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IDENTIFYING AND TEACHING CREATIVITY. THE GENERAL COLLEGE STUDIES, UNIVERSITY OF MINNESOTA, VOLUME I, NUMBER 2, 1963-1965.

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DESCRIPTORS- *JUNIOR COLLEGES, *CREATIVITY RESEARCH, *TESTING, *EDUCATIONAL EXPERIMENTS, CREATIVITY, *MEASUREMENT TECHNIQUES,

IN FOUR STUDIES TO DETERMINE THE POSSIBILITY OF INCREASING CREATIVE BEHAVIOR BY MEANS OF CLASSROOM EXERCISES, THE AUTHORS COMPARED TREATMENT AND CONTROL GROUPS WITH RESPECT TO GAINS IN SCORES ON THE MINNESOTA TEST OF CREATIVE THINKING. IN THE FIRST STUDY, STUDENTS IN A CREATIVE PROBLEM SOLVING CLASS MADE SIGNIFICANTLY GREATER GAINS THAN THE CONTROL GROUP IN FLUENCY, FLEXIBILITY AND ORIGINALITY, WHILE DIFFERENCES IN ELABORATION WERE NOT SIGNIFICANT. IN A SIMILAR SITUATION, BUT WITH A DIFFERENT INSTRUCTOR FOR THE TREATMENT GROUP, THE GROUPS DID NOT DIFFER SIGNIFICANTLY IN NONVERBAL TASKS, ALTHOUGH DIFFERENCES IN CERTAIN FACTORS OF THE VERBAL TASKS FAVORED THE TREATMENT GROUP. IN A THIRD EXPERIMENT, WITH YET ANOTHER INSTRUCTOR AND A DIFFERENT METHOD OF SELECTING THE CONTROL GROUP, THE TREATMENT GROUP TENDED TO GAIN MORE ON MOST MEASURES, THOUGH DIFFERENCES WERE SIGNIFICANT ONLY IN THE VERBAL TASKS. COMPARISON OF PERFORMANCE OF THE TREATMENT GROUPS SHOWED THAT DIFFERENCES IN STUDENTS, TEACHERS, AND METHODS FOR THE THREE CLASSES DID NOT SIGNIFICANTLY AFFECT FLUENCY, FLEXIBILITY, AND ORIGINALITY, THOUGH STUDENTS OF ONE INSTRUCTOR, WHO USED A SET OF EXERCISES DIFFERENT FROM THOSE OF THE OTHERS, SHOWED SIGNIFICANTLY GREATER GAINS IN ALL ELABORATION SCORES. FOR OTHER REPORTS IN THIS SERIES, SEE JC 670 969 AND JC 670 970. (HH)

UNIVERSITY OF MINNESOTA

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IDENTIFYING AND TEACHING CREATIVITY

Part One : Measuring Creative Growth (Phase 1)
Part Two : Measuring Creative Growth (Phase 2)
Part Three : Measuring Creative Growth (Phase 3)
Part Four : Comparing Creative Problem Solving Classes Taught by Different Instructors

Fred M. Amram

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This number of The General College Studies presents another set of Amram-Giese studies of creativity. Here, certain tests of creativity are used in an attempt to determine whether or not it is possible to increase creative behavior by means of a series of classroom exercises. The reports give an account of work that began with experimental classes in 1963 and continued into 1964. Though each experimental group was relatively small, the possibility of generalizing from the findings is increased by the fact that three separate groups of students were studied. Furthermore, three different instructors conducted the classes over a period of three academic terms. Results of comparisons among the groups is found in part four.

The General College now offers Creative Problem Solving as a regular part of its curriculum. After the course was launched, it was found that creativity can profitably be taught to classes as large as one hundred with little or no modification in techniques devised for smaller sections.

The material presented in part four was originally published in somewhat abridged form in The General Education Soundingboard, 4:1:9-15 (Spring, 1967).

I : MEASURING CREATIVE GROWTH : PHASE 1

Does a course designed to teach skills in creative problem solving improve creative behavior as measured by tests? To answer this question, we administered a test of creativity to students enrolled in a class focused on creative activities, and to two conteol groups. Pre-tests were administered on the first day of class, and post-tests were given on the last day of class. Scores were compared to test the hypothesis that the means of the post scores (adjusted for pre-scores) of the same groups would be essentially equal.

The Course

As already indicated in an earlier report (The General College Studies 1(1):9-10), the official description of the course, GC 33B, "Creative Speech Activities:, is as follows:

> ...will be organized around a study of creativity and creative problem solving. Emphasis will be directed toward making students aware of the need for creative behavior in business, industry, community affairs, and the arts. Students will participate in exercises to help them become more sensitive to problems, better able to analyze them and to demonstrate some of the techniques which aid in the discovery of unique solutions (attribute listing, morphological analysis, brainstorming, etc.). Students also will be required to devise ways to apply solutions and to communicate their ideas to others persuasively. With individual and group exercises students will demonstrate their creative abilities to themselves and to the class.
>
> Class discussion about the social and emotional blocks to creative behavior will be designed to help students discover and overcome their own blocks. The class will work in an extremely permissive atmosphere. Each student will be encouraged to follow his own interests and to work on individual projects.[1]

Generally speaking, instruction followed the pattern established in the Student Workbook for Creative Problem Solving Courses and Institutes, and its accompanying manual for instructors, both by Sidney J. Parnes, and Applied Imagination by Alex F. Osborn.[2] On occasion, guests visited the class to discuss aspects of creativity and to demonstrate some techniques for improving creative abilities.

The Subjects

One of the control groups, General College 32C, "Speech Organization," requires, like the Creative Problem Solving Class, that students have had at least one previous speech course. The General College Bulletin[2] describes the course as follows:

> 32C. Oral Communication: Speech organization. Focus is on the problems of organizing and developing a speech, so that the student is helped to increase his skill in gathering and selecting material, organizing it into outline form, and developing it in a manner appropriate to the particular audience and occasion for the speech. Major assignments include a one-point speech, an oral report, a speech to convince, and a manuscript speech.

The second control group, 5B, Functions and Problems of Logic, has no prerequisites. The official description of 5B follows:

> 5B. Functions and Problems of Logic: The student studies and attempts to apply the rules and procedures of sound argument and valid inference. He is shown the relationship of formal patterns of reasoning to such uses of ordinary language as argument, propaganda, and persuasion. He is also shown the manner in which formal logic is employed as a tool by the scientist and the mathematician.

In summary, the subjects were relatively low achievement students enrolled in the General College. The experimental group was enrolled in a course designed to teach creative problem solving. The two control groups were a class in speech organization and a class in

logic. In no instance was a student enrolled in more than one of the three courses during the quarter in which the testing occurred. The number of students who completed both the pre- and the post-test in each class is as follows: 33B - 17, 32C - 8, and 5B - 29.

The Test

The measuring device as well as the scoring procedures are described by E. Paul Torrance in Administration and Scoring Manual for Abbreviated Form VII, Minnesota Tests of Creative Thinking.[3] The complete test consists of four tasks, with ten minutes allowed for each task. Task one presents ten incomplete figures. The subject is asked to make some interesting objects or pictures by adding lines to the figures. He is encouraged to use his imagination in this task as well as in the three others.

Abbreviated Form VII presents two and one-half pages of circles as stimulus for another drawing exercise. However, because the circle task is presented as a practice exercise in the workbook used in the experimental course, 33B, we decided to use a related task, namely parallel lines, as problem two. Professor Torrance provided scoring instructions for this substitute task. The testees were presented with 30 pairs of parallel lines and asked to add their own lines to complete pictures of their own design. The students were told that they could draw inside the lines, on the lines, and outside the lines. They were encouraged to make many different pictures and to make each picture as complete and interesting as possible.

Task three presents a picture of a stuffed toy dog. It is described as being about six inches long and weighing about three ounces. In spaces provided, the student is asked to "list the

cleverest, most interesting and unusual ways you can think of for changing this toy dog so that children will have more fun playing with it."[4]

Task four asks testees to list unusual uses for empty tin cans. The instructions for this task are typical of the style of the directions and show the encouragement given the student:

> Most people throw their empty tin cans away, but they have thousands of interesting and unusual uses. In the spaces below and on the next page, list as many of these interesting and unusual uses as you can think of. Do not limit yourself to any one size of can. You may use as many cans as you like. Do not limit yourself to the uses you have seen or heard about; think about as many possible new uses as you can.[5]

Each task is scored for four factors: fluency, flexibility, originality, and elaboration. Tasks one and two require non-verbal responses. Tasks three and four require verbal responses. By offering these two types of tests we are able to study both verbal and non-verbal types of behavior. We evaluate each task independently. We then add the scores for tasks one and two to find a total non-verbal score. For each task we identify four scores (the four factors) and for each total we identify four scores. Multiplying the seven categories (task one, task two, total non-verbal, task three, task four, total verbal, grand total) by the four factors (fluency, flexibility, originality, elaboration), we isolate twenty-eight different scores useful for comparison with each other and with the scores of different groups of subjects.

