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CONTENTS

An Assessment of the Impact of Set Induction Upon Student Achievement and Retention

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THERE has been much research in psychology on set, but comparatively little attention has been given to it in education. This is surprising since teachers dispense verbal instructions and give other sets to students daily.

Several psychologists have contended that one of the essential conditions in learning is that the learner be actively engaged in the process in order to maximize the possibility of new behavioral responses. A set is assumed to increase the probability of the occurrence of other responses, usually through selecting, directing, or organizing some part of experience.

Studies and related readings on set indicate that this is a powerful tool in determining the learning environment of the classroom and that the teacher is an instrumental agent in inducing a pupil's set toward learning.

In a study conducted at Stanford University, Aubertine reported that teachers could be trained in the skill of incorporating set induction procedures in their instructional strategies. He also found that teachers who did incorporate these procedures into their instructional strategies were perceived by their pupils as more effective teachers than were a control group of teachers who did not receive training in set induction procedures (.05 level) (1: 69).

An extension of this strategy of research was undertaken by Schuck at Arizona State University. He found that preservice teachers trained in the deliberate use of set induction techniques in their instructional strategies were judged more effective teach-

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ers and their students registered higher achievement test scores in a unit on respiration (.01 level) (6: 46).

The research design employed in this study left one important question unanswered. Were the results reported caused, as was assumed, by the additional four hours' training in the skill of set induction given the experimental group; or did this group, due to the additional training in the substantive area (a BSCS unit on respiration), become more proficient than the control group which was given no training?

The research design incorporated in this study was constructed in order to eliminate the alternative hypothesis outlined above, that is: that the data reported were a result of the increase in substantive ability gained in the training of teachers as they were instructed in the employment of set induction and, due to the fact that the control group was not given any training, the experimental group of teachers elicited significant achievement gains and were judged more effective.

Statement of the Problem

This study combines one of the latest developments in the substantive and environmental dimensions of biology education (the BSCS) with one of the latest developments of the behavioral dimensions of the educative process (set induction procedures) to make an assessment of the total impact of this combination upon the learner. Specifically, this study seeks to answer the following questions:

1. Will students taught by teachers trained in set induction techniques make significant gains in achievement over those taught by teachers who have not been trained in both units in a two-unit sequence?

2. Will ninth-grade pupils, students taught by teachers trained in set induction techniques, retain the material taught to a significantly greater degree than pupils taught by teachers not so trained in both units in a two-unit sequence?

3. Will teachers trained in set induction techniques have a significantly greater knowledge of the substantive area than the control group not given this training?

In summary, this investigation was designed to answer the question: Is it important that educators take into consideration the behavioral dimension of the educative process in planning programs for biology education at the secondary level, or are the present programs with their emphasis on the environmental and substantive dimension adequate for the attainment of desired learning goals?

For the purpose of this study, the following definitions were employed:

Set: A set is a cognitive process activated by a stimulus or stimuli perceived by a person in environmental situations, determining how one is predisposed to respond to what is attended to in a given situation.

Induction: Inducing a learning set is the initial instruction act on the part of the teacher for the purpose of establishing a frame of reference deliberately designed to facilitate the creation of a communicative link between the experimental field of the pupils and the desired behavioral goals of the learning experience (the lesson).

The purpose of the set induction procedure is to focus pupil attention on some commonly known experimental referent (*orientation*) which becomes the vehicle by which the teacher makes the passage from the known to new material (*transition*) and builds continuity from lesson to lesson. The induced set lends meaning to new material through the use of analogy rather than by simple association (*operation*) and encourages pupil involvement in the lesson as judged by the teacher (*evaluation*).

Example of Inducing a Set in Teaching

In a biology class on an introductory unit on "The Process of Photosynthesis," the teacher might induce a set in the first lesson in the following manner:

1. *Orientation.* The teacher begins the lesson by exhibiting a bottle of milk for the purpose of generating a discussion of the process of milk production by cows.

