-	ite, it is	then	will not
all	for	I	may	their, there	
and	for the	I can	were	then, than	with
any	from	I have	no	there, their	with the
are, our	from the	I may	not, in	there are	with this
are not	had	I will	row	there is	would
as, has	had, as	I would	of	they	would be
at, it	have	if	of the	this	would have
at the	have not	in, not	of which	to	would not
be, but, by	he	in that	on	was	
to be	he can	in the	on the	it was	
been	he is	in this	on which	well, will	you, who
but, be, by	he may	in which	or	were, her	you are
by, be but	he would	into,	our, are	what	you can
by the	her, were	is, his	out, how	when	you may
can	his	is the	she	which	you will
can not		it, at	so	which is	you would
can the		it is	some	who, you	
			than, then	will, well	
			that		
			that the		

FIG. 5.—Shorthand key.

will be as agreeable company for them as it ever was when

79) 9 4 5
it was on his shoulders At Gwales they will spend eighty

/ 4 2) / 2 5
years. All these predictions come to pass. While the

c /
charm is on them, they are happy, oblivious of fatigue and

, c / 2 5
of the lapse of time. At last they reached London and

✓ u / 2 5
buried the head. So long as it remained buried, no invading

/ 2 9 / ~
host could enter the island. Its subsequent disinterment

/ 1
was a great stroke of misfortune.¹

4 . u
Instances of speaking heads in modern Irish folk-lore have

✓ -)
already been cited.² One, like the Green Knight's, enjoins

✓ /
upon the hero a perilous expedition.³

✓
There is a talking death's head in the lost Gawain story

FIG. 6.—Sample of the ¹/₂ practice material showing the shorthand substitutions.

During the next 15 days, exclusive of Sundays, this practice continued. One group of the class practiced one 20-minute period a day, and the other group practiced 20 minutes in two 10-minute periods, one in the morning and the other in the evening. Each man counted and recorded the number of substitutions made in each period, also noting the mental and physical conditions under which he did his work. At the end of the experiment each man tabulated his results and plotted his own curve of learning.

On the fifth and tenth days of the practice period check tests

9 we). seen. / 2 9 early 9 / eleventh century /
main versions ✓ complete Irish saga ✓ Contention ✓
Hero's Portion, / 2 combined -- text 2 actually
extant -- manuscript written about 1100. — one ✓ 2 /
Challenge 4 retained ✓ form 7 / 2 appears ✓

FIG. 7.—Sample of check test material.

TABLE I.—SCORES AND PERCENTAGES OF IMPROVEMENT OF PRACTICED AND CONTROL GROUPS

	Average initial score	Average final score	Per cent improve- ment
I. Practiced group:			
(a) Shorthand Substitution.	72	467	548
(b) Digit letter Substitution.....	98	116	18
(c) Dotting.....	102	118	16
(d) Code Substitution... ..	103	118	15
II. Control group:			
(a) Shorthand Substitution.	No practice given.		
(b) Digit letter Substitution... ..	93	103	11
(c) Dotting.....	102	113	11
(d) Code Substitution.. . . .	92	116	26

There was plainly a very great amount of improvement in the ability to make the shorthand substitutions, as the class made an average gain of 548 per cent. The gains in the test series, however, were much smaller, namely, 15, 16, and 18 per cent. These test series gains become even smaller when the results of the control group have been taken into consideration. In the Digit Letter Substitution the mere repeating of the test in the control group shows an 11 per cent improvement. As the practiced group only improved 18 per cent in this test there is left a net improvement of 18 minus 11 or 7 per cent which may be attributed to transfer. In the same way we find a 5 per cent improvement which may be attributed to transfer in the Complex Dotting test, and in the Code Substitution there is no transfer or facilitation at all, but rather interference, as the control group improves 26 per cent while 15 per cent is all that is found in the practiced group.

In comparison with the improvement of 548 per cent which took place as a result of the practice it seems fair to conclude that the transfer was insignificant. We must, however, enter into another phase of the problem. Before we can decide on the significance of the above percentages we must know something about the zero points and the physiological limits in the various tests. Fortunately, the Digit Letter and Code Substitution Tests had each been used for practice material in previous experiments. In 12 days of practice

a group of students improved 463 per cent in the Digit Letter Test, and another class improved 537 per cent in Code Substitution.¹ Thus it seems that the possibilities of improvement in these tests were considerable. The fact that so little of this possible improvement appears in one test and that there is not an improvement but a loss in the other leads us to the conclusion that the skill acquired in one field was not transferable to another field, even though the second was very similar to the first. The possibility of one sort of learning interfering with another is also neatly illustrated.