Ten minutes are allowed for each task. Under conditions of limited time periods, some subjects may not be able to demonstrate all four kinds of thinking with equal emphasis. Torrance suggests that "it is important, especially in the study of individuals, to note what direction is taken under this pressure. Considerable

variability can be expected, especially in fluency and elaboration."[6]

Method

Each of the twenty-eight scores was treated separately. In each case we compared the three classes for similarity in pre-test means using a one-way analysis of variance. First we compared the means of the two control groups. Then we compared the mean of the experimental group with the average (weighted mean) of the control groups. The post-test scores were treated in exactly the same way. Finally we compared the three groups for similarity in post-test means adjusted for differences in pre-test means using analysis of covariance.

Results

The findings are summarized in four tables, one for each of the factors (fluency, flexibility, originality, elaboration) we are measuring. Tasks one and two are the non-verbal tasks, and "NV" refers to the totals for the first two tasks. Tasks three and four are the verbal tasks. "V" refers to the totals for the verbal tasks. "GT" refers to the grand totals for the four tasks.

The lines labeled "Pre" refer to the results of the tests given on the first day of the classes. The lines marked "Post" refer to the tests administered on the last day of the quarter. The lines labeled "Adj. Post" identify the estimated post-test means. In other words, a statistical adjustment was made for differences among the three groups on the pre-tests.

The column labeled "Group Means Treatment" identifies means (arithmetic averages) of the Creative Problem Solving class. The columns labeled "Control 1" and "Control 2" identify the group means for the two control groups. The column labeled "Within Standard Deviation" identifies the average variability (spread) among the scores of the subjects within the three groups. There are three columns under the general heading "Analysis of Variance F Ratio." The F Ratio compares the variability of the mean scores to the Within Standard Deviation. If the means are close together and the standard deviation is either small or large, the F Ratio will be small. If the means are far apart (large differences between classes), the F Ratio will be small if the standard deviation is large, and large if the standard deviation is small. The first F Ratio compares the three group means. The second F Ratio compares The two control groups, and the third F Ratio compares the treatment group with the combined scores of the two control groups.

A single asterisk indicates a difference significant at the .05 level. A double asterisk indicates a difference significant at the .01 level. The level of significance measures the magnitude of the difference among the means. The .01 level indicates bigger differences among the means than the .05 level.

To interpret the findings presented in the tables, one looks at the pre-test among Groups F Ratios. If it is significant, one looks at the Between Controls and the Treatment VS. Controls F Ratios to see where the significant difference is. The difference may be between the two control groups. This difference would be indicated by a significant Between Controls F Ratio or the

difference may be between the control groups and the treatment group. This difference would be indicated by a significant Treatment vs. Control F Ratio. If the F Ratio is not significant the three groups have approximately equal test means.

One then looks at the post-test F Ratios and examines them in the same way as the pre-test F Ratios. A significant Treatment vs. Control F Ratio indicates that the students enrolled in the Creative Problem Solving class (treatment) gave responses different from those enrolled in the control classes. The higher mean scores indicate which group's responses were more "creative".

After having examined the pre- and post-test F Ratios, one looks to the adjusted post-test F Ratio to see if there would have been a difference among the three groups on the post-test had the pre-test scores been approximately equal. It is sometimes possible for the adjusted post-test F Ratio to be significant when the post-test F Ratio is not significant. The significant F Ratio could occur if the three groups had essentially equal post-test mean scores but significantly different pre-test mean scores. Similarly, if the post-test mean scores have the same pattern as the pre-test mean scores, the adjusted post-test F Ratio could be nonsignificant while the post-test F Ratio is significant.

Fluency

Table 1.1 reflects the findings of the fluency scores on all tasks.

Task 1: Although the treatment and control groups are significantly different on the pre-test, these differences do not carry over to

the post-test or adjusted post-test results.

Task 2: There is a significant difference on the post-test scores because of the difference between the treatment and the control groups. Even though there is a significant difference on the pre-test scores among the groups, the post-test scores adjusted for these pre-test differences are still significantly different, with the larger adjusted mean belonging to the treatment group.

Total Non-vergal: The large difference between the treatment group and the average of the control groups in Task 2 is reflected in the differences that exist in the total non-verbal scores. Again, the adjusted post-test scores are significantly different, with the treatment group having the largest adjusted post mean.

Task 3: The post-test scores of the three groups are significantly different, with almost all of the differences due to the Treatment vs. Control differences. Since the pre-test scores are essentially equal for the three groups, the adjusted post-test results mimic the post-test results.

Task 4: The results here are essentially the same as the results in Task 3.

Total Verbal: Because of the similarity of the results on Task 3 and 4, the total verbal results are a magnification of these results.

Grand Total: The grand total results reflect the significant differences between the treatment group and the control groups of tasks 2, 3, and 4, and hence are a magnification of these results.

Summary: The results of the fluency scores indicate that the students enrolled in the Creative Problem Solving course made more responses on the post-test adjusted for pre-test differences than did the students enrolled in the control classes. Presumable fluency

is a skill learned under the treatment. On Task 1 the treatment group scored higher on the post-test, although not significantly higher. This may be due to the difficulty of the task, but more probably is due to an insufficient number of stimuli (not enough incomplete figures).

Flexibility

Table 1.2 reflects the results for flexibility on all tasks.

Task 1: Although the treatment and control groups are significantly different on the pre-test, these differences do not carry over to the post-test or adjusted post-test results.

Task 2: There are significant differences among the groups on both pre- and post-test results, with the differences due to treatment vs. control differences. When the post-test scores are adjusted for the differences in the pre-test scores, the differences among the post-test scores are no longer significant.

Total Non-verbal: The findings on the total non-verbal scores reflect the differences that exist on Task 2.

Task 3: There are significant differences among the groups on the post-test scores. The major difference is due to the treatment vs. control. After adjustment for pre-test scores this difference is retained.

Task 4: The results of Task 4 are unusual. For some reason, the control groups had significantly higher pre-test means than did the treatment group. Post-test scores for all groups were lower than pre-test scores. The differences among the groups on the post-test scores were not significant. When the post-test scores were adjusted for pre-test differences, there was a significant difference with the treatment group having the highest adjusted post-test mean.

Total Verbal: The differences exhibited on tasks 3 and 4 showed up again on the total verbal scores. Significant differences existed on the pre-test, with the control groups having the highest scores; and on the post-tests and adjusted post-test, with the treatment group having the highest score.

Grant Total: The grand totals reflect the verbal scores, in that the adjusted post-test scores are significantly different with the treatment group having the highest adjusted mean score.

Summary: After adjustment for pre-test differences, there was no significant differences among the groups on the non-verbal tasks, although the treatment group tended to have the highest scores. On the verbal tasks, inconsistent results were noted. The students received higher post-test scores than pre-test scores on Task 3 but lower post-test scores than pre-test scores on Task 4. The adjusted post-test scores were significantly different on both tasks 3 and 4, with the treatment group receiving the highest adjusted mean score. The total verbal and the grand total reflect primarily Task 4 because the standard deviations on Task 4 are larger than the standard deviations on the other tasks (see the Within Standard Deviation column).

Originality

Table 1.3 reflects the results for originality on all tasks.

Task 1: Although significant differences among groups show up on the pre-test, these differences do not carry over on the post-test or adjusted post-test results.

Task 2: Significant differences were found on pre-test, post-test, and adjusted post-test scores, with the treatment group consistently

having the highest mean. It is interesting to note that both control groups decreased in originality scores, while the treatment group remained about the same.

Total Non-verbal: The findings of the total non-verbal scores mirror the results of Task 2.

Task 3: There were significant differences found on the post-test scores, with the difference in favor of the treatment group. Because the pre-test scores were not significantly different, the adjusted post-test scores showed the same results as the post-test. The mean of the treatment group doubled, while the means of the control groups remained at about the same level.

Task 4: Although there were differences between the control groups on the pre-test, the treatment group almost tripled its mean score, while the control groups maintained approximately the same mean scores. Consequently, these differences are reflected in the post-test and adjusted post-test F Ratios.

Total Verbal: Because the results of tasks 3 and 4 are essentially the same, these results are simply magnified on the total verbal scores.

Grand Total: The Consistent results on tasks 2, 3, and 4 are reflected on the grand total results.

Summary: While the results of the non-verbal tasks are inconsistent, it is clear that the treatment groups increased two to three times in originality mean scores, while the control groups did not change during the same period.

Elaboration

Table 1.4 reflects the results for elaboration on all tasks.

Task 1: The significant differences on the post-test and adjusted

post-test F Ratios reflect an increase in all groups, with a greater increase in the treatment group and the second control group.