2. *Transition.* The teacher uses the cow as an analogue to a manufacturing plant in which it consumes raw material (hay and water), adds its own enzymes and energy to produce a product and by-product (milk and manure).

3. *Operation.* The teacher introduces the process of photosynthesis by relating it to the above analogue in the following manner: raw material (water and carbon dioxide) to process (sunlight and chlorophyll) to product and by-product (sugar and oxygen). This could be illustrated with overlays on an overhead projector.

4. *Evaluation.* The teacher then seeks pupil comprehension through asking general questions about the process of photosynthesis. When the teacher believes that the pupils have grasped the concept, he would then proceed into the main body of the lesson with more difficult material and eventually to the Krebs cycle.

In the course of the experiment, several additional set induction strategies were developed. Each utilized the format explained in the preceding paragraphs; however, each strategy dealt with the substantive material covered in the respective BSCS unit on respiration and circulation.

The Experimental Design

The experimental design employed in this study was the Pretest—Post-test Control Group design. This design was incorporated in the following manner:

Pupil Sample. A volunteer population of ninth-grade pupils was solicited from E. O. Smith High School located in Storrs, Connecticut. The total population of pupils used was 180. These pupils were then randomly divided into 18 groups numbering 10 pupils per group.

Teacher Sample. The teacher population consisted of 18 education majors who had not taken any methods courses, nor had they been exposed to the student teaching experience. These teachers were volunteers who responded to a letter requesting their participation in the study. This letter was sent to each of the students in the College of Education.

Each of the 18 teachers participating in the study was assigned at random to one of the pupil groups already established. In turn, each of the groups and the teacher assigned to that group were randomly assigned to either the experimental or control procedure.

Curriculum Assignment. The BSCS Curriculum to be used by each teacher in instructing the pupils assigned to him was determined at random. This resulted in having three teachers instruct 10 pupils each in the BSCS Blue, Green, and Yellow Versions in both the experimental and control groups.

The Experimental Treatment. The entire population of teachers attended a two-hour meeting during the week prior to the first week of instruction. At this meeting the assignment of teachers to pupil groups and BSCS Curricula to be used was made known. Teachers were then assigned to teams by BSCS Curricula used. These teams numbered three teachers each, and consisted of all the teachers using a particular BSCS Curriculum within either the experimental or control groups. No team had members from both the experimental and control groups, because of the obvious contamination which would result. The opportunity for teachers using a BSCS Curriculum to pool information concerning their instructional strategies was made possible.

This first meeting was the only time the entire control group of teachers met together. The experimental group of teachers held four additional meetings, on the Saturday prior to the first, third, fifth, and seventh week of instruction.

The purpose of these meetings was to give instruction to the experimental group on set induction techniques, and to explain how these could be incorporated into their instructional strategies. The meetings lasted two hours each and gave a total training time of eight additional hours to the experimental group of teachers.

The data necessary to analyze the pupil behavior in this study were collected through employment of both pretests and post-tests. Three instruments were used: the Teacher Demonstration Rating Form, the Set Induc-

tion Rating Form, and the Achievement Test constructed especially for this study. A further analysis of these tests appears in a later portion of this section.

The instructional period for this study dedicated to pupils consisted of eight consecutive weeks. During these weeks the classes were conducted after school from 2:30 to 3:30 Monday, Wednesday, and Friday. This represented the total time given the unit on respiration and circulation by the BSCS program (4).

The Training Procedure for the Experimental Group

During the first Saturday training session, members of the experimental group of teachers were introduced to the following topics to clarify set induction procedures:

1. Purpose of Set Induction
2. Operational Rules for the Set Induction Process
3. Construction Rules of the Set Induction Process.

Once these procedures were thoroughly covered, the remaining time was spent in discussing a few examples of sets used by teachers in studies conducted at Stanford to better illustrate to the group an operational instructional strategy employing set induction techniques. The group members were dismissed with the request that they attempt to incorporate set induction techniques in the formation of their instructional strategies and the command that they communicate only with the members of their three-man team.