The experiment also furnishes excellent material for the study of the effects of practice on the variability of a group. To get data on this point the average deviation of each group was calculated every third day throughout the experiment. These average deviations, together with the averages and coefficients of variability on the same days are tabulated in Table 2. On Plates I and II the deviations are shown by vertical lines.

TABLE II.—AVERAGES AND AVERAGE DEVIATIONS IN SHORTHAND SUBSTITUTION PRACTICE

Day	Group I	Coefficient of variability	Group II	Coefficient of variability
1	Average..... 150 Average deviation... 12	0.08	Average..... 168 Average deviation... 20	0.12
4	Average..... 344 Average deviation... 46		Average..... 360 Average deviation... 34	
7	Average..... 535 Average deviation... 62	0.12	Average..... 507 Average deviation... 57	0.11
10	Average..... 665 Average deviation... 88	0.13	Average..... 636 Average deviation... 84	0.15
13	Average..... 844 Average deviation... 90	0.11	Average..... 814 Average deviation... 90	0.11
16	Average..... 960 Average deviation... 89	0.11	Average..... 1001 Average deviation... 106	0.11

The figures indicate that the heterogeneity of both groups was much increased by the practice. In Group I the average deviation on the first day was only 12, while on the last day it was 89. In Group II there was a rise from 20 to 106 in the average deviation.

¹ See above reference.

Manifestly the ability was more widely distributed at the end of the practice than it was at the beginning. This is shown in a rather striking way on the plates by the lines showing the daily individual performances of the slowest and most rapid learners in each group. When this change is expressed in terms of the coefficient of variability, it is seen that the increase in variability bears a fairly constant relation to the increase in the average skill of the groups.

The division of the class into two groups was for the purpose of investigating the effects of different distributions of practice time. The results of this study are best shown in Plate III where the daily averages of the two groups are plotted. These averages are tabulated in Table III. It will be seen that there are not large differences in the two curves, but the weight of evidence seems slightly in favor of the two short periods a day rather than one long one. The Group II curve is very smooth, while the daily performances of Group I

TABLE III.—DAILY AVERAGE SCORES OF TWO PRACTICED GROUPS

Day	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Group I	150	223	254	344	390	462	535	580	602	665	793	786	844	829	936	960
Group II	168	247	304	360	414	446	507	545	588	636	686	740	814	859	908	1001

show more fluctuation, especially from the tenth day on. There are two days when distinct losses are registered in the one period group, and these would be very undesirable in any learning because of the bad effect on the attitude of the learner toward his work when he fails to make progress.

The experiment is useful in a number of other ways. Plotting of the individual records, for instance, gives excellent illustrative material for the study of individual differences. In the usual class there will probably be found curves which will illustrate all the common characteristics of practice curves such as plateaus, daily fluctuations, and so on.

If the subjects keep careful records of the conditions under which they work at different times during the practice period some interesting facts may be obtained concerning the effect of various factors on the performances of individuals. Changes resulting from interest, fatigue, distractions, time of day when practice is done, and like circumstances are likely to appear, and add greatly to the value and interest of the work.

The scores in the various tests furnish excellent material for illustration of the mathematical problems of measurement. The

PLATE I.—Daily averages of Group I, with best and poorest records of the group. The perpendicular lines every third day show the average deviations on those days.

PLATE II.—Daily averages of Group II, with best and poorest records of the group. The perpendicular lines every third day show the average deviations on those days.

PLATE III.—Comparison of the two groups to determine the better time distribution in practice periods.

data obtained proved especially useful in illustrating to the class the methods of numerical and graphic correlation.

While it is believed that the findings will ordinarily be in agreement with the more general and more extensive experiments in the same field, it is possible that there will be differences in some of the select groups which make up college and normal school classes. Care should be taken, therefore, to make it clear, when this or a similar experiment is used, that the results do not prove or disprove the various educational theories concerning which they furnish evidence.¹

¹ This experiment was originally begun as a contribution to the work of a committee of the American Psychological Association on Class Experiments in Psychology. If there is sufficient demand, the materials will be printed in quantities and supplied at cost to those interested.