Task 2: Although there are differences in all the groups, with the treatment group showing the greatest difference, these differences are not large enough to be considered significant.

Total Non-verbal: The significant differences on the post-test scores are not maintained when adjustment for pre-test scores is made.

Task 3: No significant differences were found on the task 3 elaboration scores (except between the two control groups on the pre-test). However, it is interesting to note that all three groups decreased in elaboration scores during the quarter.

Task 4: The results of Task 4 were essentially the same as the results of the previous task, with even greater decreases in scores

Total Verbal: The consistent results on tasks 3 and 4 are magnified on the total verbal results.

Grand Total: The gains on Task 1 temper the quantity of the losses on the verbal tasks. The significant adjusted post-test F Ratio reflects a smaller loss in the treatment group's ability to elaborate.

Summary: The inconsistent results of the non-verbal tasks and the consistent loss in the verbal tasks lead to a series of unanswered questions concerning the elaboration scores.

Conclusions About the Experiment

1. It appears that the control groups began at essentially the same point (approximately equal pre-test mean scores) except in verbal elaboration and in one other isolated case.

2. At the end of the quarter, the two control groups obtained approximately equal mean scores (except in one case) indicating that a course in speech organization and a course in logic have similar effects on the students' behavior on these tasks.

3. On most of the tasks, the treatment group obtained pre-test scores higher than those of the control groups with the difference being significant on about half of the pre-test scores. This difference seems to indicate that some selection process is operating in the recommending of students for G.C. 33B and/or in the students choosing the course.

4. The post-test scores indicate that on fluency, flexibility, and originality scores, the three groups are significantly different, with the difference favoring the treatment group. The differences on elaboration usually favored the treatment group, but the differences were not significant.

5. When the inequality in pre-test scores is taken into account, the differences, as indicated by the adjusted post-test F Ratios, still favor the treatment group. It appears clear the the course in creative problem solving had some effects in the students' ability to perform on these tasks.

Conclusions about the Test

Because of the relatively recent introduction of this test, and creativity tests in general, it seems appropriate to comment on the test.

1. The two non-verbal tasks (incomplete figures and parallel lines) have not given us consistent results. It may be that the two tasks measure different skills or abilities.

2. The two verbal tasks (toy dog and tin cans) gave generally consistent results and seem to have measured related skills or abilities.

3. All students seem to have increased their fluency scores, both verbal and non-verbal, although the treatment group increased significantly more. This difference seems to indicate that even without a course in creative problem solving, students can be expected to be a little more fluent on the second taking of this test. It may be that there is some kind of "practice effect" in operation.

4. The control groups received approximately the same non-verbal flexibility scores on the second administration of the test as on the first. On the non-verbal tasks, the treatment group gained more than the control groups. On Task 3, the scores of all groups increased on the second administration, whereas the scores decreased on the second administration of Task 4. The treatment group gained significantly more than the control groups on Task 3 and lost significantly less on Task 4. These inconsistent results on the flexibility scores of the verbal tasks lead us to suspect that more than one factor may be operating under what has been called verbal flexibility.

5. On the originality factor, the control group scores on the second administration tend to remain about the same as on the first administration, while the treatment group scores show small increasses on the non-verbal tasks and very large increases on the verbal tasks. The difference in improvement between the non-verbal and verbal scores may reflect the emphasis placed on verbal activities in the Creative Problem Solving class.

Table 1.1

Comparison of Fluency Mean Scores of Students Enrolled in a Creative Problem Solving Course and Students Enrolled in Two Control Classes.

Task		Group Means: Treatment	Control 1	Control 2	Within Standard Deviation	Analysis of Variance F Ratio: Among Groups	Between Controls	Treatment vs. Controls
1	Pre	8.4	7.6	6.3	2.15	5.26**	2.47	8.04**
	Post	9.8	9.5	9.1	1.37	1.66	0.62	2.70
	Adj Post	9.7	9.4	9.2	1.37	0.64		
2	Pre	12.8	12.1	9.1	4.58	3.98*	2.73	5.23*
	Post	20.1	12.8	13.0	5.54	9.53**	.02	19.05**
	Adj Post	18.3	11.6	14.4	4.07	8.44**		
NV	Pre	21.2	19.8	15.4	5.87	5.71**	3.47	7.95**
	Post	29.9	22.3	22.1	6.21	9.07**	.0034	18.14**
	Adj Post	27.6	20.9	23.8	4.76	5.83**		
3	Pre	18.7	17.0	15.9	5.44	1.45	.24	2.66
	Post	35.6	17.1	19.8	9.08	19.36**	.54	38.17**
	Adj Post	34.6	17.1	20.4	8.53	17.3**		
4	Pre	22.5	18.1	18.4	7.32	1.90	.01	3.80
	Post	38.2	19.5	21.6	9.96	17.30**	.27	34.32**
	Adj Post	35.7	20.9	22.7	7.56	17.05**		
V	Pre	41.3	35.1	34.3	10.39	2.50	.04	8.77**
	Post	73.9	36.6	41.4	16.52	24.25**	.52	47.97**
	Adj Post	69.3	38.1	43.7	13.08	22.94**		
GT	Pre	62.5	54.9	50.0	13.7	4.67*	.89	8.45**
	Post	103.8	58.9	63.5	18.9	27.94**	.37	55.51**
	Adj Post	96.9	58.6	67.6	14.9	23.56**		

* significant at the .05 level
** significant at the .01 level

Table 1.2

Comparison of Flexibility Mean Scores of Students Enrolled in a Creative Problem Solving Course and Students Enrolled in Two Control Classes.

Task		Group Means			Within Standard Deviation	Analysis of Variance F Ratio		
		Treatment	Control 1	Control 2		Among Groups	Between Controls	Treatment vs. Control
1	Pre	7.5	7.0	5.7	2.14	4.08*	2.22	5.94*
	Post	9.1	8.4	8.3	1.88	1.04	.01	2.08
	Adj Post	8.9	8.3	8.5	1.80	1.66		
2	Pre	11.8	8.9	8.1	4.20	4.22*	.23	8.21**
	Post	12.2	8.1	9.3	3.23	5.85**	.84	10.86**
	Adj Post	11.3	8.3	9.8	2.89	2.95		
NV	Pre	19.3	15.9	13.8	5.52	5.32**	.89	9.75**
	Post	21.3	16.5	17.6	4.24	5.18**	.44	9.92**
	Adj Post	20.2	16.5	18.3	3.90	2.47		
3	Pre	7.1	5.8	6.3	3.71	.40	.13	1.38
	Post	9.5	7.4	6.8	2.56	5.94**	.32	16.6**
	Adj Post	9.4	7.4	6.8	2.58	5.57**		
4	Pre	21.8	25.0	25.4	2.76	9.31**	.12	18.51**
	Post	14.9	7.9	11.5	8.43	2.05	1.15	2.95
	Adj Post	16.6	7.3	10.7	8.29	3.33*		
V	Pre	28.9	30.8	31.7	2.80	5.26**	.66	9.87**
	Post	24.4	15.3	18.3	4.74	13.23**	2.56	23.91**
	Adj Post	25.2	15.2	17.8	4.61	15.87**		
GT	Pre	48.2	46.6	45.4	6.4	.98	.21	1.74
	Post	45.7	31.8	35.9	7.1	14.19**	2.12	26.25**
	Adj Post	45.0	31.7	36.3	6.7	13.36**		

* significant at the .05 level
** significant at the .01 level

Table 1.3

Comparison of Originality Mean Scores of Students Enrolled in a Creative Problem Solving Course and Students Enrolled in Two Control Classes.

Task		Group Means			Within Standard Deviation	Analysis of Variance F Ratio		
		Treatment	Control 1	Control 2		Among Groups	Between Controls	Treatment vs. Controls
1	Pre	7.2	4.6	4.7	2.74	4.86	.00	9.71**
	Post	9.8	6.9	8.4	3.94	1.6	.91	2.35
	Adj Post	9.2	7.2	8.7	3.86	.72		
	Pre	17.5	16.1	11.2	6.55	5.43**	3.53	7.34**
	Post	18.5	9.8	10.2	6.13	10.84**	.03	21.65**
	Adj Post	16.7	8.7	11.5	5.29	7.51**		
	Pre	24.6	20.8	15.9	8.01	6.53**	2.30	10.75**
	Post	28.3	16.6	18.6	8.32	8.82**	.35	17.29**
	Adj Post	25.2	15.8	20.6	6.91	5.02*		
	Pre	20.2	17.6	18.3	8.15	.41	.04	.77
	Post	40.5	18.8	20.7	11.73	17.31**	.18	34.45**
	Adj Post	39.8	19.3	21.0	11.28	16.77**		
	Pre	15.7	10.1	19.7	8.64	4.09*	7.63*	.56
	Post	43.2	12.1	18.0	14.77	19.21**	.98	37.45**
	Adj Post	44.0	16.5	16.3	13.84	23.05**		
	Pre	35.9	27.8	37.9	13.33	1.83	3.66	.00
	Post	83.6	30.9	38.7	22.01	26.55**	.79	52.31**
	Adj Post	83.5	37.2	37.0	19.52	33.03*		
	Pre	60.6	48.5	53.8	17.1	1.56	.61	2.51
	Post	111.9	47.5	57.3	25.4	29.57**	.93	58.20**
	Adj Post	108.1	52.3	58.2	22.5	28.77**		

* significant at the .05 level
** significant at the .01 level

Table 1.4

Comparison of Elaboration Mean Scores of Students Enrolled in a Creative Problem Solving Course and Students Enrolled in Two Control Classes.

