DOCUMENT RESUME

ED 064 340 TM 001 505

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TITLE The Minicourse as a Method for Training Teachers to Stimulate Divergent Thinking.
PUB DATE 72
NOTE 19p.; Paper presented at the annual meeting of the American Educational Research Association (Chicago, Illinois, April 1972)

EDRS PRICE MF-$0.65 HC-$3.29
DESCRIPTORS *Comparative Analysis; *Divergent Thinking; Educational Research; Elementary School Teachers; *Evaluation Techniques; Feedback; *Inservice Teacher Education; *Microteaching; Secondary School Teachers; Statistical Analysis; Teaching Techniques
IDENTIFIERS *Minicourse 20 Divergent Thinking

ABSTRACT

Fifty-nine inservice teachers in grades 1 through 12 took "Minicourse 20: Divergent Thinking," a course training teachers to use brainstorming to stimulate divergent thinking in students. Tapes of brainstorming sessions were made before, after, and seven weeks after the course ended. Experimental teachers improved significantly more than controls in the skills of not evaluating during brainstorming and not making unnecessary comments (e.g., repeating answers) or shaping student ideas (e.g., probing answers). They did not show improvement in the use of techniques such as categorizing to stimulate more divergent brainstorming. Teaching skills were acquired equally well by teachers who microtaught with audiotape feedback and by those who microtaught with videotape feedback. Control teachers showed no gains in teaching skills. Brainstorming responses given by students of the teachers were analyzed. Elementary students showed significantly greater gains in fluency, flexibility, and originality than the control group. The secondary sample did not improve. There were no significant differences between experimental and control groups on the Torrance Tests of Creative Thinking given before and seven weeks after the course. (Author)

ABSTRACT

THE MINICOURSE AS A METHOD FOR TRAINING TEACHERS TO STIMULATE DIVERGENT THINKING[1]

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Fifty-nine inservice teachers in grades 1 through 12 took Minicourse 20: Divergent Thinking, a course training teachers to use brainstorming to stimulate divergent thinking in students. Tapes of brainstorming sessions were made before, after, and seven weeks after the course ended. Experimental teachers improved significantly more than controls in the skills of not evaluating during brainstorming and not making unnecessary comments (e.g., repeating answers) or shaping student ideas (e.g., probing answers). They did not show improvement in the use of techniques such as categorizing to stimulate more divergent brainstorming. Teaching skills were acquired equally well by teachers who microtaught with audiotape feedback and by those who microtaught with videotape feedback. Control teachers showed no gains in teaching skills.

Brainstorming responses given by students of the teachers were analyzed. Elementary students showed significantly greater gains in fluency, flexibility, and originality than the control group. The secondary sample did not improve. There were no significant differences between experimental and control groups on the Torrance Tests of Creative Thinking given before and seven weeks after the course.

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In recent years a number of programs have been designed to encourage creativity in students. Torrance (1972) summarizes 133 reports of attempts to increase creativity through a variety of approaches including student workbooks, workshops or year long inservice training for teachers, reading or creative arts programs, and administrative arrangements. Most programs have approached creativity as divergent thinking, the operation which Guilford (1970) defines as most critical and unique to creativity--although he states that other abilities, including evaluation, are also essential. According to Guilford, divergent thinking consists of four abilities: fluency (thinking of many ideas), flexibility (producing ideas in many categories), originality (generating unique or unusual ideas), and elaboration (adding onto or elaborating on ideas).

Minicourse 20: Divergent Thinking was developed to train teachers in techniques that will increase students' fluency, flexibility, and originality. In contrast to other programs, it is a brief self-instructional course focusing on brainstorming and related techniques. The purpose of the study described here was to test the effectiveness of Minicourse 20 in training teachers to use these techniques, and to determine whether their students' divergent thinking improved. The relative effectiveness of audiotape and videotape feedback in microteaching was also tested.

METHOD

Training Procedure: Minicourse 20

Minicourses are self-contained auto-instructional packages based on the

microteaching approach developed by Stanford University. There is substantial evidence for the effectiveness of the Minicourse model (Borg et al, 1970). Minicourse 20[1] consists of five lessons, done one per week, each teaching several skills. For each lesson, the teacher reads about the skills of that lesson and does written exercises in a handbook; watches the skills modeled on videotape; and plans and carries out two fifteen minute microteach sessions with five to fifteen students in which he practices the skills and records the session on audio or videotape. He then replays the tape and evaluates his performance using forms in the handbook. The teachers microtaught at least once a week with the same group of ten students, who were tested before and after the course.

