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ABSTRACT

This is an evaluation of a project whose expressed purpose is to teach "abstract conceptually-oriented" mathematics to disadvantaged elementary school children using a discovery-oriented, pattern-recognition approach. This report is primarily of Project SEED (Special Elementary Education for the Disadvantaged) in Gary, Indiana during 1970-72. It attempts to evaluate the affective impact on children and the impact on the teachers' behavior; instrument construction in support of these evaluation areas is discussed. General conclusions are that students with SEED instruction do somewhat better in mathematics and that most like the program. There is no clear-cut evidence that this instruction has a significant effect on the child's general self-concept or that it has a lasting impact on the regular teachers' behavior. A serious problem remains concerning educational priorities and cost effectiveness of the project. (LS)

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FINAL REPORT

Gary SEED Evaluation Project

N.S.F. Grant GW6709

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BRIEF HISTORY OF PROJECT SEED

In order to provide context for this evaluation report and for the project that it reports on, a brief history of Project SEED will be given. The founding of Project SEED (Special Elementary Education for the Disadvantaged) is generally attributed to William F. Johntz. In 1963 Johntz, who was a high school mathematics teacher in Berkeley, California, took his lunch hours to teach mathematics to disadvantaged (mostly black) elementary school children. Since then Johntz has made a serious effort to generalize his success by getting others who have a strong mathematics background to teach "abstract conceptually-oriented" mathematics to disadvantaged children.

The rationale behind SEED was very much a product of the times. The writings of Jerome Bruner were being widely read by educators. The Cambridge Conference on School Mathematics had just published its "Goals for School Mathematics". The idea, in particular, that the fundamental concepts of any subject could be taught to children at any level if properly presented had caught the fancy of a number of mathematicians, mathematics teachers and mathematics educators. 1963 was also a year in which racial tensions had reached a very serious level. By this time vocational or remedial education for blacks had fallen into disrepute. Some claimed that society was unwittingly (or otherwise) using the schools to keep the poor, poor. The rationale behind Project SEED was that a child's performance in school is a product of a complex of forces including the child's cultural background and self-concept. Many children from disadvantaged backgrounds lacked the language skills, experience and motivation to function successfully in school. The failure that they experienced reinforced their own low expectations for themselves. Most remedial work tended to be "revisiting past sins" and did little to promote success in new undertakings. Abstract, conceptually-oriented mathematics was judged to be culture free, to have high prestige value and to be teachable from first principles using a discovery-oriented, pattern-recognition approach. The SEED approach is to teach abstract mathematics using guided discovery. Fundamental to SEED is a flexible curriculum in which a child's ideas can be pursued as having value. Also of great importance is positive reinforcement. Wrong answers are not to be labeled as such. Instead, they are to be either deflected or pursued to uncover the question that might underlie to which the answer was a correct response. Over the years an assortment of teaching techniques, devices and gimmicks have come to be associated with Project SEED. Hand and finger signals for various messages such as "can't be done" and "wrong" as well as signals for various numerical answers seem to help generate pupil motivation and lend a distinctive flavor to SEED classes. It was clear that classes of this kind could only be conducted by someone knowing sufficient mathematics to be comfortable and confident in a free-wheeling classroom in which a lesson might go in any direction. So the model that evolved was that of a trained mathematician teaching abstract, conceptually-oriented mathematics via a guided discovery technique to disadvantaged elementary school children in hope of improving their self expectations, self image, school achievement, and ultimately their prospects for success in life. The SEED class is typically taught for 40 minutes a day, four days a week and is regarded as being a supplement to, rather than a replacement for regular mathematics instruction.

A number of SEED classes evolved in the Berkeley area, many of which were manned by mathematics graduate students at the University of California.

In addition SEED Projects of various kinds developed throughout the country. A brief description of some of those follows.

In 1967 the legislature of the State of California passed a bill authorized by Senator George Miller, Jr., for a program to improve mathematics insturction in the California public schools. The bill provided funds for what came to be known as the Miller Mathematics Improvement Program. The program has several projects, one of which was called the Mathematics Specialist Project and provided funds to school districts throughout the state to hire mathematics specialists to teach classes that were modeled after the SEED classes in Berkeley. (The evaluation of this project is reviewed in the section entitled "Other Evaluations of SEED Projects".) A similar program called the Community Teaching Fellowship Program was funded through the eight campuses of the University of California.

Another major SEED Project evolved in Michigan. It started, as have many, with Johntz putting on a demonstration of his technique with children from a nearby elementary school; some local mathematicians taking over the demonstration class and other classes; and these mathematicians then seeking funds to expand and continue SEED. In the case of Michigan, the state legislature voted in 1970 to contract with Project SEED to provide SEED instruction in various classrooms throughout the state.

There are, or have been, SEED classes in California, Michigan, Alaska, New York, New Jersey, and Indiana to name a few states. Bell Telephone Laboratories and I.B.M. have provided released time for their employees to teach SEED classes.