Task		Group Means			Within Standard Deviation	Analysis of Variance F Ratio		
		Treatment	Control 1	Control 2		Among Groups	Between Controls	Treatment vs. Controls
1	Pre	10.6	4.9	7.9	5.54	3.06	1.87	4.25*
	Post	14.1	5.8	10.6	5.34	6.84**	5.22*	8.46**
	Adj Post	13.4	6.8	10.7	5.09	4.09*		
2	Pre	14.8	10.4	12.0	7.54	1.15	.28	2.02
	Post	14.4	8.4	12.2	6.72	2.16	2.08	2.24
	Adj Post	13.6	9.2	12.5	6.21	1.34		
NV	Pre	25.4	15.3	19.9	12.01	2.16	.92	3.40
	Post	28.5	14.1	22.9	11.08	4.61*	3.90	5.33**
	Adj Post	26.3	16.9	23.4	9.45	2.48		
33	Pre	6.1	9.6	6.5	3.65	2.86	4.66*	1.07
	Post	2.9	1.8	1.9	2.14	1.48	.00	2.95
	Adj Post	3.0	1.7	1.9	2.14	1.70		
4	Pre	7.2	10.5	5.0	5.65	3.17	5.95*	.40
	Post	.65	.88	.55	1.01	.33	.64	.01
	Adj Post	.60	.63	.65	.96	.01		
V	Pre	13.3	20.1	11.5	7.93	3.72*	7.45**	.00
	Post	3.6	2.8	2.4	2.54	1.15	.11	2.19
	Adj Post	3.6	2.2	2.6	2.47	1.25		
GT	Pre	38.6	35.4	31.1	15.1	1.28	.45	2.11
	Post	32.1	16.9	25.3	11.5	4.90*	3.33	6.47*
	Adj Post	30.2	16.4	26.5	9.8	5.43**		

* significant at the .05 level
** significant at the .01 level

6. The differences between the pre- and post-test scores for all three groups on non-verbal elaboration are small and inconsistent and therefore difficult to interpret. However, on the verbal tasks, the decrease in elaboration scores is so large that it demands some comment. At first, we expected a decrease in elaboration to accompany an increase in fluency, but this ratio did not seem to carry over to the control groups. In the control groups, the increase in fluency was minimal compared with the large decrease in elaboration. Further investigation to determine the reason for this change in behavior is clearly warranted.

Table of References

1. The General College, 1963-1965, Bulletin of the University of Minnesota, Minneapolis.

2. Sidney J. Parnes, Student Workbook for Creative Problem-Solving Courses and Institutes, Buffalo: University of Buffalo Book-store, 1963.

3. Sidney J. Parnes, Instructor's Manual for Semester Courses in Creative Problem-Solving, Buffalo: The Creative Education Foundation, 1963.

   Alex F. Osborn, Applied Imagination, New York: Charles Scribner's Sons, 1963.

3. E. Paul Torrance, Administration and Scoring Manual for Abbreviated Form VII Minnesota Tests of Creative Thinking, University of Minnesota: Bureau of Educational Research, 1962.

4. Ibid., p. 4.

5. Ibid., p. 5.

6. Ibid., p. 7.

II : MEASURING CREATIVE GROWTH : PHASE 2

Phase one of our efforts to measure creative growth involved a course in creative problem solving which was taught in the winter quarter of 1963. Our studies entered another phase in the spring quarter of 1963 when we worked with studemts in another class in creative problem solving. The course was essentially the same as the one offered in the previous quarter, but the instructor was different.

We administered the Minnesota Test of Creative Thinking : Abbreviated Form VII[1] to the creative problem solving class as well as to four control groups. Pre-tests were administered on the first, and post-tests on the last days of class. The hypothesis of equal post-test mean scores (adjusted for pre-test differences) was tested using the statistical technique known as analysis of covariance.

The Subjects

During the spring quarter of 1963, General College 33B was taught as a course in creative problem solving. Two sections of General College 32A, "Basic Principles of Speech," and two sections of General College 32E, "Business Speech," were used as control groups. The 32A course has no prerequisite. The 32E course, like the 33B, requires that the students have passed at least one previous college speech course. The General College Bulletin describes the courses as follows:

> 32A. Oral Communication: Basic Principles. The student is introduced to the basic principles of speech. By means of such assignments as an introduction, a demonstration, an argument, and a group discussion, he is given an opportunity to apply these principles. Through these

classroom projects the student is helped to develop confidence in himself, to express his ideas clearly and effectively, and to listen critically.[2]

32E. Oral Communication: Business Speech. The student is given practical experience with those special adaptations of speech principles most often employed in business and theprofessions. An attempt is made to suggest the importance of honest thinking, personal integrity, and accurate communication in business and professional speaking. Speech activities include practice in the sales demonstration, the interview, the conference, the use of dictating and recording equipment, and the special forms of informative speaking.[3]

The number of students who completed both the pre- and the post-test in each class is as follows:

33B 17	32E 12
32A 14	32E 12
32A 10	

The Test

The test as well as the scoring procedure were as described in phase one of this study.

Method

Each factor (fluency, flexibility, originality, and elaboration) and task was treated separately. Because our analysis of the data in phase one indicated that the subtotal and total scores were reflections of single task scores and gave no additional information, we decided not to use the totals and subtotals in the present study.

Future investigations will determine the interrelationships of the tasks and will suggest new tasks to isolate various phases of measured "creativity".

For each of the sixteen scores (four factors, four tasks) we compared the five classes using a one-way analysis of variance. We made an overall comparison of the five groups to see if there were significant differences on the pre-test scores as well as on the post test scores. If there were no significant differences, we moved on to the next score. If there were significant differences, we first compared the experimental group with the average of the control groups to see if the experimental course was contributing to the difference. Furthermore, if there were initial significant differences, we also compared the two 32A classes with the two 32E classes, the two 32A classes with each other, and the two 32E classes with each other.

The adjusted post-test analysis was necessarily simplified because of the nature of the statistical technique used. Only an overall comparison of the five adjusted means was made. However, by examining the pre- and post-test F Ratios and mean scores, we can still indicate where any differences might exist.

Results

The findings are summarized in two tables. Table 2.1 identifies the mean pre-test, post-test, and adjusted post-test scores for each of the four factors on each task. This information is given for each of the five classes which participated in the experiment. As we pointed out in phase one, the adjusted post-test mean scores are computed by adjusting the post-test means to discount the deviation of the pre-test means from the average pre-test mean.

Table 2.2 presents the F Ratios comparing the five groups to each other, the experimental group with the average of the four

control groups, the 32A control groups with the 32E control groups, the two 32A groups with each other, and the two 32E groups with each other.

The two tables must be interpreted together. When he identifies a difference on Table 2.2 the reader should turn to Table 2.1 to ascertain specifically where that difference lies.

Fluency

The analysis of both non-verbal tasks (Tasks 1 and 2 shows no significant differences among the mean scores of the five groups. Both verbal tasks (Tasks 3 and 4), although showing no significant differences on the pre-test means, indicate significant differences among the five groups on the post-test means. A breakdown of the "among groups" comparison shows that the major contribution to the significant difference is due to the difference between the treatment group and the average of the controls. Table 2.1 shows that the treatment group scored substantially higher than any of the control groups. There is also some difference between the two sections of 32A on Task 3 which does not show up on Task 4. These same significant differences can also be noted on the adjusted post-test.

Flexibility

There seem to be some serious inconsistencies in the results of the flexibility scores. Not only are the two verbal tasks inconsistent with each other, but the two non-verbal tasks also are inconsistent with each other.