The teacher and student skills taught in Minicourse 20 are listed in Table 1. The main technique taught is brainstorming: students think of as many varied and original answers as they can to a divergent question. All answers are accepted without evaluation or discussion by teacher or class. This removes the fear of criticism which may inhibit expression of unusual ideas. Since brainstorming is more effective if teacher talk is minimal, Minicourse 20 trains teachers to omit unnecessary or directive comments. However, they are taught to stimulate a lagging brainstorming session by helping students categorize their answers or give answers in more categories (if necessary, listing attributes), break the question into parts, or think about analogies. Finally, after brainstorming the class may wish to evaluate its ideas, so teachers are taught to guide them in evaluation using criteria which the class chooses.

These teacher skills were selected because there is evidence that they increase divergent thinking in students, or because they are part of a num-

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1. The version of Minicourse 20 tested in the main field test is described here. It has since been revised for the operational field test, with minor modifications in length and content.

TABLE 1

OBJECTIVES OF MINICOURSE 20

Course Objective: To develop teacher skills in stimulating divergent thinking in students.

LESSON 1: DIVERGENT THINKING
Teacher Skills:
1. Recognize divergent questions and divergent thought.
2. Practice teacher behaviors which encourage flow of student ideas.
   a. Don't repeat or rephrase student answers.
   b. When students are temporarily out of ideas, remain silent to allow them to think.

LESSON 2: BRAINSTORMING
Teacher Skills:
1. Inform students of goals and rules of brainstorming.
2. Conduct a brainstorming session, using the following skills:
   a. Elicit many student responses.
   b. Accept all responses without discussion.
   c. Encourage hitchhiking by asking for and reinforcing it.
   d. Provide a culminating or follow-up activity.

Student Skills:
1. Accept all responses without discussion.
2. Be fluent (produce many answers).
3. Be flexible (produce answers in many categories).
4. Be original.

LESSON 3: CATEGORIZING, TECHNIQUES FOR STIMULATING BRAINSTORMING
Teacher Skills:
1. Use techniques for increasing fluency and flexibility during brainstorming.
   a. Suggest many possible categories of answers; or ask students to suggest them.
   b. Break the question into simpler parts and ask students to brainstorm them; or ask students to break the question into parts.
   c. Suggest analogous situations or problems; or ask students to suggest them.
2. Lead students in categorizing ideas after the brainstorming session.

Student Skills:
1. Suggest many or different categories of answers.
2. Break a question into simpler parts.
3. Suggest analogous situations or problems.
4. Put ideas into categories and label the categories after brainstorming.

LESSON 4: DIVERGENT QUESTIONS
Teacher Skills:
1. Recognize and pose three types of divergent questions:
   a. Questions asking for solutions to a problem.
   b. Questions asking for consequences of a real or hypothetical situation.
   c. Questions asking for causes of a real or hypothetical situation.
2. Set up class to brainstorm in small groups.

Student Skill:
Brainstorm in small groups which don't include the teacher.

LESSON 5: EVALUATING PROBLEM SOLUTIONS
Teacher Skills:
1. Ask students for more solutions.
2. Guide students in suggesting relevant criteria for evaluating solutions that they previously brainstormed.
3. Guide students in applying criteria to ideas.
4. Guide students in choosing the most appropriate solution(s).

Student Skills:
1. Suggest relevant criteria for evaluating solutions.
2. Apply criteria to ideas.
3. Choose the most appropriate solution(s).

ber of successful creativity programs. Brainstorming has been used effectively in industry and college creativity courses to increase divergent thinking (Davis et al, 1967; Parnes, 1967). It has been tested successfully in elementary and secondary school (Anderson and Anderson, 1963; Rouse, 1965; Parnes, 1966; Torrance, 1972). Attribute listing and analogies have been used by Covington and Crutchfield (1965), Davis et al (1969), Parnes (1967), and Williams (1970). Evaluation using predetermined criteria is a standard follow-up to brainstorming and makes brainstorming practical in the classroom by using its results. However, it is a convergent activity not specifically designed to increase divergent thinking.

