THE EFFECTS OF CLASSROOM ENVIRONMENT ON CREATIVITY AND QUESTION ASKING IN GRADE SEVEN SCIENCE CLASSES

by

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Current evaluations in science education research of discovery based science programs give no clear indication of the merit of these new science programs.

Getzels and Jackson's studies in creativity suggest that permissive and authoritarian family environments may influence development of creativity and IQ respectively in children.

It was reasoned that findings relating family and school environments to creativity could have relevance in science education where discovery based science programs are having a profound effect on altering science classroom environment. It was hypothesized that permissive science classroom environments would produce significantly higher posttest creativity means than the control.

Since a current science education goal is to enhance student question asking skill (e.g. Inquiry Training) and since findings indicate question asking styles are related to aptitudes, it is hypothesized that high creative and high permissive groups will have significantly higher factual and yes-no question score means whereas high intelligence and low permissive groups will have significantly higher explanation question score means.

Creativity tests used in this study include Guilford's Uses Test and the Question Test from Torrance's Ask-and-Guess Test. The Question Test also yields factual, yes-no, and explanation question scores.

To assess classroom environment, the Classroom Environment Scale was developed. Item choices were classified by seven judges into the three environmental categories.
The sample consisted of four grade seven classes, three experimental and one control. Experimental groups were taught the ESS unit, *Batteries and Bulbs*. The experimental groups included a semipermisive group which was taught the unit according to suggestions in the teacher's guide, and the permissive and authoritarian groups which, respectively, had less and more teacher control of classroom environment than the semipermisive group. Experimental groups were shown to have significantly different classroom environment means in the direction expected.

Data for testing hypotheses of this project came from a field experiment and a field study. For the field experiment a before and after design was used, analysis of covariance being employed on the group post creativity means with significant covariates derived from step-down regression analysis of pretest data. All significance levels are at the 5% level.

Results of the field experiment indicate that for the more valid creativity test, the Uses Test, the group post creativity means of the permissive and authoritarian groups were significantly larger than the control group post mean. With the Question Test, which lacked discriminant validity in regard to intelligence, only the authoritarian group post creativity mean was significantly larger than the control post mean.

For the field study high and low groups were formed using medians of creativity, intelligence and classroom environment as cutoffs, with
analysis of variance and the F-test used to detect significant differences in means of question scores or question gains of these high and low groups. When question gain data showed non-normality the Chi-square test was used with significance at 1%.

Field study results show that the high creative group had significantly higher mean yes-no and factual question scores than the low creative group, whereas the high intelligence group had a significantly higher mean explanation question score than the low intelligence group.

Chi-square analysis revealed significant divergence in factual and explanation question gains for low and high permissive groups.

For aptitude-environment interaction low aptitude-low permissive interactions contribute most to divergence of factual question gains and high aptitude-low permissive interactions contribute most to divergence of explanation question gains. Strongest divergences in group question gains came from intelligence environment interaction.
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CHAPTER I

GENERAL INTRODUCTION

Introduction

A number of new science programs have been developed in the late 1950's and during the 1960's. Many of these new programs have been compared with traditional science programs in an attempt to evaluate the effectiveness of the new programs in producing gains in knowledge, understanding, and critical thinking. A survey of the literature reveals, however, that there is no consistent significant difference in the effectiveness of the various new science curricula in affecting gains in knowledge, understanding, and critical thinking. In addition, there are studies that throw doubt on the notion that the techniques of the new science programs show increased effectiveness in promoting interest, positive attitude toward science, retention of science knowledge, and problem solving.

That science curricula must be revised from time to time to keep pace with the forefronts of scientific research, there is general agreement. That the techniques of the presentation of revised science programs must also be revised, there is less general agreement and this aspect of program revision is open to the kinds of pedagogical investigations cited above. However, in the light of the findings of such educational research, we are still left with the question as to what the new presentation formats of the revised science curricula do better than
the presentation methods of conventional science programs.

If one takes a tour through the book publishers' displays at teachers' conventions, or better still, at science teachers' conventions, one finds phrases in the prefaces of new science texts such as "inductive teaching," "the discovery approach," "activity based," "lab-centered," "non-directed" and "inquiry-training" used in the description of the programs. It is not difficult to factor out of such terms the common emphasis on increased student participation and exploration as part of the process of learning science. For instance, the student, in recent science curriculum revisions such as CHEM Study and Biological Sciences Curriculum Study, is encouraged to perform as a scientist empirically exploring his environment.

Of course, exploration implies that the explorer is operating in new, unknown territory. If the territory is known, it is easier and more efficient to use a map or ask directions. Furthermore, exploration implies that the activities of the explorer are self-directed. If it were not so, we would call an explorer's expedition a guided tour.

While it is possible to argue that the explorer metaphor can be applied to the working scientist, there are many reasons which mitigate against the use of the same metaphor for the school science student. Some of the most profound factors which work against science students operating honestly as scientists or explorers are that students know they are not finding their way through "territories" for which there are no "maps," and that ultimately they are rewarded for knowing well the "landmarks" of heretofore discovered areas.

Why, then, do we persist in trying to incorporate the exploration
metaphor into science curricula, when it can be shown that most science courses are at best interesting or fascinating "guided tours" of information already discovered?

Such a question can, perhaps, best be answered in two parts. In the first instance, it would appear that discovery activities are included in the laboratory sections of science courses, conventional or revised, as apprenticeship training for potential scientists.

In the second instance, the orientation of science revisions to the discovery approach is an attempt to cope with the growing awareness that in all persons the human intellect has the capacity not only to know, but also to create. While discovering and creating are not synonymous, discovering becomes more fruitful if a scientist develops the capacity for generating or creating many original hunches or hypotheses.

One of the currently in-vogue processes for fostering the generation of many original ideas is the group "brainstorming" technique. One of the essential requirements of brainstorming that favours the production of a strong flow of ideas is the suspension of criticism. Anderson concurs with brainstorming advocates for he postulates that an accepting environment is one of the necessary conditions for the growth of creativity. Anderson's argument is that an atmosphere of acceptance such as is possible in a genuinely discovery-oriented science program tolerates, allows, and even encourages divergent or creative production.

Perhaps, then, an answer to the question of what the science programs which are described as using the discovery approach, or being lab-centred or activity-based, do better than traditional science programs is that they enhance the development of creativity, namely, the formulation
and testing of many original hypotheses.

By contrast, in traditional science programs, authoritarian or teacher-dominated learning situations prevail. In such learning situations, there is toleration and reinforcement primarily for the "right" answer which Guilford defines as convergent production. In traditional programs convergent production is strongly favoured and divergent or creative production is very often discouraged or simply not reinforced.

Furthermore, Richard Suchman,¹¹ in an article entitled "Putting Inquiry into Science," describes a program in which the following stages are followed:

1. present the problem;
2. ask students for theories to account for facts;
3. students ask yes-no questions to test theories presented;
4. tape inquiry sessions;
5. refine theories;
6. analyze student questions by replaying the tape.

Suchman's Learning Development Program which highlights inquiry training by encouraging students to ask yes-no questions to test theories presented, recognizes that yes-no questions are hypotheses which can be accepted or rejected from an answer of yes or no. Dahl, in an unpublished study of creativity and question asking,¹² was able to show that yes-no questions have .50 correlation with originality scores on creativity tests. In the same study he was able to demonstrate a consistent significant relationship between creativity and the frequency with which students asked yes-no questions.

It appears, then, that research into science classroom environments, as it affects creativity and question asking behaviour, would throw some light on the dynamics that are operative in some of the recently developed science programs.
The Problem

Statement of the Problem

The purpose of this study is to investigate some of the relationships that classroom environment has to creativity and question asking in science students. The study will try to focus on a possible relationship between the amount of perceived teacher direction in the classroom and the creativity of science students. Put in another way: Do permissive science classrooms tend to foster increased creativity in students?

As well, an attempt will be made to confirm some earlier findings regarding the links aptitudes (intelligence and creativity) and classroom environment have with question asking behaviour or style.

However, preliminary to all this work will be the cross-validation of the Question Test specifically developed for use in this project against a fairly standard Uses Test of creativity.

Statement of Hypotheses

All significance levels will be at the 5% level unless noted.

1. Cross-validation of the Question Test:

Null: Creativity factor scores, namely, fluency, flexibility and originality scores, as well as total creativity scores obtained with the Question Test on the pretest of the project sample will show no significant correlation with: (a) creativity factor scores of the Uses Test; (b) total creativity scores of the Uses Test; and (c) intelligence scores obtained on the Henmon-Nelson Tests of Mental Ability.

Alternate: Creativity factor scores, namely, fluency, flexibility and originality scores, as well as total creativity scores obtained with the
Question Test on the pretest of the project sample will show significant correlation with: (a) creativity factor scores of the Uses Test; (b) total creativity scores of the Uses Test and will show no significant correlation with intelligence scores obtained on the Henmon-Nelson Tests of Mental Ability.

2. Determination of Classroom Environment:
Null: The three grade seven science classes in the Oliver Elementary School will show no significant difference in class means of scores obtained on the Classroom Environment Scale given at the end of this project.
Alternate: Each of the three class means of scores obtained from the Classroom Environment Scale will be significantly different from each other in the direction intended.

3. The Relationship of Classroom Environment and Creativity:
Null: There will be no significant differences in class means of post-test creativity scores among the three experimental groups and one control group as measured by the Question Test and Uses Test.
Alternate: There will be significant differences in class means of post creativity scores as determined by: (a) the Uses Test; and (b) the Question Test with classes showing significantly higher class means on the Classroom Environment Scale also showing significantly higher post creativity class means.

4. Aptitudinal and Environmental Links to Question Asking (using one independent variable at a time):
Null: (1) The group of subjects above and the group of subjects below the median of creativity scores will show no significant difference in
the means of: (a) factual question scores; (b) yes-no question scores; and (c) explanation question scores.

(2) The group of subjects above and the group of subjects below the median of intelligence scores will show no significant difference in the means of: (a) factual question scores; (b) yes-no question scores; and (c) explanation question scores.

(3) The group of subjects above and the group of subjects below the median of the classroom environment score will show no significant difference in the means of: (a) factual question gains; (b) yes-no question gains; and (c) explanation question gains.

Alternates: (1) The group of subjects above the median of creativity will have significantly higher: (a) factual question means; and (b) yes-no question means; than the group of subjects below that median.

(2) The group of subjects above the median of intelligence scores will have significantly higher explanation question means than the group of subjects below that median.

(3)(a) The group of subjects above the median of the classroom environment scores will have significantly greater means of: (i) factual question gains; and (ii) yes-no question gains, than the group of subjects below that median.

(b) The group of subjects below the median of the classroom environment scores will have a significantly greater mean of explanation question gains than the group of subjects above that median.

5. Interaction Effects of Aptitudes and Classroom Environment on Question Asking:
Null: (1) The four groups, namely, $C_H P_H$ (high creativity, high permis-
sive), C_{HP} (high creativity, low permissive), C_{LP} (low creativity, high permissive), and C_{PL} (low creativity, low permissive), defined by applying medians of the post creativity scores and classroom environment scores to the experimental portion of the sample will show no significant differences in the means of: (a) factual question gains; (b) yes-no question gains; and (c) explanation question gains.

(2) The four groups, namely, I_{HP} (high intelligence, high permissive), I_{HP} (high intelligence, low permissive), I_{LP} (low intelligence, high permissive), and I_{PL} (low intelligence, low permissive), defined by applying medians of intelligence scores and classroom environment scores to the experimental portion of the sample will show no significant differences in the means of: (a) factual question gains; (b) yes-no question gains; and (c) explanation question gains.

No alternates will be proposed for these hypotheses as this aspect of the study is exploratory.

In the instance that question asking gain data show a non-normal distribution which is so skewed as to mask significant differences between means when analysis of variance is applied, the hypotheses of sections 4 and 5 above will be tested for group divergence in total question asking gains from total expected question asking gains. In this test a 1% level of significance will be required.

Definition of Terms

In the statement of the hypotheses a number of terms have been used that require definition or description in operational terms.
Creativity and Intelligence

Guilford, one of the major contributors to cognitive research, has operationally defined creativity as divergent production which in Guilford's context is the generation of a variety of words, ideas, or things in response to problems such as: "How many uses can you think of for a tin can?" These responses are evaluated not in terms of some conventionally designated correct answer, but rather in terms of the total number of responses, cleverness of responses, and originality of responses.

Divergent production is one of the five operations of the intellect in Guilford's *Structure of the Intellect*, a model he proposes for general intelligence. This model will be assumed to be valid in this study. The other four operations in this model are cognition, memory, convergent production, and evaluation. Tests of intelligence, such as the Henmon-Nelson Tests of Mental Ability, which will be used in this study, would measure many of the factors that make up the Guilford operations of cognition, memory, and convergent production. Tests of creativity such as the Uses Test and the Question Test would measure the factors that make up divergent production or creativity.

Creativity Factors

The divergent production operation consists of a number of factors. The most important of these, according to Guilford, are fluency, flexibility, originality, and elaboration. Guilford defines fluency as the ability to produce, in a given time, many ideas, uses, associations, or improvements. Flexibility is the production of many different categories of uses, ideas, improvements or associations in a given time. Originality
applies either to the cleverness of a response or to the number of infrequent responses on a creativity test. (In the present study the latter definition of originality will be used.) **Elaboration** is the ability to fill in details of a basic plan, or to build onto a basic idea so as to make it more interesting or tell more of a story.

**Classroom Environment**

Classroom environment will be assessed in terms of the amount of teacher direction of classroom activities as perceived by the student. A measure of the amount of teacher direction in a classroom will be determined by student responses on the Classroom Environment Scale.