The additional two-hour sessions were held on the Saturday mornings falling between the two-week instructional periods. During these sessions, questions regarding the use of sets the previous weeks were answered. A review of the set induction procedures was then undertaken. The final activity was an analysis of several sets submitted by members of the group the previous week. These sets were dittoed and handed to the members of the experimental groups of teachers.

The control group received no training beyond the initial meeting during which all 18 teachers were given the materials for their respective BSCS Curriculum. Members of the control group then depended upon this material alone to form their instructional strategies.

Three separate analyses were made of the data collected in this study. The first analysis made was of the Teacher Achievement Scores with an N=9 in both experimental and control groups. The second analysis made was of the Achievement Test Gain with an N=90 in both experimental and control groups.

Instrument Used To Collect Data

The Unit Achievement Test. An intensive search failed to uncover an adequate test for achievement in the BSCS units employed; it was decided to construct special tests to serve this function. Care was taken to establish the reliability and validity of these tests. The Achievement Test in Respiration was determined to have content validity due to the fact that a trained group of teachers had determined the questions as adequate for the purpose of measuring achievement in the unit on respiration in their respective BSCS programs.

The next step was to establish item validity. The procedure used was that suggested by Henry Garrett in his book, *Statistics in Psychology and Education*. Thus, three pilot studies of the achievement test were made. The resulting test was determined to be a valid one since it was composed of items all found to lie within the limits of discrimination and difficulty established by Garrett for valid test items.

After the test was administered to the experimental and control populations as a post-test, another check was made of the items. Only one of the items fell outside of the criteria, that item having a discrimination index of .83. Since this deviation was small, the test was once again determined to be a valid one. A similar procedure was followed in the construction of a unit Achievement Test in Circulation.

The Kuder-Richardson Formula 20 was

Variable	Hypothesis Tested	F Ratio	Significance
Student Achievement Respiration	1	33.47	P>.01
Student Achievement Circulation	2	56.06	P>.01
Student Retention Respiration	3	35.30	P>.01
Student Retention Circulation	4	27.52	P>.01
Teacher Achievement Respiration	5	.414	NSD
Teacher Achievement Circulation	6	2.45	NSD

Table 1. Summary of Results of the Analysis of Variance on the Hypotheses Tested in This Study

used to establish the minimum reliability figure for instruments used in this study. The K-R 20 Formula was run on all three pilot study data runs, and also on the post-test data in the study.

Garrett indicates that when a researcher seeks to differentiate between the means of two schools of relatively narrow range, a reliability figure need be no higher than .50 or .60. In this study, the experimental and control groups were composed of students within the same grade level and through random procedures were made similar. Hence, the criteria established by Garrett were employed. The reliability figures on the pilot studies reported were: .58, .72, and .78 respectively. The reliability coefficient found by use of the K-R 20 on the experimental post-test given to all students in the study was .86.

Hypotheses Tested

This study was designed to test the following null hypotheses:

Hypothesis 1. There is no difference in achievement on a biological unit in respiration in the BSCS program as measured through a pretest—post-test design between the experimental and control groups of high school pupils.

Hypothesis 2. There is no difference in achievement on a biological unit in circulation in the BSCS program as measured through a pretest—post-test design between the experimental and control groups of high school pupils.

Hypothesis 3. There is no difference in retention on a biological unit in respiration in the BSCS program as measured through a pretest—post-test design between the experimental and control groups of high school pupils.

Hypothesis 4. There is no difference in retention on a biological unit in circulation in the BSCS program as measured through a pretest—post-test design between the experimental and control groups of high school pupils.