Subjects and Experimental Design

All teachers were English or social studies inservice teachers in middle or lower-middle class mostly white schools in California and Utah. They taught grades one through twelve, and volunteered to participate in the study.

The assignment of the sample to groups is shown in Table 2. The 59 experimental teachers in the main sample took Minicourse 20 over a five-week period. They and their students were tested before and after the course and after a six to seven week delay period (pre, post, and delayed testing). The audio group microtaught with audiotape feeback, the video group with videotape. The control teachers were tested at times corresponding to the pre and delayed testing; they received no experimental intervention in the interim. In each participating school district there was one audio, one video, and one control school, with schools assigned randomly to treatments. An additional 14 experimental teachers who microtaught with videotape received no delayed testing. Their data are not reported here except for the measure of originality.

TABLE 2

BREAKDOWN OF MAIN SAMPLE

	Experimental		Control
	Audio	Video	
Elementary	18	15	17
Secondary	13	13	10

Testing Procedure

Four kinds of data were collected:

1. Videotapes of brainstorming sessions. Each teacher and ten students randomly selected from his class participated in a standard 20 minute videotaped session: 15 minutes of brainstorming followed by 5 minutes of evaluation. The same ten students were taped in the pre, post, and delayed sessions. One of three brainstorming topics was assigned: "Give as many uses as you can think of for bricks" (or tin cans, or newspapers). One third of the classes at each testing session used each topic, and a single class was assigned a different topic each time. Taping instructions described briefly the procedure for brainstorming and for evaluation using criteria.

Two kinds of information were obtained from these tapes. The brainstorming responses given by students were recorded and analyzed for fluency, flexibility, and originality; and the videotapes were scored independently by two coders for teacher use of the course behaviors.[1] Inter-rater reliability was high, with the Pearson product-moment correlation on tallied behaviors ranging from .87 to .99.

2. Torrance Tests of Creative Thinking (TTCT). In grades four through

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1. The use of the course behaviors of Lessons One through Three are reported here. The acquisition of evaluation skills by students and teachers is being analyzed.

twelve, students who were taped were given the TTCT before the course and after the delay period. Five out of seven questions in the Verbal TTCT, excluding the one on uses of objects, were administered.

3. Diary. Experimental teachers kept a record of how often they brainstormed with the ten students during the delay period, and were urged to do so at least once a week.

4. Questionnaire. Experimental teachers completed a questionnaire concerning the course, and giving suggestions for its revision.

The results of the diary and questionnaire are not discussed here.

RESULTS

Acquisition of Teaching Skills for Stimulating Divergent Thinking

Data from audio and video groups were combined, since statistical analysis revealed little significant difference between them. Analysis also showed no significant difference between use of teacher skills in the elementary and secondary samples, but since there were differences in the student results, and since we were particularly interested in the relative effectiveness of the course at the different grade levels, elementary and secondary results are presented separately. Analyses of covariance were done to compare the delayed scores for the experimental and control groups, using prescores as the covariate. The sample size was: elementary--31 experimental, 15 control; secondary--22 experimental, 10 control.[1]

1. Evaluation during brainstorming. The number of times each teacher praised or criticized a student's response during the 15 minute brainstorming session was tallied. Table 3 shows the mean number of praises

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1. These figures differ from those in Table 2 because some tapes were not scorable due to poor tape quality.

and criticisms in each taping session, and the significance level from the analysis of covariance comparing experimental and control groups.

TABLE 3

EVALUATION DURING BRAINSTORMING

Mean occurrences per session, with S.D's in parentheses.

	Experimental		Control		
	Pre	Delay	Pre	Delay	p
Elementary					
Praise	3.7(5.3)	0.1(0.2)	4.0(5.5)	2.5(3.9)	$< .001$
Criticism	0.8(1.2)	0.2(0.6)	1.6(1.9)	1.2(1.4)	$< .005$
Secondary					
Praise	2.1(2.9)	0.2(0.3)	2.2(2.1)	1.5(1.6)	$< .001$
Criticism	0.5(1.0)	0.3(0.7)	1.5(2.2)	0.5(0.7)	N.S.

There was a significant decrease in praise at both grade levels, with praise occurring almost never in the experimental delayed tapes. Criticism was low in pretapes, yet some improvement was shown in the delayed session.