**Question Asking**

In a study to work out scoring techniques for the Question Test, Dahl reports that factual and yes-no question scores significantly correlate with creativity scores and explanation question scores associate significantly with intelligence scores.15

In this study the same categories of question types will be used as were used in the study cited above. These categories are:

(a) factual question; questions which require simple facts for answers. e.g., Q. What is the name of that yellow flower?
   A. A dandelion.

(b) yes-no questions; questions which require yes or no for an answer. e.g., Q. Is that a dandelion growing on the lawn?
   A. Yes.

(c) explanation questions: questions which require a reason or explanation for an answer.
e.g., Q. Why are dandelions called composites?
A. Dandelions are called composites because they have flower heads composed of clusters of small flowers.

Description of the Classroom Environments

There will be four grade seven science classes involved in this study, three in the Oliver Elementary School and one in the Midway Elementary School. The three classes in Oliver will serve as experimental groups. In each of these experimental groups the amount of teacher direction will be different. In the Midway classroom, which will serve as a control, no attempt will be made to affect the amount of teacher direction.

The Experimental Classes

Semipermisive Classroom

This environment will be a product, as closely as possible, of the approaches and techniques suggested in the teacher's guide to the Elementary Science Study (ESS) unit, Batteries and Bulbs:16

[The teacher will] serve as a guide through the intricate world of batteries, bulbs and wires, as a provider of equipment, as a giver of simple mechanical instructions (such as how to use a wire stripper), as a poser of questions and, hopefully, as an enthusiastic participant.17

The class will be allowed to follow any diverting side path that may interest it.18 The children will be encouraged to make their own predictions on the basis of their own criteria or generalizations. The questions and prediction sheets included in this unit will not be used as tests but as game-like attempts at self-evaluation.19
The Authoritarian Environment

The teacher, books and mimeographed information sheets will be sources of information for this group. The direction the development of the content will take will be determined (a) by the direction taken in the semipermisive group, and (b) by the suggestions in the ESS unit. Laboratory exercises and demonstrations are to confirm information supplied by the teacher or reading materials.

Questions are to be set on laboratory exercises, teacher demonstrations, on information supplied by the teacher, and on reading assignments. The written answers to these questions will be graded for their correctness. Each lesson will begin with a 5-10 minute review of the previous day's lesson. The oral answers will be judged right or wrong by the teacher. The main emphasis in this environment will be the correctness of information given by the teacher and received in student answers and comments.

The Permissive Environment

The students in this group will receive all the booklets, materials, and apparatus used by the semipermisive group. Questions students ask will be turned back to them by remarks such as: "Well, what do you think?" No assignments will be given; no planned course of information will be taught or examined. Nor will any formal or semiformal discussions be held. Students will be allowed to elect not to do parts of, or all of the Batteries and Bulbs series.

As much as possible student initiated interests and science projects will be accommodated. Radio and television repair shops will be solicited for additional materials and equipment for student projects.
Importance of the Problem

Many science educators and curriculum developers feel intuitively that science programs like Elementary Science Study are better than traditional programs. So far, however, there is little research that consistently indicates the ESS program, or programs like it, achieve a given educational goal better than traditional programs. If programs such as ESS are to replace traditional science programs, which are alleged to be less effective, we must be able to argue for such replacement on the basis of evidence that such new science programs meet a given criterion better than traditional programs. This study will attempt to do just that, namely, to show that ESS, because the learning environment it creates, enhances divergent production to a greater extent than do traditional programs.

Let us now look at the problem in another way. Through the work of Guilford and Torrance, creativity has become an operationally defined and measurable construct. We can now realistically attempt to find ways of maximizing an individual's creative potential. If it can be shown that a permissive environment fosters development of creativity, not only will the value of programs like ESS become more evident, but more generally a technique for creativity development will have been established.

In addition, it will be possible to note from this study the optimum amount of direction needed to obtain maximum development of question asking behaviour.

Furthermore, it may be possible to gain some insight as to the role of the teacher: must he authoritatively direct student learning; must he
serve as a guide for the learning student; or must he serve as an assistant in student initiated learning for maximum creativity development?

Finally, in helping to elucidate the nature of the links that classroom environment and cognitive aptitudes, such as intelligence and creativity have with question asking styles, this study will have found a few more indicators teachers and researchers might use to know to what degree these cognitive aptitudes are being enhanced by the classroom environments teachers and researchers create. That is, knowing that a particular classroom environment increases explanation question asking may indicate that student theorizing and intellectual capacities are being developed; whereas, knowing that a classroom setting increases asking factual and yes-no questions may indicate that hypothesizing and creative abilities are being fostered.
Endnotes - Chapter I


14 Ibid., p. 15.


16 Batteries and Bulbs, Books 1, 2 and 3 (Watertown: Published by the Elementary Science Study of Educational Services Inc., 1966).

17 Batteries and Bulbs, Book 1, "Circuits I," p. 2.

18 Ibid., p. 3.

19 Ibid.

20 Ibid., pp. 6-11.

CHAPTER II

REVIEW OF THE LITERATURE

Classroom Environment and Creativity

Donald J. Schmidt, after showing that methods of lab discussion, programmed instruction, and lecture discussion produced no significant difference in achievement and understanding, concludes in his paper entitled "Can We Teach" that we can teach provided we evaluate our success under a non-authoritarian system. "We must," he says, "reward the student for originality, creativeness and inquiry. Conformity to group opinion should not be the major component of success." He argues that we encourage divergent production but presents no evidence that this is a valid direction for science education to proceed in. There is a need for such evidence and this need is echoed in Nathan S. Washton's strong plea that critical attention be given to research in science creativity. It is precisely such research that is the concern of this investigation.

Specifically, it is the point of this study that divergent production in science classes can be enhanced by the manipulation of the learning environment. Mackler has investigated the relationship between environment and the divergent production of art students. He has been able to show, using Torrance's Ask-and-Guess Test, among other tests, that stimulating art students with pieces of art and destimulating them with a drab environment produced measurable differences in their creativity. His study was able to show that a stimulating environment produces more divergent production.
Walker has also made a study of environment and creativity. His investigation involved two traditional schools and two highly creative schools. He found that teachers were less authoritarian, and that students exhibited more initiating behaviour in the highly creative schools than in the traditional schools. However, paper and pencil tests of creativity failed to show any difference in divergent production between traditional and creative schools. It should be noted, however, that when the environment is an unmanipulated variable, or uncontrolled as it was in this study, differences in creativity, great enough to be noted by paper and pencil tests of creativity may not occur.

Nevertheless, this study does suggest that schools considered creative have a more permissive atmosphere. It is precisely this point, the relationship between permissiveness and divergent production, which needs greater grounding in fact.

In Chapter I, it was noted that Anderson stresses that the propitious environment for creativity has two characteristics: (1) acceptance and (2) stimulation. Mackler, as indicated above, has shown that stimulation enhances divergent production. Walker has suggested that there is a relationship between acceptance or permissiveness and creativity, but has been unable to quantify this relationship with creativity tests. With more carefully controlled environmental conditions the present study hopes to establish such a quantitative relationship.

However, investigators who attempt to quantify the parameters that pertain to the relationship between creativity and classroom environment might ultimately have to take note of the methods of Getzels and Jackson who identified two groups of students as follows:
(1) The High Creativity Group. These were subjects in the top 20% on creativity measures when compared to students of the same age and sex, but below the top 20% in IQ.

(2) The High Intelligence Group. These were subjects in the top 20% in IQ when compared with students of the same age and sex, but below the top 20% on the creativity measures.

Then in order to generate hypotheses on possible differences in family environment between the high creativity group and high intelligence group, Getzels and Jackson used a Parent Questionnaire and a Parent Interview to obtain data on the following variables.

1. Education and occupation of the parents.
2. Age of the parents.
3. Mother's recollection of her own family situation when she was her child's age.
4. Reading interests of the family, at least as represented by the number and type of magazines taken.
5. Parental satisfaction and dissatisfaction with the child and his school.
6. Parental satisfaction and dissatisfaction with their own child rearing practices.
7. Mother's description of the kinds of friends preferred for her child.

Getzels and Jackson then subjected the data in relation to the above variables to Chi-square analysis to discover divergence from expected frequency of response of parents of the children of the two different cognitive groups. The results of this analysis are summarized in Table 2-1 below (see p. 20).

After a considerable discussion of these findings, Getzels and Jackson tentatively suggest that "authoritarian" family environments may favour the development of "convergent thinking" or "conservative cognition," and "permissive" family environments may favour the development
Table 2-1: Distinguishing Family Environment Characteristics of High Creative and High Intelligence Subjects in a Study by Getzels and Jackson\textsuperscript{7}

<table>
<thead>
<tr>
<th>Variable</th>
<th>High IQ ( (N = 24) )</th>
<th>High creative ( (N = 24) )</th>
<th>Chi-square</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Number of parents who were college graduates</td>
<td>Father</td>
<td>21</td>
<td>15</td>
<td>2.78</td>
</tr>
<tr>
<td></td>
<td>Mother</td>
<td>16</td>
<td>12</td>
<td>.77</td>
</tr>
<tr>
<td>2. Number of parents having graduate training</td>
<td>Father</td>
<td>19</td>
<td>13</td>
<td>2.34</td>
</tr>
<tr>
<td></td>
<td>Mother</td>
<td>13</td>
<td>5</td>
<td>4.36</td>
</tr>
<tr>
<td>3. Occupational status: Father: univ. teaching, research, editing</td>
<td></td>
<td>15</td>
<td>7</td>
<td>4.56</td>
</tr>
<tr>
<td></td>
<td>business</td>
<td>4</td>
<td>11</td>
<td></td>
</tr>
<tr>
<td></td>
<td>medicine, law</td>
<td>5</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>Mother: housewife only full/part time work</td>
<td></td>
<td>18</td>
<td>11</td>
<td>3.14</td>
</tr>
<tr>
<td>4. Age difference between parents</td>
<td>0 - 1 yr.</td>
<td>4</td>
<td>13</td>
<td>5.83</td>
</tr>
<tr>
<td></td>
<td>2 or more yrs.</td>
<td>20</td>
<td>11</td>
<td></td>
</tr>
<tr>
<td>(N = 22)</td>
<td>(N = 18)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Financial status and poverty in description of own home life by mothers</td>
<td>- Mention of finances</td>
<td>16</td>
<td>7</td>
<td>3.36</td>
</tr>
<tr>
<td></td>
<td>- Emphasis on past poverty</td>
<td>9</td>
<td>1</td>
<td>4.48</td>
</tr>
<tr>
<td>6. Number of magazines</td>
<td>6 or fewer</td>
<td>7</td>
<td>12</td>
<td>3.52</td>
</tr>
<tr>
<td></td>
<td>7 or more</td>
<td>15</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>(N = 23)</td>
<td>(N = 19)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. Number of unfavourable qualities observed in children by mothers</td>
<td>1 or less</td>
<td>13</td>
<td>17</td>
<td>4.02</td>
</tr>
<tr>
<td></td>
<td>2 or more</td>
<td>10</td>
<td>2</td>
<td></td>
</tr>
</tbody>
</table>

[continues]
Table 2-1 continued

<table>
<thead>
<tr>
<th>Variable</th>
<th>High IQ (N = 22)</th>
<th>High creative (N = 19)</th>
<th>Chi-square</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>8. Number of unfavourable school qualities observed by mothers</td>
<td>1 or less</td>
<td>7</td>
<td>12</td>
<td>3.27</td>
</tr>
<tr>
<td>9. Mother's opinion of own training practice</td>
<td>satisfied</td>
<td>17</td>
<td>8</td>
<td>3.15</td>
</tr>
<tr>
<td>10. Characteristics preferred for children's friends</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- External-specific (e.g. good family, manners, studious)</td>
<td>Mean significantly greater for High IQ group</td>
<td>t = 2.56</td>
<td>p &lt; .02</td>
<td></td>
</tr>
<tr>
<td>- Internal-general (e.g. sense of values, interests, openness)</td>
<td>Mean significantly greater for High Creative group</td>
<td>t = 2.13</td>
<td>p &lt; .05</td>
<td></td>
</tr>
</tbody>
</table>

of "divergent thinking" or "constructive cognition." What this study intends to do is to extend the Getzels and Jackson hypothesis to the relation of classroom environment and creativity.

Aptitudes, Environment and Question Asking

In a survey of the research literature on question asking, it quickly becomes apparent that a major portion of the research effort has gone into the question asking behaviour of teachers rather than into the question asking style or behaviour of students.

However, work on the relation of teacher question asking to student creativity has begun to appear. For instance, the studies of Gallagher and Archer show that even a slight increase in the percentage of teachers'
"higher thinking type questions" called "divergent questions" yield a large increase in students' divergent production. Such questions as "What would happen if the U.S. had been colonized from the west coast to the east coast instead of vice versa?" stimulated or elicited as many as fifteen or twenty responses, each related to the divergent or creative production on the part of the students. 9

Efforts in the direction of investigation of student question asking comes from Richard Suchman whose attempts at putting inquiry into science education have led him to develop a program which encourages student theorizing and hypothesizing. 10 In Suchman's program, student hypothesizing is developed by allowing only yes-no questions of students to test theories they have posed to account for the facts of a problem set by the teacher.

The Suchman inquiry training methods are interesting when viewed together with one of Dahl's findings, cited earlier, namely, that question asking style of students is significantly related to the aptitudes of intelligence and creativity. Specifically, Dahl's investigations with a Question Test revealed that the amount of explanation question asking by students is directly related to student IQ. 11 Seen in connection with Dahl's results, Suchman's emphasis on theorizing to explain the facts or data related to a problem may be a way to stimulate the growth of student intelligence.

Furthermore, it is similarly interesting to view Suchman's techniques of promoting student hypothesizing in connection with Dahl's discovery of a moderately strong and highly significant correlation of student yes-no questions with originality and creativity. 12 It seems
reasonable, therefore, to suggest that, perhaps Suchman has found a way of raising students' creativity in science by giving them experience at asking yes-no questions. As well, it may be reasonable to suggest that creativity in science may have something to do with the fruitfulness of hypothesizing.