On Task 1, significant differences are identified on the pre-test means, with the treatment group being lower than three of the

Table 4.1

Mean Creativity Test Scores of Students Enrolled in Creative Problem Solving Class II, Two Introductory Speech Classes, and Two Advanced Speech Classes

	NON-VERBAL TASKS						VERBAL TASKS					
	Task 1		Means	Task 2		Means	Task 3		Means	Task 4		Means
Fluency	Pre	Post	Adj Post	Pre	Post	Adj Post	Pre	Post	Adj Post	Pre	Post	Adj Post
Treatment (33B)	4.9	9.5	9.6	8.6	15.2	15.2	13.5	28.2	28.2	17.6	34.8	33.4
Control 1 (32A	5.7	8.9	8.9	8.4	11.7	12.2	13.3	20.1	20.1	15.6	18.8	19.0
Control 2 (32A)	5.7	7.6	7.6	8.9	12.9	13.0	10.3	13.8	16.4	14.4	16.6	17.7
Control 3 (32E)	7.6	9.7	9.5	8.8	12.8	13.0	13.3	17.5	17.6	14.0	19.4	20.9
Control 4 (32E)	6.0	9.0	9.0	10.0	14.9	14.0	15.9	20.5	18.4	16.7	24.2	23.5
Flexibility												
Treatment (33B)	4.9	8.5	8.5	6.8	9.4	9.3	5.8	8.1	8.2	9.0	13.9	13.3
Control 1 (32A)	5.5	8.6	8.6	6.8	8.4	8.3	6.4	7.5	7.4	6.6	9.1	10.0
Control 2 (32A)	4.9	6.3	6.3	5.9	7.6	8.1	5.4	6.2	6.5	8.5	8.6	8.3
Control 3 (32E)	7.2	8.9	8.9	6.6	9.3	9.4	6.7	7.5	7.3	7.8	10.8	11.0
Control 4 (32E)	5.5	8.3	8.3	7.2	9.9	9.6	6.3	7.9	7.8	7.8	11.8	11.9
Originality												
Treatment (33B)	3.8	8.4	8.4	7.1	14.2	14.1	13.9	35.8	35.3	14.8	34.8	32.5
Control 1 (32A)	3.9	9.5	9.5	7.3	10.5	10.2	14.3	22.6	22.0	10.8	15.3	16.4
Control 2 (32A)	3.8	5.5	5.5	5.4	8.2	9.3	8.1	12.6	15.2	9.6	10.4	12.6
Control 3 (32E)	6.2	8.3	8.2	7.7	10.0	9.4	11.9	17.5	18.1	10.2	17.0	18.7
Control 4 (32E)	4.9	6.1	6.1	6.7	11.8	11.9	15.8	25.4	24.0	13.9	27.6	26.0
Elaboration												
Treatment (33B)	7.7	10.6	10.5	8.0	10.8	10.9	2.3	2.0	2.0	.8	.9	1.0
Control 1 (32A)	10.3	11.2	10.5	11.9	8.4	7.3	2.1	1.4	1.4	1.5	.6	.5
Control 2 (32A)	5.9	4.3	4.7	5.3	6.2	7.1	.9	.8	.7	.7	.1	.2
Control 3 (32E)	7.8	7.9	7.8	7.8	9.4	9.6	3.0	1.1	1.2	1.8	1.0	.9
Control 4 (32E)	4.5	6.9	7.7	7.3	7.8	8.1	1.3	.3	.3	.5	.3	.4

Table 4.2

F Ratios Comparing the Scores of Students Enrolled in a Creative Problem Solving Class, Two Introductory Speech Classes, and Two Advanced Speech Classes

	NON-VERBAL TASKS						VERBAL TASKS					
	Task 1		F Ratios	Task 2		F Ratios	Task 3		F Ratios	Task 4		F Ratios
Fluency	Pre	Post	Adj Post	Pre	Post	Adj Post	Pre	Post	Adj Post	Pre	Post	Adj Post
Among Groups	1.9	2.1	2.0	.3	.9	.9	1.6	7.8**	10.1**	.5	8.4**	10.5**
Exp vs Cont								25.1**			29.7**	
32A vs 32E								.6			2.0	
Within 32A								4.5*			.3	
Within 32E								1.1			1.4	
Flexibility												
Among Groups	2.6*	3.0*	2.9	.3	1.0	.8	.8	1.6	1.5	1.0	5.9**	7.4**
Exp vs Cont	4.9*	.4									16.5**	
32A vs 32E	2.4	3.2									6.3*	
Within 32A	.4	8.0**									.2	
Within 32E	2.9	.5									.5	
Originality												
Among Groups	1.5	3.4*	3.3*	.5	1.5	1.7	2.5	13.8**	12.2**	.8	8.7**	9.4**
Exp vs Cont		1.0						41.0**			23.3**	
32A vs 32E		.5						1.4			6.3*	
Within 32A		9.3**						7.7**			.9	
Within 32E		2.6						4.9*			4.3*	
Elaboration												
Among Groups	1.6	3.2*	2.4*	2.5	1.4	1.5	2.9*	2.7*	2.9*	1.5	1.4	1.2
Exp vs Cont		3.0					.8	6.9*				
32A vs 32E		.3					1.1	1.2				
Within 32A		9.1**					3.2	1.1				
Within 32E		.2					6.6*	1.7				

* Significant at the .05 level

** Significant at the .01 level

control groups and equal to the fourth. On the post-test all of the groups except one 32A section have approximately the same mean score. This same difference is reflected in the significant difference on the adjusted post-test F Ratio. It is important to note that the largest class gain from the pre- to the post-test was made by the treatment group.

There were no significant differences among the five groups on the pre- or post-tests on Tasks 2 and 3.

There are no significant differences among the pre-test mean scores for Task 4 but there are among the post-test mean scores. The difference is due largely to an experimental vs. control difference with the experimental group mean being higher. There is also some difference between the 32A classes and the 32E classes, with the 32E classes having the higher mean scores. The same results are reflected on the adjusted post-test F Ratios.

Originality

There are no significant differences among the pre-test scores. The significant difference found on the post-test of Task 1 is due to a difference in the mean scores between the two 32A classes. The adjusted post-test F Ratio essentially reflects the post-test results for Task 1 since the pre-test scores were not significantly different from each other.

No significant differences appear on Task 2 pre-test or post-test scores.

Table 2.2 shows a significant difference among the five groups on the two verbal tasks (Task 3 and 4) on the post-test scores. Inspection of Table 2.1 shows that on these tasks the experimental

group scored substantially higher than the control groups. This difference is indicated by the large F Ratios associated with the experimental vs. control group comparison. The significant difference carries over to the adjusted post-test F Ratio because the pre-test mean scores were not significantly different. In addition, Task 3 isolated differences between the two 32A classes and also between the two 32E classes. On Task 4 there was a difference between the combined 32A means and the combined 32E means, the 32E means being higher. There is also a difference between the two 32E mean scores on Task 4.

Elaboration

Task 1 results show no significant pre-test differences and only one post-test difference, that being a difference between the two 32A classes.

There were no significant differences on Task 2.

On the pre-test of Task 3, the only difference is between the two sections of 32E. On the post-test, there is a difference between the treatment group and the average of the control groups, with the experimental group having the higher mean score. This difference is reflected in the adjusted post-test F Ratio.

Task 4 results show no significant differences on elaboration.

Conclusions

1. Unlike Phase 1, when the experimental class recorded higher pre-test scores than the control classes, all the present groups began at essentially the same point.

2. The "Practice effect," discussed in phase one, was even stronger in the present experiment. Students in all the classes generally received higher scores on the post-test than on the pre-test except on verbal elaboration.

3. The treatment group (Creative Problem Solving Class) did not show significantly greater gains than the control groups on the non-verbal tasks. On the verbal tasks, the gains were apparent in fluency and originality for both Task 3 and 4, for flexibility on Task 4, and elaboration on Task 3.

4. In all cases where differences were found among the four control classes the higher scores were earned by students enrolled in the one 32A class and the one 32E class taught by the instructor who also taught the 33B experimental class. Apparently the instructor of the creative problem solving class exhibited some behavior in the other classes which increased the student's skill in creative thinking (as measured by our tests).

5. It is interesting to note that there seems to be more relationship between factors on the same task (e.g. between fluency and flexibility on Task 1) than between tasks on the same factor (e.g. between Tasks 1 and 2 on flexibility). This appears to support our earlier conclusion (The General College Studies, volume 1, number 1, part 3) that the originality scores for the separate tests are not closely related.

Table of References

1. E. Paul Torrance, Administration and Scoring Manual for Abbreviated Form VII Minnesota Tests of Creative Thinking, University of Minnesota: Bureau of Educational Research, 1962.

2. The General College, 1963-1965, Bulletin of the University of Minnesota, Minneapolis.

3. Ibid., p. 28.

III : MEASURING CREATIVE GROWTH : PHASE 3

Our attempts to measure creative growth entered a third phase in the winter quarter, 1964, when a third class in creative problem solving, taught by still another instructor, was offered.

Students in this class took the Minnesota Test of Creative Thinking : Abbreviated Form VII. Methods of analysis were the same as those used in phases one and two of our work.