2. Unnecessary teacher talk. Total teacher talk is measured by the percentage of time the teacher talks during brainstorming. Since this measure includes useful teacher talk, we also tallied the occurrence of the following kinds of unnecessary talk that Minicourse 20 trained teachers to avoid:

a. "Fillers":

i. Repeating the student answer just given.

ii. Repeating previous answers.

iii. Repeating the brainstorming question (unless students didn't understand or forgot it).

iv. Conversational or irrelevant asides, or "idle chit chat".

b. Directive talk which attempted to shape student answers:

i. Rephrasing student answers.

ii. Probing--asking further questions about or commenting on an answer.

iii. Answering the brainstorming question.

Tables 4 and 5 show the means and levels of significance based on the analyses of covariance for the elementary and secondary samples.

The results are highly significant in the elementary sample. All individual behaviors but repeating the question, which occurred very rarely, showed a significantly greater gain in the experimental group. The final level of performance is also impressive; almost no unnecessary teacher talk, and in fact, very little teacher talk of any kind, occurred. However, even in the pretape teachers followed brainstorming instructions quite well, and talked relatively little except for repeating answers. The results are similar but not quite as significant in the secondary sample.

3. Use of techniques to stimulate divergence. Minicourse 20 presents four techniques which teachers can use to help students think more divergently if brainstorming lags. Table 6 shows the mean number of occurrences of all four techniques. All were used rarely, and there was no significant difference between experimental and control groups. Since it might be inappropriate to use a technique often during a session, the number of teachers who used each technique even once was also determined. A quarter to half of the teachers in the delayed tapes suggested using more categories, or categorized, but analogies and subquestions were used by almost no one. However, these data do not tell us whether techniques were not used because

TABLE 4

UNNECESSARY TEACHER TALK, ELEMENTARY SAMPLE

Mean percent or mean occurrences per session, with S.D.'s in parentheses.

	Experimental		Control		
	Pre	Delay	Pre	Delay	p
Percent teacher talk	12.6%(8.5)	5.3%(4.8)	16.7%(7.8)	14.8%(8.7)	< .001
Repeat last answer	35.7(29.8)	2.0(2.7)	36.1(21.1)	36.3(23.9)	< .001
Repeat previous answer	0.7(1.3)	0.1(0.2)	0.4(0.7)	1.2(1.9)	< .001
Repeat question	0.6(1.2)	0.2(0.8)	1.6(1.8)	0.8(0.9)	N.S.
Idle comments	3.8(3.3)	0.5(0.9)	3.4(1.9)	2.7(3.4)	< .005
Total fillers	40.9(30.6)	2.8(3.2)	41.5(22.3)	41.0(25.5)	< .001
Rephrase	4.6(4.6)	0.3(0.6)	4.1(3.8)	2.6(2.4)	< .001
Probe	3.8(3.6)	0.6(1.0)	4.3(3.8)	3.5(2.0)	< .001
Answer question	0.4(0.9)	0.0(0.2)	0.7(1.9)	0.7(1.1)	< .005
Total directive comments	8.8(7.3)	0.9(1.2)	9.1(6.9)	6.7(3.5)	< .001

TABLE 5

UNNECESSARY TEACHER TALK, SECONDARY SAMPLE

Mean percent or mean occurrences per session, with S.D.'s in parentheses.

	Experimental		Control		
	Pre	Delay	Pre	Delay	p
Percent teacher talk	12.9%(8.5)	6.7%(8.3)	13.1%(7.0)	10.8%(9.7)	N.S.
Repeat last answer	31.3(20.1)	6.3(12.6)	29.2(31.7)	31.5(38.2)	$<.001$
Repeat previous answer	0.8(2.1)	0.8(1.5)	1.0(1.6)	0.6(1.3)	N.S.
Repeat question	1.0(2.1)	0.3(0.7)	0.4(1.0)	0.3(0.7)	N.S.
Idle comments	3.3(2.4)	1.4(2.0)	5.1(4.3)	2.8(3.4)	N.S.
Total fillers	36.5(20.6)	8.8(13.3)	35.6(34.8)	35.2(40.3)	$<.005$
Rephrase	4.3(3.5)	1.0(2.0)	2.3(2.3)	2.0(3.2)	N.S.
Probe	3.0(2.4)	1.0(1.6)	2.1(2.0)	1.9(1.7)	N.S.
Answer question	1.0(1.7)	0.3(0.7)	0.6(1.3)	0.3(0.4)	N.S.
Total directive comments	8.3(5.5)	2.3(3.9)	5.0(5.0)	4.2(4.1)	$<.05$

teachers did not know how to use them, or because they were not needed.