By juxtaposing the results of Getzels and Jackson which show a relationship between family environment and cognitive styles with the findings of Dahl, which indicate significant association between aptitudes and question asking styles, it has become possible to hypothesize that if authoritarian classroom environments promoted the development of intelligence, they may favour students asking more explanation questions. It has likewise become possible to hypothesize that if permissive classroom environments enhance creative ability they could reasonably be expected to increase the number of yes-no and, perhaps, factual questions asked.
Endnotes - Chapter II


5Jacob W. Getzels and Phillip W. Jackson, Creativity and Intelligence (New York: John Wiley and Sons, 19 ), p. 20.

6Ibid., pp. 61-62.

7Ibid., pp. 62-72.

8Ibid., p. 76.


10J. Richard Suchman, op. cit., p. 4.


12Ibid., pp. 34, 41-46.
CHAPTER III

MATERIALS AND TESTS USED

Course Materials and Content

The ESS unit Batteries and Bulbs will serve as the basic content for all three experimental classes. As the ESS units are part of a non-sequential, activity oriented program developed primarily to provide children with stimuli to explore, the semipermissive group which is to use the Batteries and Bulbs unit, as suggested in the teacher's guide, may at times digress from the main direction of the unit. When such spontaneous changes in course direction occur, the content of the digressions will be worked into the content to be learned by the authoritarian group.

As the authoritarian group is to experience the largest amount of teacher direction and control and the least amount of personal exploration, the Batteries and Bulbs unit for the authoritarian group will be fact oriented and characterized by text books and teacher lecture/demonstration methods. Mimeographed, illustrative laboratory exercises, as well as mimeographed information and question sheets will be prepared. The three study guides provided in the unit will be used as texts.

The permissive group may use the student booklets and materials which constitute the unit Batteries and Bulbs. Other materials and information open to this group will vary with individual interest and initiative, and will only be limited by what is safe and available. As mentioned earlier, the permissive group will have access to discarded
radios and television sets gleaned from local radio and tv repair shops.

The Tests

Question Test

The Question Test, a copy of which is included in Appendix A, has been adapted from Torrance's Ask-and-Guess Test of creativity as one of the devices for measuring divergent production and question asking before and after the manipulation of the classroom environments.

The Question Test yields four creativity factor scores, namely, fluency, flexibility, elaboration, and originality, as well as three scores of question asking behaviour. The question asking scores are counts of the numbers of factual questions, yes-no questions, and explanation questions asked.

The test consists of a sample picture and three test pictures. The first test picture shows two men who are playing a checker-like game, being interrupted by soldiers. The second picture is of a balloon attached to the top of a soft drink bottle with hot water being run over the bottle. The last picture depicts a scene in the making of a butter candle. All three pictures have a degree of open-endedness and are, therefore, open to a number of interpretations.

The administration and scoring of the Question Test is explained fully in Appendix A. The only additional descriptive aspects of the test to be included here are technical data, such as coefficients of reliability and validity.

Reliability

It has been possible to calculate the reliability of the total
creativity score as well as the reliabilities of the four creativity factor scores derived from the Question Test by considering the subtests of the Question Test as parallel forms administered in immediate succession. This has been done with two different samples of grade 7 students.

As seen from Table 3-1, factors of fluency and elaboration, as well as the creativity scores of the subtests show very similar reliabilities for the two samples. Furthermore, flexibility and originality have shown considerably improved reliability with a larger sample. However, compared with reliabilities of intelligence and achievement tests, which range in the .80's and .90's, these creativity reliabilities are low. Nevertheless, they are typical of creativity tests.²

Table 3-1: Reliability Coefficients of Creativity Factor Scores and Creativity Scores Obtained on Parallel Forms of the Question Test Given in Immediate Succession

<table>
<thead>
<tr>
<th>Score</th>
<th>Grand Forks (N = 78)</th>
<th>Oliver (N = 122)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fluency</td>
<td>.63</td>
<td>.66</td>
</tr>
<tr>
<td>Flexibility</td>
<td>.35</td>
<td>.58</td>
</tr>
<tr>
<td>Elaboration</td>
<td>.37</td>
<td>.44</td>
</tr>
<tr>
<td>Originality</td>
<td>.41</td>
<td>.67</td>
</tr>
<tr>
<td>Creativity score</td>
<td>.63</td>
<td>.60</td>
</tr>
</tbody>
</table>

Furthermore, the reliabilities of the question scores have been determined on the basis of retest with a six week interval between tests, using the control group as the sample. The control group has been used as a sample because no experimental manipulations of classroom environment have been applied to it. Although the sample is small, the use of
the entire pretest/posttest scores allows the inclusion of a larger number of responses than does the method of parallel forms using subtests of the Question pretests as was done for creativity reliability coefficients above. The correlation of the larger numbers of responses using the pretests and posttests contributes to more stable correlation and helps to offset the smallness of the sample (see Table 3-2).

<table>
<thead>
<tr>
<th>Score</th>
<th>Reliability Coefficient</th>
</tr>
</thead>
<tbody>
<tr>
<td>Factual questions</td>
<td>.78</td>
</tr>
<tr>
<td>Yes-no questions</td>
<td>.61</td>
</tr>
<tr>
<td>Explanation questions</td>
<td>.71</td>
</tr>
</tbody>
</table>

The question scores show somewhat higher reliabilities than some of the creativity factors. However, what is interesting for the purposes of this study is that these categories of question types shown in Table 3-2 are capable of repeatable measurement.

**Validity**

When considering the validity of the Question Test as a measure of creativity, two correlations of Question Test creativity scores with other independent estimates of creativity show that the Question Test does give a measure of what is considered to be creativity. One of these estimates is a teacher rating of student creative ability. The teacher ratings of creativity obtained on the Grand Forks sample show, as is evident from Table 3-3, a low but significant correlation with the Question Test scores
of creativity.

Table 3-3: Validity Coefficients of the Question Test Calculated Against Teacher Ratings of Creative Ability and Uses Test Creativity Scores

<table>
<thead>
<tr>
<th>Criterion</th>
<th>Validity coefficient</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teacher ratings</td>
<td>.23 (N = 78)</td>
<td>&lt; .05</td>
</tr>
<tr>
<td>Uses Test scores</td>
<td>.68 (N = 122)</td>
<td>&lt; .01</td>
</tr>
</tbody>
</table>

A second independent estimate of creative ability is derived using the Uses Test during the pretest of the Oliver-Midway sample of the present study. In the light of validity coefficients of the Uses Test against other creativity measures (see Table 3-5), the validity coefficient of .68 for the Question Test against the Uses Test is quite substantial. More will be said on the matter of the validity of the Question Test in Chapter V when results involving the cross-validation of the Question Test are presented.

The Uses Test

A second creativity test to be used in this study is the Uses Test, a sample of which can be found in Appendix B. The Uses Test has been used as a creativity measure by Guilford, Getzels and Jackson, and Wallach and Kogan, among others.

The test asks the examinee to write down as many different uses as he can think of in a given time for a given common object. Examinees are encouraged to write down any use that comes to mind no matter how strange the use may seem.
In this study three creativity factors will be scored on the Uses Test. These are fluency, flexibility, and originality. For an account of scoring procedures on the Uses Test, see Appendix B.

**Reliability**

The reliability coefficient of the Uses Test, as determined by Getzels and Jackson, using the internal consistency method is .86. Although psychometricians generally consider internal consistency as a measure of the degree of homogeneity of a test, a measure which has some relevance to its construct validity, it is possible to see the correlation of subtest scores against total scores (internal consistency) as an indicator of reliability as well.

A second measure of the reliability of the Uses Test has been obtained by using the subtests of the Uses Test as parallel forms. Correlations ranged from .30 to .80. Table 3-4 shows means of these correlations for the three creativity factors and the total creativity score to be of the same relative strength as the reliability coefficients obtained for the Question Test.

<table>
<thead>
<tr>
<th>Score</th>
<th>Reliability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fluency</td>
<td>.58</td>
</tr>
<tr>
<td>Flexibility</td>
<td>.55</td>
</tr>
<tr>
<td>Originality</td>
<td>.55</td>
</tr>
<tr>
<td>Creativity</td>
<td>.69</td>
</tr>
</tbody>
</table>
Validity

The validity of the Uses Test has been checked by Getzels and Jackson by correlating the Uses Test scores against the scores of four other creativity measures to obtain indicators of convergent validity, and against intelligence test scores for indicators of discriminant validity.9

From Table 3-5, it is evident that the convergent validities of the Uses Test, namely, those validity correlations of Uses Test scores with other creativity test scores which would be expected to show a strong relationship, are of the same magnitude as the validities for the Question Test.

<table>
<thead>
<tr>
<th>Criterion measure</th>
<th>Validity coefficient (N = 533)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Word association</td>
<td>.37</td>
</tr>
<tr>
<td>2. Hidden shapes</td>
<td>.20</td>
</tr>
<tr>
<td>3. Fables</td>
<td>.25</td>
</tr>
<tr>
<td>4. Make-up-problems</td>
<td>.23</td>
</tr>
<tr>
<td>5. Intelligence (IQ)</td>
<td>.17</td>
</tr>
</tbody>
</table>

While most researchers into creativity maintain that creativity is a distinctly different cognitive ability from intelligence (IQ), the low but significant correlation of the Uses creativity score with IQ, shown in Table 3-5, is insufficient evidence of discriminant validity for the Uses Test. Therefore, in the present study the time given for each Uses
subtest will be increased from three minutes, as in the Getzels and Jackson study, to five minutes to reduce the similarity of creativity measurement with that of timed intelligence measurement. Wallach and Kogan have shown that by making their creativity measures, which included the Uses Test, strictly power tests, they were able to obtain stronger convergent validities as well as a near zero discriminant validity for creativity measures against intelligence.

The Classroom Environment Scale

The Classroom Environment Scale, a copy of which has been included in Appendix C, is an instrument that has been developed specifically for this study to detect the amount of teacher direction and control students of the three experimental classes perceived at the end of the six week interval of this study. The results of this scale will be used to verify that the amount of teacher direction in each experimental classroom was significantly different from the other two in the direction intended.

The Classroom Environment Scale consists of eleven items. These items cover such areas as content required, materials provided, amount of time the teacher talked, teacher questioning methods, approach to experiments, testing procedures, teacher reinforcement, and teaching methods.

Each of the eleven items of the scale have three to five choices, ranging in the amount of teacher direction and control from permissive to authoritarian.

In order to validate that these choices for each item on the scale are indicative of permissive, semi-permissive or authoritarian classrooms, seven teachers were asked to categorize the choices into the three exper-
imental categories. In order for a particular item choice to be classified in an environment category, the number of judges selecting that choice for a given category had to exceed the 95% confidence limits. These confidence limits were calculated in terms of the number of judges' selections for all choices of an item in a given category. Details of this calculation can be found in Appendix C.

Of the 42 choices included in the Classroom Environment Scale, the number of choices significantly selected for the experimental categories was 17 choices and 18 choices respectively for the authoritarian and permissive groups and 7 choices for the semipermissive group.

In order to score this scale, each permissive choice will receive three points, each semipermissive choice two points, and each authoritarian choice one point. Assigning points in this way, the Classroom Environment Scale yields a classroom environment score.
Endnotes - Chapter III


5 Jacob W. Getzels and Phillip W. Jackson, Creativity and Intelligence: Explorations with Gifted Students (London: John Wiley and Sons, 1963), pp. 200-201.


7 Jacob W. Getzels and Phillip W. Jackson, op. cit., p. 201.


10 Jacob W. Getzels and Phillip W. Jackson, op. cit., p. 20.

11 Michael A. Wallach and Nathan Kogan, op. cit., p. 55.

CHAPTER IV

METHODOLOGY

Validation of Creativity Tests

In the descriptions of the creativity tests in Chapter III, data were given regarding the validity of the two creativity tests to be used. However, for the newly developed Question Test, the needed cross-validation data will be derived from pretest data of the project sample. As well, determinations will be made for both the Question Test and Uses Test of convergent and discriminant validity using pretest data.

Question Test Cross-Validation

It is essential that test validity be computed on a different sample of persons from that on which the scoring procedures were developed. This cross-validation is done on the assumption that the variance of chance factors which may have entered to give a spurious validity coefficient on the first sample will fall away when validity is determined on a second sample.¹

Thus, for the Question Test, cross-validation will be accomplished by calculations on pretest data of the sample of the present study, convergent validity being derived from correlations of creativity scores of the Question Test against pretest creativity scores of the Uses Test, and discriminant validity being derived from correlation of pretest creativity scores of the Question Test against the Henman-Nelson intelligence test scores available from student records.
Uses Test Validity Using Extended Subtest Timing

As pointed out in Chapter III in the description of the Uses Test, the convergent validities of the Uses Test (correlations with other creativity measures) are low when three minutes are allocated per subtest. As well, the discriminant validity (correlation of uses scores against intelligence scores) is too high when three minutes per subtest are used.

Wallach and Kogan have shown that such deficiencies in validity can be corrected by administering creativity tests individually and by removing time constraints. In the present study an attempt will be made to improve the validity of the Uses Test by extending the time per subtest from three minutes to five minutes. Success at improving the Uses Test validities will be indicated by raising its convergent validity from the .20's of the Getzels and Jackson study to the .40's of the Wallach and Kogan work, and by lowering discriminant validity from the statistically significant level of the Getzels and Jackson data to the statistically insignificant level of the Wallach and Kogan data.

Description of the Sample

The sample in this study consists of four grade seven classes. Three of these classes are located in Oliver, British Columbia and one in Midway, British Columbia. The total sample consists of 132 students.