A major source of difference, however, lies in the selection of control groups. During the winter, 1964, quarter, tests were administered to two sections of 32B "Oral Communication: Language and Speech Style" and one section of 23A "Art Laboratory" in addition to the experimental group. The General College Bulletin describes the control groups as follows:

> 32B. Oral Communication: Language and Speech Style. Special emphasis is given to the problems of using voice, body, and spoken language clearly, vividly, and impressively in communicating ideas and feelings. Speech activities include retelling short stories, sharing personal experiences, reading aloud, and persuading by means of narration and description.[2]
>
> 23A. Art Laboratory. Laboratory activity provides the student with opportunity for creative experience in a number of art mediums. It is planned and operated to meet the individual needs and interests of the student and provide him with the means to develop his creative awareness and ability. In addition to the laboratory activity there are assignments in reading, lectures, and gallery trips.[3]

Again the hypothesis of equal post-test mean scores (adjusted for pre-test differences) for the four classes was tested by the statistical technique, analysis of covariance, first mentioned in phase one.

The number of students who completed both the pre- and the post-test in each class is as follows:

33B	15	32B	13
23A	11	32B	8

Results

Table 3.1 shows pre-, post-, and adjusted post-test mean scores for each of the four factors on each of the four tasks for each of the classes. As was pointed out earlier, the adjusted post-test mean scores are computed by adjusting the post-test means to discount the deviation of the pre-test means from the average pre-test mean.

Table 3.2 presents the F Ratios comparing the four groups with each other, the experimental group with the average of the three control groups, the two 32B groups with each other, and the average of the 32B groups with the 23A group.

The two tables must be interpreted together. When he identifies a significant difference on Table 3.2 the reader should turn to Table 3.1 to ascertain specifically where that difference lies.

Fluency

No significant differences can be found among the four groups on Task 1. Task 2 results reflect a difference among the groups on the post-test due primarily to a difference between the two 32B classes. This significant difference is carried over to the adjusted post-test.

On the two verbal tasks (Tasks 3 and 4) no significant difference can be found among the pre-test scores although a significant difference shows up on the post- and adjusted post-test scores.

Table 1

Mean Creativity Test Scores of Students Enrolled in Creative Problem Solving Class III, Two Advanced Speech Classes, and an Art Laboratory

	NON-VERBAL TASKS						VERBAL TASKS					
	Task 1		Means	Task 2		Means	Task 3		Means	Task 4		Means
Fluency	Pre	Post	Adj Post	Pre	Post	Adj Post	Pre	Post	Adj Post	Pre	Post	Adj Post
Treatment (33B)	5.4	9.2	9.4	8.3	14.1	14.4	13.9	29.2	29.9	16.7	32.0	31.3
Control 1 (32B)	6.8	8.9	8.7	9.7	11.4	10.7	16.2	15.2	13.9	17.2	21.2	20.0
Control 2 (32B)	7.9	9.4	8.9	10.6	16.3	15.0	13.1	18.3	19.6	12.6	22.8	25.7
Control 3 (23A)	5.1	7.9	8.2	6.7	10.7	12.0	15.2	18.0	17.6	15.5	18.6	18.9
Flexibility												
Treatment (33B)	4.7	8.1	8.2	7.0	11.7	11.8	6.9	9.7	9.7	10.7	14.3	14.0
Control 1 (32B)	5.8	7.7	7.6	8.3	8.8	8.5	7.5	6.5	6.4	11.0	9.9	9.5
Control 2 (32B)	6.4	8.5	8.4	8.1	12.9	12.5	5.3	6.6	7.0	7.9	12.9	13.8
Control 3 (23A)	4.7	6.1	6.2	5.9	9.0	9.4	6.8	6.7	6.7	9.3	10.8	11.1
Originality												
Treatment (33B)	6.5	11.4	11.6	12.6	26.5	27.2	14.9	37.2	37.2	12.0	32.7	32.2
Control 1 (32B)	7.0	8.8	8.8	15.5	20.0	19.0	15.2	14.5	14.3	10.6	16.5	17.8
Control 2 (32B)	9.9	10.6	9.6	19.5	28.4	25.1	12.9	21.3	23.1	8.4	17.3	21.3
Control 3 (23A)	6.1	8.9	8.5	9.6	16.6	19.2	16.2	20.5	19.4	15.0	20.0	15.9
Elaboration												
Treatment (33B)	18.9	34.4	35.0	14.1	23.8	24.2	8.1	11.7	10.8	4.3	9.7	9.9
Control 1 (32B)	18.8	22.3	22.9	11.2	14.3	16.5	5.2	3.1	3.8	4.8	3.0	2.8
Control 2 (32B)	24.6	20.9	18.7	15.3	17.1	16.8	4.1	4.9	6.2	3.1	6.5	7.4
Control 3 (23A)	19.9	29.0	29.1	19.7	24.0	21.0	7.2	6.1	5.6	5.7	5.3	4.6

Table 3.2

F Ratios Comparing the Scores of Students Enrolled in a Creative Problem Solving Class III, Two Advanced Speech Classes, and an Art Laboratory

	NON-VERBAL TASKS						VERBAL TASKS					
	Task 1		F Ratios	Task 2		F Ratios	Task 3		F Ratios	Task 4		F Ratios
Fluency	Pre	Post	Adj Post	Pre	Post	Adj Post	Pre	Post	Adj Post	Pre	Post	Adj Post
Among Groups	2.6	2.0	1.7	2.1	3.0*	2.9*	1.0	10.0**	17.2*	1.2	5.3**	7.2**
Exp vs Cont					1.5			28.9**			14.9**	
Bet 32B Sections					5.5*			0.8			0.1	
32B vs 23A					2.1			0.4			0.8	
Flexibility												
Among Groups	1.9	6.6**	6.1**	1.5	3.5*	3.6*	2.0	6.4**	6.4**	2.0	3.7*	4.6**
Exp vs Cont		3.5			2.6			19.2**			8.0**	
Bet 32B Sections		1.8			6.6*			0.0			3.0	
32B vs 23A		14.6**			1.1			0.0			0.0	
Originality												
Among Groups	2.1	2.4	3.0*	2.5	3.5*	3.0740*	0.3	9.3**	14.0**	1.3	2.8	3.7*
Exp vs Cont					3.3			25.8**				
Bet 32B Sections					3.7			1.6				
32B vs 23A					3.3			0.6				
Elaboration												
Among Groups	0.9	5.4**	7.9**	2.8*	2.9*	1.9849	2.7	7.5**	5.2059**	0.8	4.7**	6.9**
Exp vs Cont		11.8**		0.2	3.0			20.4**			11.2**	
Bet 32B Sections		0.1		1.5	0.4			0.6			2.6	
32B vs 23A		4.2*		6.7*	5.2*			1.5			0.3	

* Significant at the .05 level

** Significant at the .01 level

The results clearly show that the experimental (33B) group gained more than the control groups.

Flexibility

Task 1 and 2 pre-test scores show that the groups do not differ significantly from each other at this stage of the experiment. However, Task 1 post-test scores show a significant difference--one favoring the 32B classes--between the average of the 32B scores and the 23A scores, as well as a significant difference on Task 2 between the two 32B classes. These two differences are reflected in the adjusted post-test scores.

Tasks 3 and 4 results indicate no differences on the pre-test mean scores although significant differences do show up on the post- and adjusted post-test scores. These are differences between the experimental group and the average of the control groups, with the creative problem solving class having higher mean scores in both cases.

Originality

No differences can be found among the four groups on Tasks 1 and 2 on the pre-test scores. Significant differences do show up on the adjusted post-test of Task 1 and the post- and adjusted post-test results of Task 2. It is difficult to determine probably is due to between - group differences which were not measured in this statistical design (e.g. differences between 23A and one section of 32B).

There is no significant difference among the groups on the pre-test scores of Task 3 although a difference does show up on

the post- and adjusted post-test results of this task. The difference is due primarily to a much higher mean score gain by the students in the experimental group than by the students in the control classes.

Task 4 results show a difference among the groups only on the adjusted post-test. These results are difficult to interpret because of the large variability within some of the groups.

Elaboration

On Task 1 no differences can be found among the groups on the pre-test mean scores although post- and adjusted post-test results do indicate differences which are due partially to a difference between the average of the 32B classes and the 23A class favoring the 23A class and partially to a difference between the experimental class and the average of the control groups favoring the experimental group.

Table 3.2 indicates significant differences among the groups on the pre- and post-test mean scores of Task 2 but not on the adjusted post-test results. Table 3.1 indicates that these unusual results point to the fact that the mean score for 23A was higher than the mean scores of the other groups on the pre-test (the first day of class) and again on the post test. No difference is found on the adjusted post-test results because there is no significant difference on the gain in score earned by the students in four classes. When adjustment was made for initial differences it was found that all groups showed essentially the same gain in mean score. Our ability to explain these unusual results, incidentally, points up the value of the statistical technique of adjusting for pre-test differences.