TABLE 6

USE OF TECHNIQUES TO STIMULATE DIVERGENT THINKING

Mean total occurrences of all four techniques per session, with S.D's in parentheses.

	Experimental		Control		
	Pre	Delay	Pre	Delay	p
Elementary	1.3(1.7)	1.1(1.9)	1.7(1.6)	1.6(2.9)	N.S.
Secondary	1.4(1.8)	1.4(1.8)	1.5(1.9)	0.8(1.0)	N.S.

Acquisition of Skills by Elementary Compared with Secondary Teachers

Inspection of the means in Tables 3 to 6 shows no striking differences in level of performance of elementary and secondary teachers in either pre or delayed tapes. An analysis of covariance was done to compare elementary and secondary sample performance in posttapes, using prescores as the covariate. No significant differences were found in any of the behaviors listed above.

Relative Effectiveness of Audio and Video Feedback When Microteaching

The audio and video experimental groups were compared on five teacher scores: frequency of occurrence of evaluation, fillers, and directive teacher talk; percentage of teacher talk; and use of techniques to stimulate brainstorming. An analysis of covariance was done on post scores for these behaviors, separately for elementary and secondary levels, using prescores as the covariate. Of the ten comparisons made, audio and video groups differed significantly on only one: percentage of teacher talk in the elementary sample. Here, the audio group did better, but as they decreased from 11.0% to 4.7% and the video group decreased from 15.3% to 8.6%, the difference is not large enough to have much practical significance.

Acquisition of Divergent Thinking Skills by Students

1. Behavior during brainstorming. One student behavior, not evaluating each others' answers, was tallied. Evaluation occurred infrequently on pretapes (Mean = 0.4 for elementary and 1.2 for secondary experimental groups) and delayed tapes (Mean = 0.5 and 1.1); there was no significant change.

2. Divergent thinking during brainstorming. The ability of a group of ten students to think divergently in a brainstorming situation was measured by analysis of the answers they gave to the brainstorming question. Fluency, flexibility, and originality scores were determined from the list of brainstorming responses recorded by the teacher during the brainstorming session.

Fluency and flexibility were determined for each taping session. Fluency was the total number of responses given. To score flexibility, each response was put into one of 46 categories, based on those used in the TTCT for scoring uses of objects. Flexibility was the total number of categories into which the responses given in one brainstorming session fell. Table 7 gives mean fluency and flexibility scores, and shows the significance levels resulting from analyses of covariance on delayed scores, using prescores as the covariate, with audio and video groups combined.

TABLE 7

FLUENCY AND FLEXIBILITY

Means per session, with S.D.'s in parentheses.

	Experimental		Control		
	Pre	Delay	Pre	Delay	p
Elementary					
Fluency	50.9(27.5)	68.6(24.7)	45.5(17.2)	50.4(18.7)	<.01
Flexibility	14.5(4.1)	17.9(4.7)	14.3(3.2)	15.2(4.0)	<.05
Secondary					
Fluency	61.0(20.2)	55.6(28.1)	58.5(34.2)	78.3(43.2)	<.01*
Flexibility	19.5(3.9)	17.2(5.1)	19.7(6.4)	19.7(5.0)	N.S.

*Controls improved significantly more than experimental group.

In the elementary sample, the experimental group increased significantly more than the control group in both fluency and flexibility between the pre and delayed testing. However, in the secondary sample there was no difference between experimentals and controls in flexibility, and the control group actually gained more in fluency. The elementary experimental group's increase in fluency was quite large and in the final testing they were very fluent, giving almost five answers a minute. The increase in flexibility is less striking but also of practical significance.

Originality of responses was defined as infrequency of occurrence. For preliminary analysis, original responses for the elementary sample were defined as those given only once (for a given topic) by the entire elementary group, experimental and control (including the classes which were only pre and posttaped), in all taping sessions. Original responses in the secondary sample were similarly defined. There were around 6000

responses given in each sample, with 1140 unique or "original" responses in the elementary sample and 1086 in the secondary. The mean number of original responses given per class in each testing session is shown in Table 8.