Experimental Groups

Access to the Oliver portion of the sample has come about as a result of discussions with Mr. Ken Beck, head of the science department in the Oliver Elementary School, while he was at a science teachers'
conference here at the University of British Columbia in the fall of 1967. As a result of these discussions, he has offered three of his grade seven science classes as part of the sample for this experiment.

Mr. Beck has declared himself willing to teach the ESS unit Batteries and Bulbs according to the three treatments outlined earlier. At the time of writing (February 1968), conversations with Mr. Beck indicate that he has already taught several ESS units, namely, Small Things, Kitchen Physics, and Behaviour of Mealworms, to these three grade seven science classes. Having taught science by content oriented, traditional methods earlier in his career, Mr. Beck is well-equipped to teach Batteries and Bulbs by permissive as well as authoritarian approaches.

Also, of course, the Oliver students have all, by now, had experience with permissive and authoritarian classroom environments. Therefore, it is likely that these three experimental classes will have a relatively easy time becoming accustomed to the particular classroom environment that will be assigned to them.

The Control Group

The control group is a grade seven class in the Midway Elementary School in Midway, British Columbia. Mr. Peter Perepelkin, the grade seven science teacher, has kindly permitted the pre- and posttesting of his class at times that coincide with the testing of the experimental groups. From discussions with Mr. Perepelkin and from visits to the classroom during science lessons, it would appear that the control group is receiving instruction in science using the standard B.C. Department of Education text and curriculum guide.
Description of Experimental Design

Field Study

Kerlinger divides educational and social science research into four major categories, namely, laboratory experiments, field experiments, field studies, and survey studies. Under such a classification the present study is, in part, a continuation of an earlier exploratory field study by Dahl on the relationship of the aptitudes of creativity and intelligence to question asking styles. Therefore, an accurate description of that part of the present work that has to do with question asking is that of a hypothesis testing field study.

Because of the ex post factor character of the field study, statements of the causal relations established in such studies are weaker than statements of causal relations derived from experimental research. Therefore, the field study aspect of the present research will serve in the role of clarification and support of the field experiment concerning the relationship between classroom environment and measurable changes in creativity.

Definition of Groups in the Field Study

The field study aspect of this project has taken its direction from the work of Getzels and Jackson, referred to earlier, in which two different groups were defined as follows:

(1) the high creative group, composed of students who scored in the top 20% on creativity tests, but did not score in the top 20% on intelligence tests;

(2) the high IQ group composed of students who scored in the top 20% on
IQ tests, but did not score in the top 20% on creativity tests. These two groups were then studied by Getzels and Jackson in ex post facto fashion using Chi-square analysis for the most part.

As in the case of Getzels and Jackson the field study aspect of this project will start with the observations of the dependent variables, namely, question asking scores and retrospectively study the independent variables of intelligence, creativity, and classroom environment for their possible effects on question asking scores. However, instead of studying the top 20% of the sample with respect to the independent variable, the method here will be to define groups in terms of the upper half and lower half of the sample with respect to the median of a given independent variable.

**Definition of Groups Using One Independent Variable at a Time**

Proceeding with groups defined in this manner, it will be possible to test hypotheses regarding the relationship of aptitudes such as intelligence and creativity to question asking. For testing these hypotheses the entire sample will be used.

For hypotheses regarding the relationship of classroom environment to question asking only the experimental part of the sample will be used. The reason for limiting the sample to the experimental portion of the sample on the environmental variable is that the most distinct and intentional manipulation of classroom environment has occurred in this part of the sample.
Definition of Groups Using Two Independent Variables at a Time

To detect interaction effects such as possible consistent effects of the combination of high creative ability with a high permissive environment \( (C^H_P^H) \) on question asking, four distinct groups will be segregated using the medians of creativity and classroom environment, as shown in Diagram 4-1.

![Diagram 4-1: A schematic diagram illustrating the method of partitioning groups defined in terms of two independent variables; creativity and classroom environment.](image)

In a similar way, groups will be formed for study of possible interaction effects of classroom environment with intelligence on question asking.

Proposed Methods of Data Analysis in the Field Study

In the analysis of data derived from the field study part of this project, analysis of variance and the F-test will be used. One of the criteria for the use of analysis of variance is that the data show a
normal or near normal distribution. The factual and yes-no question asking scores have been shown in an exploratory study, referred to earlier to have a normal or near normal distribution. Furthermore, in samples greater than 15 a certain lack of normality can be tolerated by analysis of variance procedures.

In situations where the F-test detects significant differences among four groups, as in the interaction groups, the t-test calculated in terms of the least significant difference will be used to detect between which of the four groups significant differences exist.

The field study analysis described above will be done for pretest and posttest data in regard to the hypotheses of aptitudes of intelligence and creativity in relation to question asking. However, in the analysis of question asking as it relates to groups determined by the classroom environment variable and as it relates to groups determined by interaction of environment and aptitude variables, only the changes in question asking from pretest to posttest will be analyzed.

As indicated in Chapter I, should question gain data show non-normality that is strong enough to cause significant differences in group means of question gains to be obscured in analysis of variance, Chi-square analysis of divergence of group question gains from expected group question gains will be calculated with the significance level set at 1%.

The Field Experiment

The field experiment of this project sets out to test hypotheses relating science classroom environments and creativity. In a true experiment the investigator has the power to assign subjects to experimental
groups or to assign experimental treatments to groups at random. 8

From the earlier description of the sample, it is evident that several practical constraints will make it necessary to limit randomization of the three experimental treatments to the three Oliver grade seven classes. One of these constraints has to do with the need to control for the possibility of increased sensitization due to pretest, 9 the presence from time to time of a graduate student, and the likely discussion among students of differences in the content of their science classes. With all three experimental groups in one place receiving a course in *Batteries and Bulbs*, experimental sensitization may be kept to a minimum.

A further consideration which led to locating all the experimental groups in Oliver had to do with the practicality of determining with one teacher the ways in which classroom environments would be implemented. Ultimately, however, limiting the experimental groups to the Oliver classes has had to do with need to control reactive measures as Campbell calls the sensitization due to the awareness of being part of an experiment. 10

Proposed Methods of Data Analysis from the Field Experiment

Since it is practically impossible to establish group equivalence among the four groups on the basis of creativity pretests and other relevant variables, analysis of covariance comes to the investigator's assistance. Through the analysis of covariance it is possible to control group differences statistically by removing from the dependent variable sum of squares that part due to the relation between the independent variable and dependent variable. 11
In order to detect such significant correlates of creativity (the dependent variable), a backward step-wise regression analysis will be conducted. The variables with which the regression analysis will start will be IQ, age, sex, pretest creativity factor scores, and pretest question asking scores. Such regression analysis together with the related analysis of covariance will be conducted for the group means of the post Uses Tests and post Question Tests of creativity.

The computation of statistical analyses will for the most part be conducted at the University of British Columbia Computing Centre.
Endnotes - Chapter IV


3 Jacob W. Getzels and Phillip W. Jackson, Creativity and Intelligence: Explorations with Gifted Students (London: John Wiley and Sons, 1963), p. 20.

4 Michael A. Wallach and Nathan Kogan, op. cit., p. 55.


8 Fred N. Kerlinger, op. cit., p. 291.

9 Ibid., p. 294.


CHAPTER V

REPORT OF FINDINGS

Validity of Creativity Tests

Reference has already been made in Chapter III to the low, but significant validity coefficient of .23 for the Question Test using teacher ratings of creative ability as the criterion measure. This result was obtained on the sample on which scoring procedures of the Question Test were developed. In the validation of the Question Test on a second sample using the Uses Test as an independent measure of creativity, correlations of .68 and .54 were obtained for pretests and posttests respectively. These substantial convergent validities are strong indicators that the Question Test measures the divergent production Guilford has operationally defined in his Structure of the Intellect Model and measured with the Uses Test among others (see Table 5-1).

<table>
<thead>
<tr>
<th>Test to be validated</th>
<th>Criterion measure</th>
<th>Uses Test</th>
<th>Total score</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Fluency</td>
<td>Flexibility</td>
<td>Originality</td>
</tr>
<tr>
<td>Question Test</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fluency</td>
<td>.52</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Flexibility</td>
<td></td>
<td>.46</td>
<td></td>
</tr>
<tr>
<td>Originality</td>
<td></td>
<td></td>
<td>.51</td>
</tr>
<tr>
<td>Total score</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Although the Question Test appears to exhibit satisfactory convergent validity, it is evident from Table 5-2 that the Question Test also appears to be measuring some of the cognitive factors usually measured by intelligence tests. The low, but significant discriminant validity coefficients of the Question Test creativity score and factor scores (except originality) do not allow the assumption that the Question Test measures only divergent production.

<table>
<thead>
<tr>
<th>Test to be validated</th>
<th>Criterion measure</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Question Test</td>
<td>Intelligence test scores</td>
<td>(N = 122)</td>
</tr>
<tr>
<td>Fluency</td>
<td>.19</td>
<td>&lt; .05</td>
</tr>
<tr>
<td>Flexibility</td>
<td>.32</td>
<td>&lt; .01</td>
</tr>
<tr>
<td>Elaboration</td>
<td>.18</td>
<td>&lt; .05</td>
</tr>
<tr>
<td>Originality</td>
<td>.16</td>
<td>ns</td>
</tr>
<tr>
<td>Total creativity score</td>
<td>.21</td>
<td>&lt; .05</td>
</tr>
</tbody>
</table>

This failure to detect only creative or divergent production will be taken into account when interpreting the part of the field experiment which involves the Question Test data.

Turning now to the validities of the Uses Test, it appears from Table 5-3 that the use of a longer time per subtest gives the Uses Test the capacity to measure creativity as defined in Guilford's *Structure of the Intellect* and also gives it the capacity to distinguish the cognitive factors of divergent production from those cognitive factors measured by intelligence tests.
Table 5-3: Convergent and Discriminant Validities of the Uses Test and Other Creativity Tests Using Three Different Times for the Tests

<table>
<thead>
<tr>
<th></th>
<th>Getzels and Jackson 3 min. subtest</th>
<th>Wallach and Kogan no time constraint</th>
<th>Present study test 5 min. subtest</th>
</tr>
</thead>
<tbody>
<tr>
<td>Convergent Validity</td>
<td>r = .26, p = .01</td>
<td>r = .41, p = .01</td>
<td>r = .61, p = .01</td>
</tr>
<tr>
<td></td>
<td>mean of 4 creativity tests vs. Uses Test</td>
<td>mean of 45 r's including the Uses Test</td>
<td>mean of 2 r's of Uses Test vs. Question Test</td>
</tr>
<tr>
<td>Discriminant Validity</td>
<td>r = .17, p = .01</td>
<td>r = .09, ns</td>
<td>r = .08, ns</td>
</tr>
<tr>
<td></td>
<td>Uses vs. IQ</td>
<td>100 r's of creativity scores vs. IQ</td>
<td>Uses vs. IQ</td>
</tr>
</tbody>
</table>

From a review of the validation data presented above, it is possible to reject the null hypothesis dealing with the validation of the Question Test. However, it is only possible to accept that part of the corresponding alternate hypothesis dealing with convergent validity.

The Sample

Once all data had been collected the entire sample consisted of 122 students for whom complete sets of data were available. The breakdown by groups can be seen in Table 5-4.

Table 5-4: The Breakdown of the Sample by Groups

<table>
<thead>
<tr>
<th>Group</th>
<th>Number of students</th>
</tr>
</thead>
<tbody>
<tr>
<td>Permissive</td>
<td>34</td>
</tr>
<tr>
<td>Semipermissive</td>
<td>31</td>
</tr>
<tr>
<td>Authoritarian</td>
<td>33</td>
</tr>
<tr>
<td>Control</td>
<td>24</td>
</tr>
<tr>
<td>Total</td>
<td>122</td>
</tr>
</tbody>
</table>
The Classroom Environment Scale was administered on a day following posttesting. On that day the experimental groups had the following numbers: permissive 32, semipermisive 29, and authoritarian 31. Although most of the statistical analyses were done at the University of British Columbia Computing Centre, a few analyses such as the analysis of classroom environment data of the experimental groups were done by hand. For ease of analysis each experimental group was made equivalent in number to the semipermisive group by randomly deleting three students from the permissive group and two from the authoritarian group. This would permit analysis of variance with samples of equal size.

Analysis of Classroom Environment Data

In the determination of classroom environment data, the Classroom Environment Scale used with the experimental groups was written in terms of Batteries and Bulbs experiences. To minimize sensitizing the control group, the classroom environment of the control group was assessed by two classroom teachers using a parallel form of the student version of the Classroom Environment Scale but prepared for general application.

The form of the Classroom Environment Scale used on the control group had eleven items. However, the teachers were asked to select only one choice per item. Using the method of weighting applied on the Classroom Environment Scale for students (one point for an authoritarian choice, two points for a semipermisive choice, and three points for a permissive choice), a completely authoritarian set of choices would yield a score of 11, a totally semipermisive set of choices would give a score of 22, and a totally permissive score would be 33. With this procedure
one classroom teacher scored the control group at 13 and the other teacher scored the group at 16, indicating a classroom environment between authoritarian and semipermisive.

In the student version of the Classroom Environment Scale used to assess the classroom environment in the experimental groups, students were not restricted to one choice per item as were the teachers assessing the control group. The weighting of choices was done as for the control.

The analysis of the classroom environment data shown in Table 5-5 indicates that the experimental group means obtained on the Classroom Environment Scale are significantly different from each other at well below the 1% level, thus allowing the rejection of the null hypothesis concerning Classroom Environment Scale group means. Furthermore, it is possible to accept the alternate hypothesis regarding significant differences in experimental group means on the Classroom Environment Scale.