The results of Tasks 3 and 4 indicate no differences among the pre-test scores. The post- and adjusted post-test mean scores indicate significant differences, which according to Table 3.1, show higher mean scores earned by the experimental group than the control group on Tasks 3 and 4.

Conclusions

1. Like phase two, but unlike phase 1, the present experiment establishes no significant differences among the groups on the pre-test scores (except in one case).

2. In most cases the mean scores increased from pre- to post-test, reflecting something analogous to the "practice effect" discussed in phase one and again noted in the conclusions reached after phase two. This increase in score held true for every measure of the experimental group.

3. Although the treatment group tended to earn higher adjusted post-test scores on most of the measurements, this difference was consistently significant only on the verbal tasks where a larger gain for the Creative Problem Solving class was clearly demonstrated.

4. Inspection of Table 3.1 shows that one of the 32B classes earned higher adjusted post-test mean scores than the other on fifteen of the sixteen measurements. Although this difference is significant in only two instances, a clear tendency is shown. One necessarily wonders how one instructor differed from the other in teaching this speech class.

Table of References

1. E. Paul Torrance, Administration and Scoring Manual for Abbreviated Form VII Minnesota Tests of Creative Thinking, University of Minnesota: Bureau of Educational Research, 1962.

2. The General College, 1963-1965, Bulletin of the University of Minnesota, Minneapolis.

3. Ibid., P. 24.

IV COMPARING CREATIVE PROBLEM SOLVING CLASSES TAUGHT BY DIFFERENT INSTRUCTORS

Introduction

Our three attempts to measure creative growth which are summarized in the foregoing studies were each focused upon a single section of a course in creative problem solving as taught once in the General College during each of these three quarters: winter, 1963; spring, 1963; winter, 1964. Each class was taught by a different instructor. The instructors visited one another's classes frequently, and cooperated closely in planning and presenting the course. They all used the same textbooks and manuals, except that the instructor of the winter, 1964, class used techniques to develop awareness adapted from Perls, Hefferline, and Goodman, Gestalt Therapy,[1] and some exercises from W.J.J. Gordon's Synectics.[2]

The students in each of the three classes were given a test of creative thinking (Minnesota Test of Creative Thinking : Abbreviated Form VII[3]) as were several control groups. The tests were administered on the first and last days of class, and the results were analyzed to compare each of the creative problem solving classes to its control groups. In each case, greater increase in creative thinking (as measured by the test) was found in the experimental classes then in the control groups.

The purpose of the present report is to compare the three creative problem solving classes to each other. Noting that the

same students were not, of course, registered in each class (no attempt was made to equate the students), that each class was taught by a different instructor, and that in at least one case a few additional exercises were used, one might expect some difference in the amount of student improvement (or test score gain). Our hypothesis is that no differences in test score gain will be evident among the three groups.

The Subjects

The students enrolled in the creative problem solving classes were General College students who had completed at least one G. C. Speech course. During the winter quarter of 1963, the students were recommended by their speech instructors, who judged them to be students with some potential for adapting to the subject matter of the course. Although this selection procedure was partially observed during the following two quarters, the requirements for gaining admission to the course were less strict, and as a result a more representative sample of the General College student body was enrolled.

The Test

The test of creative thinking and the method for scoring this test already have been described in detail.

Method

In previous studies involving the comparison of an experimental class with control classes, the investigators attempted to gain additional information about creativity from specific comparisons of the control classes. For example, in phase two we selected as two of our four control groups, classes taught by the instructor

who taught the experimental class. We also included additional sections of each of these courses for base comparisons. We then compared the following groups: The experimental class vs. the 32E classes, the two 32A classes with each other, and the two 32E classes with each other. These comparisons were determined before the start of the experiment.

In the present report there are no comparisons which the authors can specify in advance. The fact that these comparisons cannot be predetermined forces us to modify our method of analysis. As a first step of the present analysis, an F Ratio comparing the three classes was computed for the pre-test scores, the post-test scores, and the adjusted post-test scores. If the F Ratio for the pre-test or the post-test indicated differences significant at at least the .05 level, individual comparisons of the three means were computed (i.e. Winter, 1963, with Spring, 1963; Winter, 1963, with Winter, 1964; and Winter, 1964, with Spring, 1963). These comparisons are described statistically by a pair of numbers. The pair of numbers is computed by finding the difference between the two sample means and then both adding and subtracting from this difference the average of the within group standard deviation. (This technique is known as Scheffe's confidence interval method for posterior comparisons). For example, on the fluency factor of Task 1 the pre-test Spring, 1963 mean was 4.9, the Winter, 1964 mean 5.4, and the average standard deviation was 2.3. The average standard deviation was both added and subtracted from the difference between the means (.5) to achieve the pair of numbers which constitute the confidence interval. For this example, the interval is -2.8 to +1.8 which is indicated in Table 4.1 in the following way: (-2.8, 1.8). Because this interval

includes zero we cannot say that these groups were significantly different at the .05 level. If the interval did not include zero, we would conclude that the difference was significant at at least the .05 level. These computations were made for the four factors of each of the four tasks for pre-test and post-test scores. Because of computational difficulties the adjusted post-test confidence intervals were not computed.

Results

The results of the comparison of the three creative problem solving classes can be gleaned from the following four tables. Table 4.1 lists the Pre-, Post-, and adjusted post-test mean scores, F Ratios, standard deviations, and confidence intervals for fluency. Tables 4.2, 4.3, and 4.4 list respectively the same information for the factors of flexibility, originality, and elaboration. A brief explanation of the results follows.

Fluency

On Task 1 of the pre-test, the F Ratio indicates a significant difference among the groups, Examination of the confidence intervals shows that the intervals which do not encompass zero (and therefore are significant intervals) are ones which represent the comparisons between the Winter, 1963, Class and the Spring, 1963, class; and between the Winter, 1963, class and the Winter, 1964, class. Examination of the mean scores indicates that the highest pre-test score for Task 1 was earned by the Winter, 1963, class. On the post-test for Task 1 there is no significant difference among the groups. On the adjusted post-test means scores (which have been adjusted for the pre-test differences) there is no significant F Ratio, indicating that the gains made by the three groups

Table 4.1

Fluency Mean Scores, F Ratios, Confidence Intervals
for Creative Problem Solving Classes

PRE-TEST

Fluency	Mean Scores w 63	s 63	w 64	F Ratio	Confidence Intervals w 63 vs s 63 sd	CI	w 63 vs w 64 sd	CI	s 63 vs w 64 sd	CI
Task 1	8.4	4.9	5.4	10.7**	2.3	(1.2, 5.8)	2.3	(.7, 5.3)	2.3	(-2.8, 1.8)
Task 2	12.8	8.9	8.3	5.6**	4.1	(-0.2, 8.0)	4.2	(.4, 8.6)	4.2	(-3.6, 4.8)
Task 3	18.8	13.5	13.9	6.4**	4.6	(.7, 9.9)	4.8	(.1, 9.7)	4.8	(-5.2, 4.4)
Task 4	22.5	17.6	16.7	3.4						

POST-TEST

Fluency	Mean Scores w 63	s 63	w 64	F Ratio	Confidence Intervals w 63 vs s 63 sd	CI	w 63 vs w 64 sd	CI	s 63 vs w 64 sd	CI
Task 1	9.8	9.5	9.2	1.7						
Task 2	20.1	15.2	14.1	4.7*	5.7	(-.8, 10.6)	5.9	(.1, 11.9)	5.9	(-5.0, 6.8)
Task 3	35.6	28.4	29.2	3.0						
Task 4	38.2	34.8	32.0	1.2						

ADJUSTED POST-TEST

Fluency	Mean Scores w 63	s 63	w 64	F Ratio
Task 1	9.6	9.6	9.3	0.7
Task 2	17.7	16.2	15.7	0.6
Task 3	32.2	30.3	30.8	0.2
Task 4	35.1	36.0	34.1	0.2

Table 4.2

Flexibility Mean Scores, F Ratios, Confidence Intervals
for Creative Problem Solving Classes

PRE-TEST

Flexibility	Mean Scores w 63	s 63	w 64	F Ratio	Confidence Intervals w 63 vs s 63 sd	CI	w 63 vs w 64 sd	CI	s 63 vs w 64 sd	CI
Task 1	7.5	4.3	4.7	14.8**	1.8	(1.4, 5.0)	1.9	(.9, 4.7))	1.9	(-2.3, 1.5)
Task 2	11.8	6.8	7.0	8.3**	3.9	(1.1, 8.9)	4.0	(.8, 8.8)	4.0	(-4.2, 3.8)
Task 3	7.1	5.8	6.9	0.6						
Task 4	21.8	9.0	10.7	53.5**	3.8	(9.0,16.6)	3.9	(7.2, 15.0)	3.9	(-5.6, 2.2)