Hypothesis 5. There is no difference in

	Experimental				Control		
	Pre	Post	Dif		Pre	Post	Dif
Green				Green			
Teacher #1	13.0	20.7	7.7	Teacher #1	14.0	14.8	.8
Teacher #2	13.4	20.5	7.1	Teacher #2	14.3	15.4	1.1
Teacher #3	13.5	20.0	6.5	Teacher #3	14.8	15.1	.3
Yellow				Yellow			
Teacher #1	12.7	19.7	7.0	Teacher #1	12.9	16.9	4.0
Teacher #2	13.3	21.8	8.5	Teacher #2	13.5	17.6	4.1
Teacher #3	13.4	20.9	7.5	Teacher #3	13.6	16.6	3.0
Blue				Blue			
Teacher #1	13.1	20.6	7.5	Teacher #1	13.3	15.3	2.0
Teacher #2	13.6	19.7	6.1	Teacher #2	13.4	15.8	2.4
Teacher #3	14.1	21.0	6.9	Teacher #3	12.8	16.1	3.3
Overall	13.2	20.5	7.3	Overall	13.7	15.9	2.2

Difference Between Groups

Pretest	.5 Experimental < Control
Post-test	4.6 Experimental > Control

Table 2. A Summary of the Achievement Scores Obtained by Pupils in Both the Experimental and Control Groups in a BSCS Unit on Respiration

teacher achievement on a biological unit in respiration.

Hypothesis 6. There is no difference in teacher achievement on a biological unit on circulation.

Results

An examination of Table 1 will reveal the F values derived from the analysis of variance treatments for data relevant to each of the above null hypotheses. Hypotheses 1, 2, 3, and 4 were rejected. In each case the pupils taught by teachers trained in set induction techniques scored higher on the tests employed than did the control group of pupils.

As was mentioned earlier, however, one explanation for this result could be that the teachers trained in set induction techniques gained a greater knowledge of the subject matter taught and hence the pupils they taught made greater achievement and retention gains. Hypotheses 5 and 6 were tested to make a judgment concerning the validity of this alternative explanation. An examination of the F ratios resulting from an analysis of variance of the data related to hypotheses 5 and 6 revealed that these null hypotheses failed to be rejected. Hence no significant differences in teacher achievement in units on circulation and respiration were found between those teachers in the experimental and control groups. The alternative explanation that those teachers trained in set induction procedures had a better knowledge of the subject matter than the control group teachers, which thus influenced the fact that their pupils scored higher in achievement and retention than did the control group pupils, was not sustained.

Discussion of the Findings

The data collected in this investigation indicated that pupils of teachers trained in the deliberate skill of set induction did achieve significantly higher on the Achievement and Retention Tests employed, .01 level of confidence. These findings held when both units on respiration and circulation in the BSCS Curricula were taught.

Data Related to the Unit on Respiration. A closer examination of the data revealed some interesting information. When the mean scores of the Pretest Achievement Test of the experimental and control groups were compared, a difference of .5 of one point in favor of the control group was found. This may be seen by examination of Table 2. The

	Experimental				Control		
	Pre	Post	Dif		Pre	Post	Dif
Green				Green			
Teacher #1	19.9	35.8	15.9	Teacher #1	21.3	28.5	7.2
Teacher #2	20.4	33.9	13.5	Teacher #2	22.2	28.8	7.6
Teacher #3	20.8	34.1	13.3	Teacher #3	21.4	28.3	6.9
Yellow				Yellow			
Teacher #1	21.3	34.3	13.0	Teacher #1	21.3	27.7	6.6
Teacher #2	21.9	33.9	12.0	Teacher #2	21.6	28.0	7.6
Teacher #3	20.8	34.6	13.8	Teacher #3	20.7	27.6	6.6
Blue				Blue			
Teacher #1	21.4	34.3	12.9	Teacher #1	21.8	28.4	6.6
Teacher #2	21.0	35.0	14.0	Teacher #2	22.1	28.6	6.5
Teacher #3	19.5	34.0	14.5	Teacher #3	20.9	25.5	6.6
Overall	20.3	34.3	14.0	Overall	21.4	28.1	6.7

Difference Between Groups

Pretest	1.1 Experimental < Control
Post-test	6.2 Experimental > Control

Table 3. A Summary of the Achievement Scores Obtained by Pupils in Both the Experimental and Control Groups in a BSCS Unit on Circulation