Table 5-5: Analysis of Variance of Classroom Environment Means of the Three Experimental Groups

<table>
<thead>
<tr>
<th>Source</th>
<th>df</th>
<th>SS</th>
<th>MS</th>
<th>F</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between</td>
<td>2</td>
<td>9062</td>
<td>4531</td>
<td>320.9</td>
<td>&lt;.005</td>
</tr>
<tr>
<td>Within</td>
<td>84</td>
<td>1186</td>
<td>14.12</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

MEANS:

<table>
<thead>
<tr>
<th>Group</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Permissive</td>
<td>38.7</td>
<td>2.66</td>
</tr>
<tr>
<td>Semipermissive</td>
<td>29.7</td>
<td>4.21</td>
</tr>
<tr>
<td>Authoritarian</td>
<td>24.1</td>
<td>3.92</td>
</tr>
<tr>
<td>Least significant difference (1% level)</td>
<td>2.63</td>
<td></td>
</tr>
</tbody>
</table>
The Backward Stepwise Regression Analysis

For reasons indicated in Chapter IV, it has been impossible to match each of the four groups involved in this study on all characteristics relevant to their creativity at the outset of the experiment. Therefore, the analysis of the group post means of creativity derived for the four groups from scores on the Question Test and Uses Test has been done by analysis of covariance. The significant covariates for the group post means of creativity have been determined by a backward stepwise regression analysis using age, IQ, pretest creativity factor scores, pretest creativity scores, and question scores as possible independent variables and the post creativity scores as the dependent variable.

Covariates for Analysis of Post Question Test Group Means

The regression analysis of the post creativity scores obtained from the post Question Test used age, IQ, pretest creativity factor scores, and Uses pretest creativity scores as possible independent variables. From Table 5-6 it is apparent that the pretest creativity factors of elaboration and originality and the pretest factual question score turned out to

<table>
<thead>
<tr>
<th>Pretest variable</th>
<th>Coefficient</th>
<th>Standard error</th>
<th>F-ratio</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Elaboration</td>
<td>1.3905</td>
<td>0.3880</td>
<td>12.84</td>
<td>.0006</td>
</tr>
<tr>
<td>Originality</td>
<td>1.1210</td>
<td>0.3512</td>
<td>10.19</td>
<td>.002</td>
</tr>
<tr>
<td>Factual questions</td>
<td>0.7525</td>
<td>0.2831</td>
<td>7.07</td>
<td>.009</td>
</tr>
</tbody>
</table>

$R^2 = .51$
be significant covariates and explain about 51% of the variation in the post Question Test scores.

**Covariates for Analysis of Post Uses Test Group Means**

A second step down regression analysis was conducted. This time the post Uses Test creativity scores served as the dependent variable with age, IQ, pretest creativity factor scores of both the Question Test and Uses Test as well as pretest question scores serving as possible independent variables. The resulting significant covariates of the post Uses Test creativity scores are the pretest factual and yes-no question scores and the originality score of the Uses pretest. These three covariates account for 36% of the variance in the post Uses Test creativity scores. (see Table 5-7).

| Table 5-7: The Significant Covariates of the Backward Stepwise Regression Analysis for Posttest Creativity Scores of the Uses Test |
|---|---|---|---|---|
| Pretest variable | Coefficient | Standard error | F-ratio | p |
| Originality (Uses) | 1.2610 | 0.2681 | 22.12 | .0000 |
| Factual questions | 0.4835 | 0.1649 | 8.60 | .0041 |
| Yes-no questions | 0.6129 | 0.1853 | 10.94 | .0014 |
| $R^2 = .36$ |

**Analysis of Covariance of Post Group Creativity Means**

Having determined the significant covariates for each of the two sets of post creativity scores, the next step was the analysis of covariance to determine any significant differences among the posttest
creativity means of the four groups involved in this study. From an examination of Tables 5-8 and 5-9 it becomes clear that there are significant differences among the means of creativity scores of the four groups. However, it is apparent from a cursory look at the adjusted means for both tests that the means for permissive and authoritarian groups do not show similar trends.

**Table 5-8: Analysis of Covariance of the Four Group Means of Post Creativity Scores for the Question Test (p < .05, F = 3.92, p < .01, F = 6.84)**

<table>
<thead>
<tr>
<th>Source</th>
<th>df</th>
<th>SS</th>
<th>MS</th>
<th>F</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group</td>
<td>3</td>
<td>885.8</td>
<td>295.3</td>
<td>7.33</td>
<td>&lt; .01</td>
</tr>
<tr>
<td>Error</td>
<td>115</td>
<td>4633.7</td>
<td>40.3</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**ADJUSTED MEANS (based on standard scores).**

<table>
<thead>
<tr>
<th>Group:</th>
<th>Permissive</th>
<th>Semipermissive</th>
<th>Authoritarian</th>
<th>Control</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>-2.27</td>
<td>0.68</td>
<td>3.99</td>
<td>-2.68</td>
</tr>
</tbody>
</table>

**Table 5-9: Analysis of Covariance of the Four Group Means of Post Creativity Scores from the Uses Test**

<table>
<thead>
<tr>
<th>Source</th>
<th>df</th>
<th>SS</th>
<th>MS</th>
<th>F</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group</td>
<td>3</td>
<td>289.2</td>
<td>94.6</td>
<td>5.45</td>
<td>&lt; .05</td>
</tr>
<tr>
<td>Error</td>
<td>115</td>
<td>2033.1</td>
<td>17.7</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**ADJUSTED MEANS**

<table>
<thead>
<tr>
<th>Group:</th>
<th>Permissive</th>
<th>Semipermissive</th>
<th>Authoritarian</th>
<th>Control</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2.52</td>
<td>-0.55</td>
<td>-0.52</td>
<td>-2.02</td>
</tr>
</tbody>
</table>
These significant differences among the group means of both tests now demand a further analysis of covariance between each pair of group means, using the covariates employed in the analysis of covariance among the means. This analysis of covariance between pairs of group means allows one to make a judgement regarding the alternate hypotheses concerning classroom environment and creativity set down at the outset of this study (see Table 5-10).

Table 5-10: Analysis of Covariance Between All Possible Pairs of the Four Group Means of Creativity Obtained from the Post Question Test

<table>
<thead>
<tr>
<th>Group pair</th>
<th>Source</th>
<th>df</th>
<th>SS</th>
<th>MS</th>
<th>F</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Permissive vs.</td>
<td>Group</td>
<td>1</td>
<td>118.4</td>
<td>118.4</td>
<td>2.18</td>
<td>ns</td>
</tr>
<tr>
<td>Semipermissive</td>
<td>Error</td>
<td>58</td>
<td>3145.1</td>
<td>54.2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Permissive vs.</td>
<td>Group</td>
<td>1</td>
<td>585.5</td>
<td>585.5</td>
<td>17.13</td>
<td>&lt;.01</td>
</tr>
<tr>
<td>Authoritarian</td>
<td>Error</td>
<td>62</td>
<td>2119.4</td>
<td>34.2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Permissive vs.</td>
<td>Group</td>
<td>1</td>
<td>16.1</td>
<td>16.1</td>
<td>0.44</td>
<td>ns</td>
</tr>
<tr>
<td>Control</td>
<td>Error</td>
<td>55</td>
<td>2004.9</td>
<td>36.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Semipermissive vs.</td>
<td>Group</td>
<td>1</td>
<td>123.9</td>
<td>123.9</td>
<td>2.76</td>
<td>ns</td>
</tr>
<tr>
<td>Authoritarian</td>
<td>Error</td>
<td>57</td>
<td>2554.8</td>
<td>44.8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Semipermissive vs.</td>
<td>Group</td>
<td>1</td>
<td>187.0</td>
<td>187.0</td>
<td>3.90</td>
<td>ns</td>
</tr>
<tr>
<td>Control</td>
<td>Error</td>
<td>50</td>
<td>2395.7</td>
<td>47.9</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Authoritarian vs.</td>
<td>Group</td>
<td>1</td>
<td>573.0</td>
<td>573.0</td>
<td>21.43</td>
<td>&lt;.01</td>
</tr>
<tr>
<td>Control</td>
<td>Error</td>
<td>54</td>
<td>1443.8</td>
<td>27.7</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
The analysis of covariance between pairs of group means of post Question Test creativity scores brings out, as can be seen from Table 5-10, that the authoritarian group mean of creativity is significantly greater than both the permissive and control group means of creativity.

It appears that for the Question Test the null hypothesis suggesting no difference among creativity means can be rejected, but the alternate hypothesis that classes showing significantly higher class means on the Classroom Environment Scale would show significantly higher class means of creativity could not be accepted. In fact, the magnitudes of group means of creativity from the Question Test suggest the reverse of the order of relationship with classroom environment from that proposed in the alternate hypothesis. However, once all the findings of the study are reported a clarification of this unexpected reversal may be possible.

A similar analysis of covariance of pairs of group means of post Uses Test creativity scores reveals (Table 5-11) that the permissive group mean of creativity is significantly greater than the semipermissive and control group means of creativity. As well, the authoritarian group mean of creativity is significantly greater than the control group mean of creativity.

As there are significant differences among the group means of the post Uses Test, the null hypotheses relating classroom environment means and post group means of creativity can be rejected. Furthermore, from the order of the significant differences in the analysis of all possible pairs of post Uses means shown in Table 5-11, it is possible to accept the alternate hypothesis for the permissive group except in relation to the authoritarian group as there is lack of a significant difference.
Table 5-11: Analysis of Covariance Between All Possible Pairs of the Four Group Means of Creativity Obtained from the Post Uses Test

<table>
<thead>
<tr>
<th>Group pair</th>
<th>Source</th>
<th>df</th>
<th>SS</th>
<th>MS</th>
<th>F</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Permissive vs.</td>
<td>Group</td>
<td>1</td>
<td>162.5</td>
<td>162.5</td>
<td>6.77</td>
<td>&lt; .05</td>
</tr>
<tr>
<td>Semipermissive</td>
<td>Error</td>
<td>58</td>
<td>1391.2</td>
<td>24.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Permissive vs.</td>
<td>Group</td>
<td>1</td>
<td>83.2</td>
<td>83.2</td>
<td>3.51</td>
<td>ns</td>
</tr>
<tr>
<td>Authoritarian</td>
<td>Error</td>
<td>62</td>
<td>1469.3</td>
<td>23.7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Permissive vs.</td>
<td>Group</td>
<td>1</td>
<td>261.2</td>
<td>261.2</td>
<td>11.36</td>
<td>&lt; .01</td>
</tr>
<tr>
<td>Control</td>
<td>Error</td>
<td>55</td>
<td>1264.4</td>
<td>23.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Semipermissive</td>
<td>Group</td>
<td>1</td>
<td>0.2</td>
<td>0.2</td>
<td>0.01</td>
<td>ns</td>
</tr>
<tr>
<td>Authoritarian</td>
<td>Error</td>
<td>57</td>
<td>708.5</td>
<td>12.4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Semipermissive</td>
<td>Group</td>
<td>1</td>
<td>32.0</td>
<td>32.0</td>
<td>3.02</td>
<td>ns</td>
</tr>
<tr>
<td>Control</td>
<td>Error</td>
<td>50</td>
<td>2529.6</td>
<td>10.6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Authoritarian</td>
<td>Group</td>
<td>1</td>
<td>73.6</td>
<td>73.6</td>
<td>8.79</td>
<td>&lt; .01</td>
</tr>
<tr>
<td>Control</td>
<td>Error</td>
<td>54</td>
<td>451.9</td>
<td>8.4</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

between means of the permissive group and authoritarian group. In both analyses, namely, for the Question Test and the Uses Test, the authoritarian treatment shows an unexpected flourish in creativity. In addition and also contrary to hypothesized expectation, the semipermissive group shows means on both posttests that are statistically no different from the control group.
Analysis of Field Study Data

The reason for including hypotheses concerning question asking in an experimental study of classroom environment and creativity is that the frequency of asking factual, yes-no and explanation questions has been shown by Dahl, in an unpublished exploratory field study, to be significantly and specifically related to the aptitudes of intelligence and creativity. The assumption is that if one can confirm the relationships of the three question scores to aptitudes of intelligence and creativity shown to exist in the exploratory study cited above, then significant differences in question scores between groups exposed to permissive and authoritarian treatments could serve as supportive or clarifying evidence for the findings in the field experiment reported above.

Analysis of Question Score Means of High and Low Aptitude Groups

For the analysis of the question score means the sample was formed into groups high and low in intelligence scores and into groups high and low in creativity scores using medians of intelligence and creativity scores as cutoffs for forming the groups. The question score means of these high and low aptitude groups were then subjected to analysis of variance. These analyses were done for pretest and posttest data for the sake of establishing consistent patterns.

Preliminary to these analyses, it is instructive to examine the question score means of high and low creativity groups and high and low intelligence groups shown in Table 5-12. All the means show consistent trends in terms of pre- and posttest data. As well, all means except
Table 5-12: Question Score Means of High and Low Creativity Groups and High and Low IQ Groups. Subjects in a High Group Are Above the Median of IQ or Creativity; Subjects in a Low Group Are Below the Median of IQ or Creativity. Means Are Based on Standard Scores.

<table>
<thead>
<tr>
<th></th>
<th>Pretest</th>
<th>Posttest</th>
<th>Pretest</th>
<th>Posttest</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Low</td>
<td>High</td>
<td>Low</td>
<td>High</td>
</tr>
<tr>
<td>Factual questions</td>
<td>0.42</td>
<td>-0.46</td>
<td>0.39</td>
<td>-0.43</td>
</tr>
<tr>
<td>Yes - no questions</td>
<td>-0.60</td>
<td>0.66</td>
<td>-0.28</td>
<td>0.31</td>
</tr>
<tr>
<td>Explanation questions</td>
<td>-0.67</td>
<td>0.74</td>
<td>-0.44</td>
<td>0.48</td>
</tr>
</tbody>
</table>

Factual question means of the high and low intelligence groups are consistently higher in the high aptitude group. However, in factual question means of groups high and low in intelligence an interesting consistent reversal of the above pattern is evident.