POST-TEST

Flexibility	Mean Scores w 63	s 63	w 64	F Ratio	Confidence Intervals w 63 vs s 63 sd	CI	w 63 vs w 64 sd	CI	s 63 vs w 64 sd	CI
Task 1	9.1	8.5	8.1	2.2						
Task 2	12.2	9.4	11.7	3.4						
Task 3	9.5	8.1	9.7	2.7						
Task 4	14.9	13.9	14.3	0.4						

ADJUSTED POST-TEST

Flexibility	Mean Scores w 63	s 63	w 64	F Ratio
Task 1	9.3	8.3	8.0	2.5
Task 2	10.5	10.3	12.5	3.2
Task 3	9.4	8.2	9.7	2.4
Task 4	11.9	15.8	15.6	2.4

Table 4.3

Originality Mean Scores, F Ratios, Confidence Intervals
for Creative Problem Solving Classes

PRE-TEST

Originality	Mean Scores w 63	s 63	w 64	F Ratio	Confidence Intervals w 63 vs s 63 sd	CI	w 63 vs w 64 sd	CI	s 63 vs w 64 sd	CI
Task 1	7.2	3.8	6.5	8.9**	2.4	(1.0, 5.8)	2.5	(-1.8, 3.2)	2.5	(-5.2, -.2)
Task 2	17.5	7.1	12.6	12.4**	5.9	(4.5, 16.3)	6.1	(-1.2, 11.0)	6.1	(-11.6, .6)
Task 3	20.2	13.9	14.9	3.7						
Task 4	15.7	14.8	12.0	0.8						

POST-TEST

Originality	Mean Scores w 63	s 63	w 64	F Ratio	Confidence Intervals w 63 vs s 63 sd	CI	w 63 vs w 64 sd	CI	s 63 vs w 64 sd	CI
Task 1	9.8	8.4	11.4	3.9						
Task 2	18.5	14.2	26.5	9.3**	7.9	(-3.6, 12.2)	8.2	(-.2, 16.2)	8.2	(4.3, 20.7)
Task 3	40.5	35.8	37.2	0.6						
Task 4	43.2	34.8	32.6	1.3						

ADJUSTED POST-TEST

Originality	Mean Scores w 63	s 63	w 64	F Ratio
Task 1	9.5	8.9	11.2	2.3
Task 2	14.6	18.2	26.3	12.0**
Task 3	37.3	37.8	38.4	0.0
Task 4	41.6	34.2	35.0	0.8

Table 4.4

Elaboration Mean Scores, F Ratios, Confidence Intervals
for Creative Problem Solving Classes

PRE-TEST

Elaboration	Mean Scores w 63	s 63	w 64	F Ratio	Confidence Intervals w 63 vs s 63 sd	CI	w 63 vs w 64 sd	CI	s 63 vs w 64 sd	CI
Task 1	10.6	7.8	18.9	11.4**	6.6	(-3.8, 9.4)	6.8	(1.5, 15.1)	6.8	(4.3, 17.91)
Task 2	14.8	8.8	14.1	6.4**	5.9	(.1, 11.9)	6.1	(-5.4, 6.8)	6.1	(-.8, 11.4)
Task 3	6.1	2.3	8.1	15.9**	2.9	(.9, 6.7)	3.0	(-1.0, 5.0)	3.0	(2.8, 8.8)
Task 4	7.2	0.8	4.3	10.1**	4.0	(2.4, 10.4)	4.2	(-1.3, 7.1)	4.2	(-.7, 7.7)

POST-TEST

Elaboration	Mean Scores w 63	s 63	w 64	F Ratio	Confidence Intervals w 63 vs s 63 sd	CI	w 63 vs w 64 sd	CI	s 63 vs w 64 sd	CI
Task 1	14.1	10.6	34.4	62.8**	6.2	(-2.7, 9.7)	6.4	(13.9, 26.7)	6.4	(17.2, 30.2)
Task 2	14.4	10.8	23.8	12.2**	7.4	(-3.8, 11.0)	7.6	(1.8, 17.0)	7.6	(5.4, 20.6)
Task 3	2.9	2.0	11.7	24.7**	4.1	(-3.2, 5.0)	4.3	(4.5, 13.1)	4.3	(5.4, 14.0)
Task 4	0.7	0.9	9.7	37.6**	3.2	(-3.4, 3.0)	3.3	(5.7, 12.3)	3.3	(5.5, 12.1)

ADJUSTED POST-TEST

Elaboration	Mean Scores w 63	s 63	w 64	F Ratio
Task 1	14.5	11.6	32.8	35.3**
Task 2	13.4	12.5	23.1	9.5**
Task 3	2.8	2.6	11.2	15.5**
Task 4	0.0	1.9	9.7	42.8**

during the quarter were not significantly different from each other.

Task 2 pre-test scores indicate a significant difference between the winter, 1963, and the winter, 1964 classes with the former having the higher scores. This difference shows up again on the post-test but not on the adjusted post-test, indicating that, although the Winter, 1963 group began the course with the highest scores and ended the course with the highest scores, the gains in score made by the three groups were not significantly different from each other.

Although the Winter, 1963 class scores significantly higher on the pre-test on Task 3, this difference vanishes on the post- and adjusted post-test scores, again indication no significant difference in gain among the three groups.

No significant differences exist on Task 4 between the three groups on the pre-, post- and adjusted post-test scores.

Flexibility

On Tasks 1, 2, and 4 the Winter, 1963 class scored significantly higher than the other two classes on the pre-test scores but not on the post- or adjusted post-test scores, indicating that there were no significant differences in gain of score among the three groups.

No significant differences among the groups show up on any of the tests for Task 3.

Originality

There is no significant difference in gain among the three groups on Task 1, even though a significant difference is found on the pre-test comparison between the winter, 1963 and the spring,

1963 classes, with the former class earning the higher mean score.

On Task 2 a significant difference on the pre-test is found between the spring, 1963 and the winter, 1964 classes. A significant difference on the adjusted post-test scores indicates that the winter, 1964 class made a greater gain in originality scores on Task 2 than did the other two classes.

Tasks 3 and 4 show no significant differences on the pre-, post-, and adjusted post-test scores.

Elaboration

On the pre-, post-, and adjusted post-tests of Task 1, the winter, 1964 class earned significantly higher scores than those earned by the other two classes. The existence of a significant F Ratio on the adjusted post-test scores and examination of the adjusted post-test means indicate the winter, 1964, class made a greater gain in score than did the other two classes.

On Tasks 2 and 4 significant differences indicate that the winter, 1963 class scored significantly higher than the spring, 1963 class on the pre-test, that the winter, 1964, class scored significantly higher than the other two classes on the post-test, and that the winter, 1964 class, as indicated by the adjusted post-test means and the significant adjusted post-test F Ratio, made a greater mean gain than the other two classes.

On the Task 3 pre-test, the two winter classes scored significantly higher than the spring, 1963 class. The post-test indicates that the winter, 1964 class earned significantly higher scores than those of the other two groups. The adjusted post-test results reflect that the winter, 1964 class made a gain greater than that of the other two classes.

Conclusions

1. On fourteen of the sixteen pre-test scores the winter, 1963 class earned scores higher than the other two classes. Although this difference between the winter, 1963 class and the other two is not always significant, it does tend to reflect a more discriminating selection of students for that quarter (described earlier in this report.) Apparently teachers can select the more "creative" students with some success.

2. The gains made by the three groups on fluency, flexibility, and originality were essentially the same (except on originality Task 2). It appears that the difference in students, teachers, and method for the three classes had no significant effect on the factors of fluency, flexibility, and originality.

3. The winter, 1964 class achieved a significantly (phenominally) greater gain on each of the four elaboration scores than did the other two classes. It appears to us that this consistent difference reflects the awareness and synectics exercises used by the instructor of the winter, 1964 class. In order to determine whether or not these exercises really do improve elaboration ability as measured by our test we expect to have the instructor of the winter, 1963 class use the awareness and synectics exercises when he teaches the course in creative problem solving again in the future. If one or both of these exercises are effective in improving elaboration ability without interfering with the growth in fluency, flexibility, and originality (as seems to be the case), we would certainly recommend that they be incorporated into creative problem solving courses and that they be incorporated into the text and workbooks currently available for these courses.

Table of References

1. Frederick S. Perls, Ralph F. Fefferline, and Paul Goodman, Gestalt Therapy, New York: Julian Press, 1951.

2. W. J. J. Gordan, Synectics, New York: Harper and Brothers, 1961.

3. E. Paul Torrance, Administration and Scoring Manual for Abbreviated Form VII Minnesota Tests of Creative Thinking, University of Minnesota: Bureau of Educational Research, 1962.