Experimental			Control		
	Respiration	Circulation		Respiration	Circulation
Green			Green		
Teacher #1	19.5	31.2	Teacher #1	13.9	25.3
Teacher #2	19.2	30.7	Teacher #2	13.7	25.1
Teacher #3	19.3	31.0	Teacher #3	13.0	24.9
Yellow			Yellow		
Teacher #1	19.2	30.2	Teacher #1	13.1	24.6
Teacher #2	18.6	31.6	Teacher #2	13.9	23.9
Teacher #3	19.3	30.4	Teacher #3	14.1	24.6
Blue			Blue		
Teacher #1	19.2	30.8	Teacher #1	12.8	23.4
Teacher #2	18.0	30.1	Teacher #2	13.7	24.5
Teacher #3	17.9	29.6	Teacher #3	13.4	24.3
Mean	18.8	30.6	Mean	13.4	24.5

Difference Between Groups
Respiration 5.4
Circulation 6.1

Table 4. A Summary of the Retention Scores Obtained by the Teachers in Both Experimental and Control Groups in Units on Respiration and Circulation

high degree of randomization employed in the design of this study appeared to be a prime factor in the production of the close proximity of these mean scores.

The post-test data in the area of achievement revealed a difference between the experimental and control group mean scores of 4.6 points in favor of the experimental group. This indicated that the experimental group overcame a .5 of a point deficit, and upon the post-test obtained a 4.6 point difference making a total net gain of 5.1 points. This can be seen in Table 2. A difference, as was noted earlier, was significant ($p < .01$).

Data Related to the Unit on Circulation. A closer examination of the data related to the unit on circulation revealed some interesting information. When the mean scores of the Pretest Achievement Test of the experimental and control groups were compared, a difference of 1.1 points in favor of the control group was found. This may be seen by examination of Table 3.

The post-test data in the area of achievement revealed a difference between the experimental and control group mean scores of 6.2 points in favor of the experimental group. This indicated that the experimental group overcame a deficit of 1.1 points, and upon the post-test obtained a 6.2 point difference, making a total net gain of 7.3 points. This can be seen in Table 3. A difference, as was noted earlier, was significant ($p < .01$).

Data Related to Pupil Retention. An examination of the data related to pupil retention reveals several interesting facts. In the unit on respiration, the control group mean score was 13.4 and the experimental group mean score was 18.8. The difference in these mean scores was 5.4 points in favor of the experimental group. This figure was significant ($p < .01$).

In the unit on circulation the mean retention score for the control group was 24.5 and for the experimental group was 30.6. The difference in these mean scores was 6.1 points. This figure was significant ($p < .01$).

The data concerning the retention scores may be found in Table 4 and are broken down by teacher.

Summary of Findings

1. The pupils of teachers trained in the deliberate skill of set induction made significant ($p < .01$) gains in achievement over the pupils taught by teachers who were not exposed to the training.

2. The pupils of teachers trained in the deliberate skill of set induction made significant ($p < .01$) gains in retention over the pupils taught by teachers who were not exposed to the training.

3. There is no difference between teachers in the control group and those in the experimental group in their knowledge of the substantive areas that were taught.

Conclusions

This study dealt with a sample of 180 ninth-grade students drawn from E. O. Smith High School, Storrs, Connecticut. Consequently, results of this study should be generalized to other situations only after definite relationships between those groups and the sample employed in this study have been clearly established. On this basis, the findings listed in this study would appear to warrant the following general conclusions:

1. Pupils taught by teachers trained in the deliberate use of set induction techniques are likely to make greater gains in achievement than those exposed to teachers not trained in this instructional skill.

2. Pupils taught by teachers trained in the deliberate use of set induction techniques will retain more of the content that was learned than those exposed to teachers not trained in this instructional skill.

3. The alternative hypothesis that the experimental treatment affords greater knowledge to the teachers of the experimental group and as such provides the explanation for superior achievement and retention by their pupils failed to be substantiated.

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