The subsequent analysis of variance of the factual question means of the high and low aptitude groups indicates, as evident from Table 5-13, a strong, direct and consistently significant relationship between factual question means and high and low creativity. However, the inverse relationship of factual question means with high and low intelligence groups comes consistently close, but does not reach significance levels. Thus the null hypothesis concerning factual question means of the high and low creativity groups can be rejected and the alternate hypothesis, which proposes that groups high in creativity will have significantly higher
Table 5-13: Analysis of Variance of Factual Question Means. Medians for Groups High and Low in Creativity and High and Low in IQ are from Pretest and Posttest Data

<table>
<thead>
<tr>
<th>Cognitive ability</th>
<th>Source</th>
<th>df</th>
<th>SS</th>
<th>MS</th>
<th>F</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>PRETEST</td>
<td>IQ Group</td>
<td>1</td>
<td>23.60</td>
<td>23.60</td>
<td>3.77</td>
<td>0.052 (ns)</td>
</tr>
<tr>
<td></td>
<td>Error</td>
<td>120</td>
<td>751.38</td>
<td>6.26</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Creativity</td>
<td>1</td>
<td>29.88</td>
<td>29.88</td>
<td>4.81</td>
<td>0.029</td>
</tr>
<tr>
<td></td>
<td>Error</td>
<td>120</td>
<td>745.10</td>
<td>6.21</td>
<td></td>
<td></td>
</tr>
<tr>
<td>POSTTEST</td>
<td>IQ Group</td>
<td>1</td>
<td>20.48</td>
<td>20.48</td>
<td>3.06</td>
<td>0.079 (ns)</td>
</tr>
<tr>
<td></td>
<td>Error</td>
<td>120</td>
<td>804.16</td>
<td>6.70</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Creativity</td>
<td>1</td>
<td>86.92</td>
<td>86.92</td>
<td>14.14</td>
<td>0.000</td>
</tr>
<tr>
<td></td>
<td>Error</td>
<td>120</td>
<td>717.23</td>
<td>6.03</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

factual question means than groups low in creativity, can be accepted. A similar null hypothesis for factual question means and high and low intelligence groups can, of course, not be rejected.

From the analysis of variance of yes-no question means presented in Table 5-14, it is possible to reject the null hypothesis that there will be no significant difference in yes-no question means of groups high and low in creativity. Moreover, it is possible to accept the alternate hypothesis that the group high in creativity will, on the average, ask more yes-no questions than the group low in creativity. However, a similar null hypothesis for the yes-no question means of high and low intelligence groups cannot be rejected.

In the analysis of variance of explanation question means the pattern for asking explanation questions is the reverse of that set for factual and yes-no questions. On examining Table 5-15 one finds that the
Table 5-14: Analysis of Variance of Yes-No Question Means from Pretest and Posttest Data. Means Are of Groups High and Low in Creativity and High and Low in IQ

<table>
<thead>
<tr>
<th>Cognitive ability</th>
<th>Source</th>
<th>df</th>
<th>SS</th>
<th>MS</th>
<th>F</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>PRETEST</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IQ</td>
<td>Group</td>
<td>1</td>
<td>48.03</td>
<td>48.03</td>
<td>9.15</td>
<td>0.003</td>
</tr>
<tr>
<td></td>
<td>Error</td>
<td>120</td>
<td>629.83</td>
<td>5.23</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Creativity</td>
<td>Group</td>
<td>1</td>
<td>41.33</td>
<td>41.33</td>
<td>7.79</td>
<td>0.006</td>
</tr>
<tr>
<td></td>
<td>Error</td>
<td>120</td>
<td>636.53</td>
<td>5.30</td>
<td></td>
<td></td>
</tr>
<tr>
<td>POSTTEST</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IQ</td>
<td>Group</td>
<td>1</td>
<td>10.75</td>
<td>10.75</td>
<td>1.77</td>
<td>0.183(ns)</td>
</tr>
<tr>
<td></td>
<td>Error</td>
<td>120</td>
<td>729.07</td>
<td>6.08</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Creativity</td>
<td>Group</td>
<td>1</td>
<td>94.44</td>
<td>94.44</td>
<td>17.56</td>
<td>0.000</td>
</tr>
<tr>
<td></td>
<td>Error</td>
<td>120</td>
<td>645.39</td>
<td>5.38</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 5-15: Analysis of Variance of Explanation Question Means from Pretest and Posttest Data. Means Are of Groups High and Low in Creativity and High and Low in IQ

<table>
<thead>
<tr>
<th>Cognitive ability</th>
<th>Source</th>
<th>df</th>
<th>SS</th>
<th>MS</th>
<th>F</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>PRETEST</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IQ</td>
<td>Group</td>
<td>1</td>
<td>60.51</td>
<td>60.51</td>
<td>10.51</td>
<td>0.002</td>
</tr>
<tr>
<td></td>
<td>Error</td>
<td>120</td>
<td>690.94</td>
<td>5.76</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Creativity</td>
<td>Group</td>
<td>1</td>
<td>18.19</td>
<td>18.19</td>
<td>2.98</td>
<td>0.083(ns)</td>
</tr>
<tr>
<td></td>
<td>Error</td>
<td>120</td>
<td>733.27</td>
<td>6.11</td>
<td></td>
<td></td>
</tr>
<tr>
<td>POSTTEST</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IQ</td>
<td>Group</td>
<td>1</td>
<td>25.94</td>
<td>5.94</td>
<td>4.29</td>
<td>0.038</td>
</tr>
<tr>
<td></td>
<td>Error</td>
<td>120</td>
<td>726.01</td>
<td>6.05</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Creativity</td>
<td>Group</td>
<td>1</td>
<td>4.32</td>
<td>4.32</td>
<td>0.69</td>
<td>0.412(ns)</td>
</tr>
<tr>
<td></td>
<td>Error</td>
<td>120</td>
<td>747.63</td>
<td>6.23</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

High IQ group consistently and significantly asked, on the average, more explanation questions than the low IQ group. However, the explanation question means of high and low creativity groups show no significant
difference.

From the consistently significant trends of explanation question means it is possible to reject the null hypothesis relating explanation question means with groups high and low in intelligence and to accept the alternate hypothesis that the groups high in intelligence will, on the average, ask significantly more explanation questions than the group low in intelligence. A similar null hypothesis relating explanation question means and groups high and low in creativity could not be rejected.

In summary, the results of the above analyses indicate that in the sample of this study the high creativity groups, on the average, consistently and significantly asked more factual questions and yes-no questions than the low creativity groups. In addition, the analyses show that the high intelligence group consistently and significantly asked more explanation questions, on the average, than the low intelligence group. There is also a consistent though not quite significant trend for the low intelligence group to ask, on the average, more factual questions than the high intelligence group.

Analysis of Question Scores in Terms of Classroom Environment

Having analyzed the patterns of question asking in terms of creativity and intelligence, this study proposes in its hypotheses, the assessment of the three question scores in terms of permissive and authoritarian environments. It is assumed that significant differences in the mean frequency of asking a given question type by groups under different classroom environments may shed some additional light on which aptitudes, intelligence or creativity, are being affected by the given
classroom environment.

In the experimental groups there were 88 students for whom complete sets of data, including classroom environment data, were available. The median on the Classroom Environment Scale for this sample (31.5) served as the cutoff score for the formation of a group high in permissive character and a group low in permissive character. The groups will be designated $P_H$ (high permissive) and $P_L$ (low permissive) to avoid confusion with groups designated permissive and authoritarian in the field experiment reported above.

The means of question score gains from pretest to posttest for $P_H$ and $P_L$ groups are given in Table 5-16. For all three question scores the $P_L$ group appears to show the greatest gains.

<table>
<thead>
<tr>
<th></th>
<th>$P_H$ group (N = 44)</th>
<th>$P_L$ group (N = 44)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total gain</td>
<td>Mean gain</td>
</tr>
<tr>
<td>Factual question</td>
<td>208</td>
<td>4.73</td>
</tr>
<tr>
<td>Yes-no question</td>
<td>136</td>
<td>2.93</td>
</tr>
<tr>
<td>Explanation question</td>
<td>-3</td>
<td>-0.07</td>
</tr>
</tbody>
</table>

In Chapter IV, analysis of variance was proposed for testing hypotheses regarding the question gain means of the $P_H$ and $P_L$ groups. However, the large standard deviations of these means does not allow the assumption
of normality or near normality of the data from which these means are derived. While analysis of variance will be used, as proposed, the masking of possible significant differences due to non-normal distribution is probable. Thus, if the large differences in the mean gains of question scores from pretest to posttests for \( P_H \) and \( P_L \) groups are statistically insignificant, the non-parametric Chi-square test will be used to test whether the total gains in question scores for \( P_H \) and \( P_L \) groups diverge significantly at the 1% level from gains expected if mean gains were equivalent for both groups.

| Table 5-17: Analyses of Variance for Question Gain Means of \( P_H \) and \( P_L \) Groups |
|---|---|---|---|---|
| Source | df | SS | MS | F | p |
| Factual questions | Between groups | 1 | 128 | 128 | 1.8 | ns |
| | Within groups | 86 | 6032 | 70.1 | | |
| Yes-no questions | Between groups | 1 | 23 | 23 | 0.41 | ns |
| | Within groups | 86 | 4816 | 56 | | |
| Explanation questions | Between groups | 1 | 69 | 69 | 2.68 | ns |
| | Within groups | 86 | 2214 | 25.7 | | |

The analysis of variance of question gain means displayed in Table 5-17 indicates no significant differences between the question gain means of \( P_H \) and \( P_L \) groups even though the actual differences between the \( P_H \) and \( P_L \) means appear to be considerable. On the basis of analysis of variance the null hypothesis relating the question gain means of \( P_H \) and \( P_L \) groups could not be rejected.

However, a Chi-square analysis of total question gains for \( P_H \) and \( P_L \) groups indicates, as shown in Table 5-18, that the \( P_L \) group displayed
Table 5-18: Chi-square Analysis of Total Question Gains of $P_H$ and $P_L$ Groups (Significance Level set at 1%)

<table>
<thead>
<tr>
<th>Total question gains</th>
<th>$P_H$</th>
<th>$P_L$</th>
<th>$\chi^2$</th>
<th>df</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Factual questions</td>
<td>f 208</td>
<td>F 261</td>
<td></td>
<td>1</td>
<td>&lt;.005</td>
</tr>
<tr>
<td></td>
<td>f 314</td>
<td>F 261</td>
<td>21.52</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Yes-no questions</td>
<td>f 136</td>
<td>F 158.5</td>
<td>6.40</td>
<td>1</td>
<td>ns</td>
</tr>
<tr>
<td></td>
<td>f 181</td>
<td>F 158.5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Explanation questions</td>
<td>f -3</td>
<td>F 36</td>
<td>84.50</td>
<td>1</td>
<td>&lt;.005</td>
</tr>
<tr>
<td></td>
<td>f 75</td>
<td>F 36</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

a significantly greater total gain in factual and explanation question scores than the $P_H$ group. These groups, however, showed no significant differences on the Chi-square analysis of total yes-no question gains.

Thus when the null hypothesis relating to question score gains is tested in terms of divergence of total gains for $P_H$ and $P_L$ groups from expected total gains for $P_H$ and $P_L$ groups, it is possible to reject at the 1% significance level the null hypothesis for total factual and explanation question gains for $P_H$ and $P_L$ groups but not for yes-no question gains. Furthermore, the alternate hypothesis for total explanation question gains which proposes significantly greater gains for the $P_L$ group can be accepted. The alternate hypothesis for total factual question gains which proposed that the $P_H$ group would make significantly greater gains in total factual question gains could not be accepted.

The final set of hypotheses listed in Chapter I were concerned with the interaction effects of classroom environment and aptitudes (creativity and intelligence) on question asking gains. In Chapter IV it was
indicated that these hypotheses would be tested by forming two sets of four environment-aptitude groups from the experimental sample, namely, four environment-creativity groups and four environment-intelligence groups. The four environment-aptitude groups of each set were defined in terms of the medians of classroom environment scores and aptitude scores. Thus, for example, the group above the medians of creativity and environment scores would be designated as \( C^P^H \). For each group \( N = 22 \).

Table 5-19 gives the question gain means for the four groups defined in terms of creativity and environment medians. The only groups that come close to showing any significant difference in means of question gains are the \( C^P_L \) and \( C^L_P \) groups in regard to explanation question gains.

<table>
<thead>
<tr>
<th>Question type</th>
<th>Mean gains for group</th>
<th>LSD (.05)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>( C^P_H )</td>
<td>( C^P_L )</td>
</tr>
<tr>
<td>Factual question</td>
<td>5.33</td>
<td>6.55</td>
</tr>
<tr>
<td>Yes-no question</td>
<td>3.09</td>
<td>4.27</td>
</tr>
<tr>
<td>Explanation question</td>
<td>0.05</td>
<td>2.95</td>
</tr>
</tbody>
</table>
As with the earlier analyses of question gain means the non-normality of question gains is a possible reason for lack of significance in some of the marked differences in group question gain means. In a subsequent analysis of the creativity-environment interaction effect on question gains using the Chi-square, the creativity-environment groups show highly significant divergence in factual and explanation question gains from gains expected. From Table 5-20 it would appear that the groups contributing the greatest amounts of divergence in the factual question gains are the low creativity groups with the $C_{LH}$ group well below and $C_{LP}$ group well above the expected factual question gains, indicating, perhaps, that variations in classroom environment have their most profound effect on low creatives in terms of asking factual questions.