TABLE 8

MEAN NUMBER OF ORIGINAL RESPONSES GIVEN BY EACH CLASS

	Elementary		Secondary	
	Experimental	Control	Experimental	Control
Pretape	6.7 (N=38*)	8.3 (N=17)	8.7 (N=35)	9.7(N=10)
Posttape	9.5 (N=38)	----	9.8 (N=33)	----
Delayed tape	10.9 (N=33)	7.2 (N=17)	11.3 (N=26)	17.0(N=10)

*N=number of classes

Since we do not have an originality score for each class but only for the taping session as a whole, there is no appropriate test of significance. However, inspection of the means indicates that in the elementary sample, the experimental group increased considerably more than the controls in number of original responses given. In the secondary sample the experimental group increased in originality, but the control group increased even more.

3. TTCT. Each class was assigned a fluency, flexibility, and originality score which was the mean of the ten student scores on the TTCT. An analysis of covariance was done to compare experimental and control delayed scores (using prescores as covariate) for elementary (grades four to six), junior high, and high school samples. There were no significant differences between experimental and control groups on any of the three variables at any grade level. Both experimental and control groups improved by approximately the same small amount over the 12 to 13 week period.

CONCLUSIONS

Acquisition of Course Skills by Teachers

Minicourse 20 is effective at both elementary and secondary levels in teaching the skills of not evaluating and not talking unnecessarily when leading a brainstorming session. The gains on most individual behaviors and the totals were striking, especially at the elementary level. Also, these were results obtained in the delayed taping; that is, teachers retained impressive use of the skills for at least six weeks after the course ended. The small amount of teacher talk in delayed sessions (5%-7% of the time) is remarkable, since many studies have found teacher talk to occur from 50% to 80% of the time (Borg et al, 1970, pp. 59-60). By remaining silent, teachers reduced their role as center of the discussion and allowed students an opportunity to express their ideas. And by not evaluating ideas directly or indirectly, they established an accepting atmosphere which freed students to give unusual responses.

However, teachers seldom used the specific techniques for stimulating brainstorming in either pre or delayed sessions. One possible explanation for this finding is that the brainstorming questions were simple and not very appropriate for the use of either analogies or subquestions--the least used of the techniques. Second, the techniques are only needed if brainstorming lags. The high fluency scores suggest that most classes produced many responses and teachers may have felt no need to stimulate divergence further. The non-use of the techniques could be a sign of a successful brainstorming session. However, it is possible that the course did not succeed in training teachers to use the techniques--and indeed many teachers did report difficulty using analogies. Therefore, Lesson Three was strengthened in the operational field test version of the course.

Relative Effectiveness of Audio and Video Feedback

Teachers who microtaught with audio and videotape feedback were equally successful in learning to use course skills. The only significant difference was a small one favoring the audio group. Therefore, if the instructional models were available on film, school districts without videotape equipment could use the course successfully. Gall et al (1971) also compared the effectiveness of audio and videotape feedback in microteaching in Minicourse 5: Individualizing Instruction in Mathematics and found no difference in the acquisition of tutoring skills.

Divergent Thinking by Students

Seven weeks after their teachers completed Minicourse 20, elementary school students in group brainstorming sessions produced more responses in more categories, and more unusual responses than before the course. This improvement may have been due to their practice brainstorming, or their teachers' greater skill in leading brainstorming, or both. In addition to the divergent thinking exhibited in the group situation, teachers also reported cases of individual students who opened up, and a freer classroom atmosphere. These results were also reported by secondary teachers, but their students showed no improvement in divergent thinking. This difference may be partly due to the older students' boredom with the three simple and similar brainstorming topics. Or it may take a longer time and more intense efforts to change older students. The difference was probably not due to the level of teacher skills, as this was similar in elementary and secondary samples. Most secondary teachers felt that the course was worthwhile and that they and their students had benefited.

The improvement which elementary students showed in group divergent

thinking in the brainstorming situation did not transfer to the written creativity test (TTCT). It is possible that if the delay period had been longer than six to seven weeks an improvement in TTCT scores might have occurred. It is also possible, however, that the habit of thinking divergently in a group does not transfer automatically to individual thinking on a written test, and that teachers using Minicourse 20 should give students additional practice in brainstorming alone. In addition, if students had become more adept at using categorizing, etc., there might have been a greater improvement. Research cited earlier suggests that the skills incorporated in Minicourse 20 can improve creativity measured in a written test, as well as in a group situation.

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