Table 5-20: Chi-Square Analysis of Question Gains of Creativity-Environment Groups

<table>
<thead>
<tr>
<th>Question type</th>
<th>Observed frequency for group</th>
<th>$F$</th>
<th>df</th>
<th>$\chi^2$</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$C_{HP}$</td>
<td>$C_{HL}$</td>
<td>$C_{LP}$</td>
<td>$C_{LP}$</td>
<td></td>
</tr>
<tr>
<td>Factual question</td>
<td>108</td>
<td>144</td>
<td>100</td>
<td>170</td>
<td>130.5</td>
</tr>
<tr>
<td>Yes-no question</td>
<td>68</td>
<td>94</td>
<td>68</td>
<td>87</td>
<td>79.3</td>
</tr>
<tr>
<td>Explanation question</td>
<td>1</td>
<td>65</td>
<td>-4</td>
<td>10</td>
<td>18.0</td>
</tr>
</tbody>
</table>
Furthermore, in terms of explanation questions, the high permissive environment appears to have had a depressing effect on both high and low creatives in explanation question asking. However, the low permissive environment appears to have influenced only the high creatives into increases in explanation question asking.

In terms of the Chi-square analysis the null hypothesis concerning question gains of the four creativity-environment groups could be rejected for factual and explanation question gains but not for yes-no question gains.

Turning now to the analysis of question gains in terms of intelligence-environment interaction shown in Table 5-21, the only pair of group mean question gains that shows a significant difference is the mean gain in explanation questions of the $I^P_H$ and $I^P_L$ groups. It appears that the different intelligence levels are significantly affected by classroom environment in the asking of explanation questions.

Table 5-21: Question Gain Means for Four Groups Defined in Terms of Intelligence and Classroom Environment Medians. Also Included is the Least Significant Difference (LSD) at the 5% Level for Any Pair of these Means

<table>
<thead>
<tr>
<th>Question type</th>
<th>Mean gains for group</th>
<th>LSD (.05)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$I^P_H$</td>
<td>$I^P_L$</td>
</tr>
<tr>
<td>Factual question</td>
<td>5.33</td>
<td>6.55</td>
</tr>
<tr>
<td>Yes-no question</td>
<td>3.09</td>
<td>4.27</td>
</tr>
<tr>
<td>Explanation question</td>
<td>0.05</td>
<td>2.95</td>
</tr>
</tbody>
</table>
Subjecting the question gains of the four groups formed on the basis of intelligence and classroom environment score medians to Chi-square analysis, one finds, as evident from Table 5-22, that group gains in factual and explanation questions are significantly affected by interaction of intelligence and environment. In terms of factual questions, low intelligence groups contribute most to divergence from expected gains with the low intelligence group in the more permissive environment well below the expected gain and the low intelligence group in the less permissive environment well above the expected gain in factual questions.

Table 5-22: Chi-Square Analysis of Question Gains of Intelligence-Environment Groups

<table>
<thead>
<tr>
<th>Question type</th>
<th>Observed frequency for group</th>
<th>F</th>
<th>df</th>
<th>( \chi^2 )</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>( I_H^P )</td>
<td>( I_H^P )</td>
<td>( I_L^P )</td>
<td>( I_L^P )</td>
<td></td>
</tr>
<tr>
<td>Factual question</td>
<td>128</td>
<td>142</td>
<td>80</td>
<td>172</td>
<td>130.5</td>
</tr>
<tr>
<td>Yes-no question</td>
<td>57</td>
<td>95</td>
<td>79</td>
<td>86</td>
<td>79.3</td>
</tr>
<tr>
<td>Explanation question</td>
<td>-20</td>
<td>62</td>
<td>17</td>
<td>13</td>
<td>18.0</td>
</tr>
</tbody>
</table>

As to gains in explanation questions, it appears that changes in classroom environment have their effect primarily on the high intelligence groups with the more permissive environment depressing the asking of explanation questions and the less permissive environment encouraging the asking of explanation questions.

Thus, as with the Chi-square analyses of question gains of creativity-environment groups, the Chi-square analyses of the question gains of
the intelligence-environment groups indicate that the null hypotheses with regard to question gains could be rejected for factual and explanation question gains, but not for yes-no question gains. Furthermore, from the size and direction of the divergences in question gains, it appears that the intelligence-environment interaction is stronger than the creativity environment interaction.
CHAPTER VI

SUMMARY AND CONCLUSIONS

At the outset of this study it was noted that the current evaluation of the newly emerging, discovery based science programs gives no clear indication of their merit in terms of some definable goal. However, concurrent with the school science curriculum evolution from content oriented to process oriented, there has been an increase in the psychometric attention to the parameters of creativity measurement and an increased interest in making creativity development an educational goal.

It therefore seemed to make synergistic sense to evaluate one of these new science programs in terms of how it measurably affects student creativity. One such science program, the Elementary Science Study (ESS) has managed to organize its units around natural phenomena that have been shown to be of interest to children and have got children involved in exploring these phenomena. As ESS units noticeably alter science classroom environments, it was hypothesized that variations in science classroom environments would produce measurable differences in class means of creativity.

Thus, using the ESS unit, Batteries and Bulbs as the basic science instructional material, it was possible to establish three verifiably different science classroom environments, in three grade seven classes at Oliver, British Columbia. These three separate classroom environments, labelled permissive, semipermissive and authoritarian, varied with regard
to the amount of teacher direction and control and served as the experimental groups of this study. A fourth grade seven class in Midway, British Columbia, which was taught the standard British Columbia curriculum and had an assessed classroom environment between authoritarian and semipermissive, served as the control.

As a result of the experimental manipulation of science classroom environment described above, the semipermissive treatment in which classroom environment was to reflect the teaching suggestions in the teacher's guide of *Batteries and Bulbs* appeared on the two creativity tests used in this study, namely, the Uses Test and Question Test, to be statistically no different from the control group in post group means of creativity.

However, the permissive group which had significantly the least amount of teacher direction of all three experimental treatments, had a post Uses Test mean significantly greater than all groups except the authoritarian group. Although the permissive group post Uses creativity mean was larger than the authoritarian group post mean, it was not significantly different. On the Question Test the permissive and control groups post creativity means were not statistically different.

Furthermore, an unexpected and unhypothesized result was the authoritarian group's achievement of post Uses Test and post Question Test means of creativity that were significantly greater than the control group's post means of creativity. In fact, the authoritarian group's post Question Test mean of creativity was significantly greater than the permissive post Question Test mean of creativity.

Thus far, then, it would appear that permissive and authoritarian treatments contribute to significantly greater post mean scores of
creativity. However, in the assessment of creativity test validities, it was found that, while the Uses Test demonstrated both convergent and discriminant validity, the Question Test, while adequate in convergent validity, showed a low, but significant correlation with intelligence scores and thus lacked discriminant validity. On the basis of the more valid creativity test of this study, the Uses Test, the permissive and authoritarian groups achieved significantly greater post mean creativity scores than the control group.

In an attempt to further elucidate the effect classroom environment has on creativity, hypotheses relating student question asking styles to aptitudes such as creativity and intelligence were tested. It was found that the more creative students asked, on the average, significantly more factual and yes-no questions and that the more intelligent students asked, on the average, significantly more explanation questions.

In terms of the present study the question was then asked: "What differences in gains were there in the three kinds of questions asked by students in the more permissive environment compared with students in the less permissive environment?" It turned out that in this study, students in the less permissive environment showed a significantly greater gain in explanation and factual questions than students in the more permissive environment. However, no such significant differences in gains of yes-no questions could be shown between the more permissively and less permissively treated parts of the sample.

One possible implication of the fact that more intelligent students ask significantly more explanation questions and of the fact that gain in explanation questions is greater in students in
the less permissive environment is that perhaps the less permissive environment favours the growth of cognitive factors measured by intelligence tests.

However, because factual questions and yes-no questions (which are types of questions which more creative students asked significantly more of) did not both show significant gains in a particular environment, it is impossible to clearly draw the implication from question gains that a particular environment favours growth in creativity.

Finally, it has been instructive from this study to learn how the degree of classroom permissiveness affects question asking behaviour at various levels of creative ability and intellectual ability. In Chapter V of this study it was reported that factual question gains of the low creativity group and of the low intelligence group were most affected by the degree of permissiveness, with the low creative group and the low intelligence groups in more permissive environments showing greatest divergence below expected gains and the low creative and low intelligence groups in the less permissive environment showing the greatest divergence above the expected gains. For the high creative group as well as the high intelligence group, in the more permissive environment, there is a divergence in explanation question gains well below expected gains, whereas for the high creative group as well as the high intelligence group in the less permissive environment, there is a divergence in explanation question gains well above expected gains.

In a general overview of the aptitude-environment effects in this study, it appears from the size and direction of the divergences in
question gains that the intelligence-environment interaction has been stronger in affecting question gains than the creativity-environment interaction has been.

Thus far in this study the assumption has been that environmental factors, be they family or classroom, are primary to the development of creativity. However, Torrance has shown that there is a pattern in the development of creativity using fluency (number of questions asked in the Ask-and-Guess Test) as a measure of creativity. The curve from grade one through grade twelve has a decline in the fourth grade and the seventh grade as seen in Diagram 6-1. Of interest is the decline in the frequency of question asking from grade six to grade seven. It is, perhaps, because of this natural decline in the frequency of asking questions that all the group question gains in the more permissive environments showed divergences well below the expected question gains, whereas through teacher direction and motivation in the less permissive environment this natural developmental decline is countered.

Diagram 6-1: Creativity growth curve.
Furthermore, in research that centres on a single age group, as the present study has done, there arises the question of how generalizable the results are. Having noted how pivotal grade seven is with regard to the mean frequency of question asking, it can be argued that the research in this project is the study of a special case.

However, Merrifield, using Guilford's tests of divergent thinking, was able to show that Guilford tests such as the Uses Test do differentiate seventh grade children in ways similar to their results with adults. Merrifield's finding would suggest that the results with the Uses Test in relation to classroom environment and creativity are perhaps more generalizable than the conclusions throughout the study that are based on the Question Test.

Of course, such distinction of generalizability between data of the Uses Test and data of the Question Test stands so long as it is assumed that creative fluency based on the frequency of question asking follows a developmental curve that is different from fluency derived from the frequency of giving uses of a common object. In fact, the differing results with the Uses Test and the Question Test in the classroom environment-creativity experiment of this study would fit with an interpretation of differing developmental curves for the frequency of question asking and the frequency of other patterns of expression. Nevertheless, the existence of such differences in developmental curves has yet to be established.

Thus far, based on the work of Merrifield and of Torrance, it is possible to suggest that the results with Uses Test in relation to classroom environment and creativity are, perhaps, more generalizable to
populations of other ages than the balance of the results of this study derived from data from the Question Test.

Given that this is the case, namely, that the conclusions based on data of the Question Test be viewed more tentatively because of the unique developmental nature of question asking for grade seven students, the work done on question asking in this study is, nevertheless, a timely contribution to science education and cognitive research. It is research which in elucidating the relationships of question asking styles to aptitudes and classroom environment begins to shed light into areas that should be of interest to the science educator, and to the student of the cognitive domain.
Endnotes - Chapter VI


3P.R. Merrifield, "Aptitudes and Personality Measurement Related to Creativity in the Seventh Grade," Reports from the Psychological Laboratory, 28, January 1964, p. 4.
BIBLIOGRAPHY


Batteries and Bulbs, Books 1, 2 and 3. Watertown: Elementary Science Study of Educational Services, 1966.


Merrifield, P.R., Gardner, S.F. and Cox, A.B. "Aptitudes and Personality Measurement Related to Creativity in the Seventh Grade." Reports from the Psychological Laboratory, no. 28, January 1964.


APPENDIX A

The Question Test
THE QUESTION TEST

The purpose of this test is to find out how curious you are.

The test consists of three pictures. For each picture you will be given five minutes to write as many questions as you can. The questions must be about items in the picture. They must be questions that cannot be answered by looking at the picture.

Now, look at the sample picture below. Study the questions asked about items in the picture, and think of some of your own.

SAMPLE QUESTIONS:
1) What is the colour of the horse?
2) Why does the rider not have stirrups?
3) What does the rider have under his arm?
4) Are there more than five people chasing the rider?
5) What is the sex of the horse?
6) Is the horse wearing horseshoes?

Write three questions you have thought of?
1.
2.
3.

Are all of your questions, ones you could not answer by looking at the picture?

Now, turn the page, and wait to be started.
Write as many questions about items in the picture above. These questions must be ones that cannot be answered by simply looking at the picture.

Now, begin. (5 minutes)

1

2

3

4

5
Write as many questions about items in the picture above. These questions must be ones that cannot be answered by simply looking at the picture.

Now, begin. (5 minutes)

1

2

3

4

5

6

7

8

9

10
Write as many questions about items in the picture above. These questions must be ones that cannot be answered by simply looking at the picture.

Now, begin. (5 minutes)

1

2

3

4

5

6
Scoring Procedures for the Question Test

Fluency. In each subtest the count of all questions asked yields the fluency score. The total fluency score is the sum of all three subtest fluency scores.

Flexibility. As flexibility is a measure of the ability to shift from category to category, the method of scoring flexibility is to categorize questions according to the first two words of each question. Thus questions beginning with "What is...?" belong to one category and questions beginning with "What colour...?" would belong to another category. The subtest flexibility score is the number of categories per picture with the total flexibility score being the sum of subtest flexibility scores.

Elaboration. Since elaboration is defined as the number of details or ideas added to a single starting stimulus, the elaboration score is determined by counting only questions that refer to a given item in a picture a second, third, fourth, etc. time. The sum of all these counts for each picture yields a subtest elaboration score and the sum of subtest elaboration scores yields the total elaboration score.

Originality. As originality is defined here in terms of the number of uncommon questions asked, the questions asked about a picture by all examinees in the sample are tabulated. From this list all questions that appear more than once are written on a separate list. The examinee is then given one point for each question that does not appear on the list of common questions. The total originality score is the sum of all subtest scores.
Total creativity score. In order to calculate the total creativity score the four total factor scores are converted to standard scores and then summed.
APPENDIX B

The Uses Test

FORM A

Uses for Things

Given below is a common object. Your task is to write down as many different uses as you can for the object. Several examples are given, you will have approximately 5 minutes. Write down anything that comes to mind, no matter how strange it may seem. Do not begin until told to do so.

COMMON OBJECT: TIN CAN

Samples of uses: 1. pencil holder  2. drum.

Begin (Time 5 min)

1.  
2.  
3.  
4.  
5.  
6.  
7.  
8.  
9.  
10.  
11.  
12.  
13.  
14.  
15.  
16.  
17.  
18.  
19.  
20.  
21.  
22.  
23.  
24.  
25.  
26.  
27.  
28.  
29.  
30.  

Do NOT turn the page until told to do so.
FORM A

COMMON OBJECT: CORK

Samples of uses: 1. close bottles  2. fishing float

Begin (Time 5 min)

1. ____________________________  16. ____________________________
2. ____________________________  17. ____________________________
3. ____________________________  18. ____________________________
4. ____________________________  19. ____________________________
5. ____________________________  20. ____________________________
6. ____________________________  21. ____________________________
7. ____________________________  22. ____________________________
8. ____________________________  23. ____________________________
9. ____________________________  24. ____________________________
10. ____________________________  25. ____________________________
11. ____________________________  26. ____________________________
12. ____________________________  27. ____________________________
13. ____________________________  28. ____________________________
14. ____________________________  29. ____________________________
15. ____________________________  30. ____________________________
Uses for Things

Given below is a common object. Your task is to write down as many different uses as you can for the object. Several examples are given. You will have approximately 5 minutes. Write down anything that comes to mind, no matter how strange it may seem. Do not begin until told to do so.

COMMON OBJECT: SHOE
Sample of uses: 1. wear on your feet 2. play game of horseshoes
Begin (Time 5 min)

1. ____________________________ 16. ____________________________
2. ____________________________ 17. ____________________________
3. ____________________________ 18. ____________________________
4. ____________________________ 19. ____________________________
5. ____________________________ 20. ____________________________
6. ____________________________ 21. ____________________________
7. ____________________________ 22. ____________________________
8. ____________________________ 23. ____________________________
9. ____________________________ 24. ____________________________
10. ____________________________ 25. ____________________________
11. ____________________________ 26. ____________________________
12. ____________________________ 27. ____________________________
13. ____________________________ 28. ____________________________
14. ____________________________ 29. ____________________________
15. ____________________________ 30. ____________________________

Do NOT turn the page until told to do so.
FORM B

COMMON OBJECT: BUTTON
Sample of uses: 1. keep your shirt buttoned 2. a counter in a game
Begin (Time 5 min)

1. ________________________________ 16. ________________________________
2. ________________________________ 17. ________________________________
3. ________________________________ 18. ________________________________
4. ________________________________ 19. ________________________________
5. ________________________________ 20. ________________________________
6. ________________________________ 21. ________________________________
7. ________________________________ 22. ________________________________
8. ________________________________ 23. ________________________________
9. ________________________________ 24. ________________________________
10. ________________________________ 25. ________________________________
11. ________________________________ 26. ________________________________
12. ________________________________ 27. ________________________________
13. ________________________________ 28. ________________________________
14. ________________________________ 29. ________________________________
15. ________________________________ 30. ________________________________
Scoring Procedures for the Uses Test

Fluency. For each common object the score of fluency is the count of all uses listed. The total fluency score is the sum of the two subtest fluency scores.

Flexibility. Flexibility is assessed in terms of the number of categories of uses proposed for each common object. When only one scorer is available, use a thesaurus as a final arbiter for deciding whether a given use belongs to a category. When two or more scorers are available, attempt through discussion to reach a consensus as to what categories exist for each common object. Then have each scorer separately score a randomly chosen sample of tests and prepare an interscorer reliability correlation as a check of consensus on uses categories.

As with fluency, the total flexibility score is the sum of the two subtest flexibility scores.

Originality. Originality is scored in terms of the uncommonness of the uses for each common object. To do this, all uses given by the examinees of the sample for a common object are listed. From this list a second list is prepared consisting of uses given more than once in the sample. The examinee's subtest originality score is the count of all uses for the common object that do not appear on the common uses list. The total originality score is the sum of the two subtest originality scores.

Total creativity score. In order to calculate the total creativity score, the three total factor scores are converted to standard scores and then summed.
APPENDIX C

Classroom Environment Scale

Circle the letter or letters that correspond to the appropriate choice in each item. All these items have to do with what occurred in your science classroom during the unit Batteries and Bulbs.

1. In the unit on Batteries and Bulbs, which of the following were required of you?
   A. work sheets
   B. prediction sheets
   C. taking notes from the board
   D. tests
   E. none of these

2. What materials did you use in this unit?
   A. those the teacher provided
   B. materials you brought from home
   C. materials others brought
   D. materials from the storeroom which you selected
   E. no materials

3. During most of the classes on Batteries and Bulbs did you teacher talk to the class?
   A. more than half of the time?
   B. half of the time?
   C. much less than half of the time, say 5 minutes?
   D. none of the time?

4. Did your teacher ask questions
   A. that were based mainly on information he had already taught?
   B. that were based on topics the teacher had asked you to investigate?
   C. on topics you had decided to investigate?
   D. on none of the work you had decided to do?

5. In the experiments on this unit the teacher
   A. told you what to do most of the time
   B. told you what to do some of the time
   C. did not tell you what to do most of the time
6. The teacher gave
   A. prediction sheets and quizzes which were graded or marked
   B. prediction sheets which were not tests and were not marked
   C. no tests and did not mark any of your work

7. The teacher
   A. approved of correct answers and disapproved of wrong answers
   B. accepted any ideas you put forward
   C. did A and B at different times

8. The teacher supplied
   A. most of the information you learned
   B. some of the information you learned
   C. little or none of the information you learned, that is, you
declared most of the time what you wished to learn

9. Did the teacher work with
   A. the whole class most of the time?
   B. the whole class some of the time and small groups some of the
   time?
   C. small groups and individual students?
   D. you little or none of the time?

10. What teaching methods did the teacher use?
    A. lecture
    B. question and answer
    C. discussion in which no one seemed to be the leader
    D. discussion in which the teacher seemed to be the leader
    E. conversations with individuals and groups.

11. The teacher
    A. insisted that you keep a neat notebook of your work which had
to be handed in for marking
    B. did not insist on you keeping a notebook
    C. asked you to keep a record of your results but did not mark it
Development of Scoring Procedure for Classroom Environment Scale

The seven teacher-judges were asked to prepare a profile of choices for each environment category. The judges' choices for each category were then collated and the 95% confidence limits using \( p \pm 1.96\sqrt{pq/n} \) were calculated to determine how many selections per choice were needed in terms of the total number of selections in an item in a given category. Using item one as an example, profiles of choices for each category were as follows:

<table>
<thead>
<tr>
<th>Item 1</th>
<th>Authoritarian</th>
<th>Semipermisive</th>
<th>Permissive</th>
</tr>
</thead>
<tbody>
<tr>
<td>A B C D E</td>
<td>A B C D E</td>
<td>A B C D E</td>
<td></td>
</tr>
<tr>
<td>5 1 7 6 0</td>
<td>2 6 0 4 0</td>
<td>0 2 0 0 7</td>
<td></td>
</tr>
<tr>
<td>n = 19</td>
<td>n = 12</td>
<td>n = 9</td>
<td></td>
</tr>
</tbody>
</table>

For all categories \( p = .2, q = .8 \)

If selections were randomly distributed each choice in the three categories would be as follows:

| Authoritarian | 19/5 = 3.8 |
| Semipermisive | 12/5 = 2.4 |
| Permissive    | 9/5 = 1.8  |

The 95% confidence limits in item one by category are:

| Authoritarian | 3.8 ± 18% = 3.11 to 4.48 |
| Semipermisive | 2.4 ± 23% = 1.85 to 2.95 |
| Permissive    | 1.8 ± 26% = 1.33 to 2.27 |

Therefore selections beyond the 95% confidence limits are for item one by environmental category:

<p>| Authoritarian | A C D |
| Semipermisive | B (D excluded by definition of environment) |
| Permissive    | E    |</p>
<table>
<thead>
<tr>
<th>Item</th>
<th>Authoritarian</th>
<th>Semi-permissive</th>
<th>Permissive</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>A C D</td>
<td>B</td>
<td>E</td>
</tr>
<tr>
<td>2</td>
<td>A</td>
<td>B C D E</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>A B</td>
<td>C D</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>A</td>
<td>B C D</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>A</td>
<td>B</td>
<td>C</td>
</tr>
<tr>
<td>6</td>
<td>A</td>
<td>B</td>
<td>C</td>
</tr>
<tr>
<td>7</td>
<td>A</td>
<td>C</td>
<td>B</td>
</tr>
<tr>
<td>8</td>
<td>A</td>
<td>B</td>
<td>C</td>
</tr>
<tr>
<td>9</td>
<td>A B</td>
<td>C D</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>A B D</td>
<td>C E</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>A</td>
<td>C</td>
<td>B</td>
</tr>
</tbody>
</table>

Items were scored by assigning three points to a permissive choice, two points to a semi-permissive choice, and one point to an authoritarian choice. These points were then summed to give a classroom environment score.
Classroom Environment Scale (Teacher Form)

Circle the letter of the appropriate choice in each item. Make only one choice per item.

1. The teacher asks
   A. questions that are based mainly on information students have already been taught
   B. questions that are based on topics students are to investigate or have investigated
   C. no questions
   D. other (specify)

2. The teacher supplies
   A. a major portion of the content to be learned
   B. instructions primarily on basic techniques (e.g. "How to use a wire stripper")
   C. no information
   D. other (specify)

3. The laboratory exercises are
   A. directed
   B. partly non-directed, and partly directed
   C. non-directed
   D. other (specify)

4. The laboratory exercises are
   A. illustrative of concepts already studied
   B. discovery-based
   C. discovery-based with some guided discovery present
   D. other (specify)

5. Teaching techniques:
   A. lecture
   B. teacher dominated discussion
   C. teacher initiated question-answer reviews or instruction
   D. discussion in which the teacher is a non-evaluating participant
   E. guidance by suggestion or provocative question
   F. other (specify)
6. **Reinforcement:**

A. approval for correct answers and comments—written or oral  
B. disapproval for all incorrect answers and comments—written or oral  
C. acceptance of all suggestions, ideas and discoveries with expressions like: "that's fine"  
D. to students seeking the teacher's opinion of their correctness: "Let's try it" or "Try it"  
E. to students seeking the teacher's opinion of their correctness: "Try it" or "What do you think"  
F. other (specify)

7. **The teacher**

A. closely supervises laboratory exercises  
B. participates in laboratory exercises to assist and show students correct procedures  
C. participates as a curious investigator in activities  
D. neither participates nor supervises  
E. other (specify)

8. **The teacher**

A. insists students pursue activities assigned  
B. allows students to pursue any activity they wish (except activities which endanger life or property)  
C. other (specify)

9. **Assignments are:**

A. written laboratory exercises and/or quizzes  
B. gamelike prediction sheets  
C. not given  
D. other (specify)

10. **Evaluation:**

A. laboratory exercises and quizzes are graded by the teacher  
B. gamelike self-evaluation on prediction sheets—no teacher grading  
C. no evaluation of any kind  
D. other (specify)

11. **The teacher initiates lessons by**

A. announcing what is to be studied  
B. asking a question which provokes discussion and experimentation e.g. "How can you make a compass needle move?"  
C. letting students pursue investigations started the previous day  
D. merely putting out materials  
E. reviewing content already taught  
F. other (specify)
Scoring Procedure for the Teacher Form of the Classroom Environment Scale

Classification of item choices into environmental categories was achieved by the same methods as for the student form.

Classification of Item Choices by Environmental Category

<table>
<thead>
<tr>
<th>Item</th>
<th>Authoritarian</th>
<th>Semipermisive</th>
<th>Permissive</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>A</td>
<td>B</td>
<td>C</td>
</tr>
<tr>
<td>2</td>
<td>A</td>
<td></td>
<td>C</td>
</tr>
<tr>
<td>3</td>
<td>A</td>
<td>B</td>
<td>C</td>
</tr>
<tr>
<td>4</td>
<td>A</td>
<td>C</td>
<td>B</td>
</tr>
<tr>
<td>5</td>
<td>A B C</td>
<td>E</td>
<td>D</td>
</tr>
<tr>
<td>6</td>
<td>B</td>
<td>A</td>
<td>C</td>
</tr>
<tr>
<td>7</td>
<td>A</td>
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<tr>
<td>8</td>
<td>A</td>
<td></td>
<td>B</td>
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<tr>
<td>9</td>
<td>A</td>
<td>B</td>
<td>C</td>
</tr>
<tr>
<td>10</td>
<td>A</td>
<td>B</td>
<td>C</td>
</tr>
<tr>
<td>11</td>
<td>A E</td>
<td>B</td>
<td>C</td>
</tr>
</tbody>
</table>

Items are scored by weighting the choices for the teacher form as was done in the student form. However, since only one choice per item is permitted the range of scores is from 11 to 33, with 22 as the median. To assess a classroom score into one of the three categories, the following range of scores can be used:

- Authoritarian: 11 - 14.5
- Semipermisive: 14.6 - 29.4
- Permissive: 29.5 - 33

Where "other" choice is specified, it will be classified into environmental categories by consensus of three judges and scored as above.