In February 1970 two SEED classes were started in Bloomington, Indiana. One taught by a faculty member and one by a graduate student in the mathematics department at Indiana University. A state-wide committee was formed to determine what role Indiana University should play in encouraging Project SEED in Indiana. The Committee visited the SEED Project in Ypsilanti, Michigan, and communicated with other SEED Projects. As a result of the Committee's recommendations the Indiana University Foundation provided funds for faculty released time and graduate student salaries for SEED instruction in Gary and Bloomington. The Gary SEED Project also received funds from both the School City of Gary and from the National Science Foundation, and the Bloomington SEED project received funds from the Monroe County Community School Corporation.

A note of clarification is probably in order concerning responsibility for the control of SEED projects. In this report the phrase "SEED project" is being applied to any instructional program which is modeled after the original Berkeley SEED project. Most of these projects, including the Gary Project maintain little or no ongoing connection with the Berkeley project. However, a few, e.g. the Michigan project, have remained in direct contact.

BACKGROUND FOR THIS EVALUATION

This report is of the Gary SEED Evaluation Project which is a result of a proposal by the director of the Bloomington SEED Project to evaluate Project SEED in Indiana. By the time of funding, the Gary SEED Project was the only SEED activity in Indiana, so the evaluation was focused there. A brief history of the Gary SEED Project follows.

The statewide committee appointed by the Indiana University Foundation arranged a demonstration of the SEED teaching approach which was given on May 8, 1970 at Indiana University Northwest in Gary. Subsequent to that demonstration funds were granted by the Indiana University Foundation and the School City of Gary for a SEED project to be held in certain Gary schools. Some pilot evaluation activities were carried on during that 1970-71 project and are reported below.

For the 1971-72 year funding was received from the National Science Foundation as well as from the School City of Gary to continue SEED teaching activities and to conduct this evaluation. In the summer of 1971 a workshop for teachers was held which focused on discovery-oriented teaching of high school algebra to elementary school children. Then, in addition to the regular SEED classes during the school year, weekly workshops were held for the homeroom teachers in these classes. In these workshops an effort was made to help the teachers plan laboratory-type activities to enhance the teaching in their "regular" mathematics lessons. At the end of the 1971-72 academic year all SEED instructional activities in Gary were ended. More details of the Gary SEED Project are contained in the description of the treatment.

The Gary SEED Evaluation Project reported on here was funded by the National Science Foundation in the spring of 1971 to expand and continue evaluation efforts that had already been begun by the Gary SEED Project. There are two aspects of the Evaluation Project, the evaluation aspect and the instrument construction apsect. The evaluation aspect has two parts, the evaluation of the affective impact of SEED instruction on children and the evaluation of the impact of SEED instruction on the teaching behavior of the home room teacher. The instrument construction aspect was partly in support of the evaluation aspect and partly in response to the discovered need for affective self-evaluation instruments that are closely tied to specific school content areas. The untimely closing of the Gary SEED Project in 1972 prevented the full use in the evaluation of some of the instruments that were developed and validated.

OTHER EVALUATIONS OF SEED PROJECTS

During the last five years Project SEED has undergone several evaluations, both formal and informal. These evaluations have ranged from a direct observation of a single class session through a sustained and elaborate evaluation using more sophisticated instruments to measure achievement to a longitudinal study which tried to measure student achievement and attitudinal change over a longer period of exposure to SEED teaching.

As regards direct observations of SEED classes by various individuals, Project SEED has fared well. The experience of watching supposedly disadvantaged children respond to mathematics which is normally regarded as being years beyond them has caught the fancy of many.

Most of the informal evaluations are generalistic reports of journalists and in some cases university mathematicians or scientists who found SEED's discovery method of learning-teaching mathematics exciting. For instance Professor George E. Backus, Professor of Geophysics at University of California at San Diego after attending Mr. Johntz's demonstration of the techniques he used to teach algebra to second and fifth graders at Logan Elementary School on May 9, 1968, observed "To say that I was impressed with his results is an understatement. Children with obvious language problems responded correctly and enthusiastically, and asked very shrewd and insightful questions." He further continues to report ".... my direct observations indicate clearly that children do grasp concepts which some of my undergraduate mathematics students at M.I.T. were vague about, and that the children show a genuine intellectual curiosity which I would be glad to see more widespread among our graduate students at U.C.S.D."

In even more enthusiastic language George A.W. Boehm extols the success of the SEED method of teaching mathematics to lower grades in the article "How to Teach the Esoteric Mathematical Principle of Infinite Convergence and Make Any Sixth Grader Eat It Up," the September/October 1970 issue of Think. He found in the SEED classes conducted by Warren Lefler, a co-worker of Mr. Johntz, "no rules to memorize, no lectures, no drill, drill, drill, drill. Yet disadvantaged children from first to sixth grades master math that might topple a bright college undergrad. The secret: combine socratic questions with a love of math and a belief in kids ... Result: the kids begin believing in themselves." Boehm is also a sympathetic critic of the SEED project. For example he senses limitations in this method. He writes "teaching SEED-style is not at all easy. The teacher must curb his impulse to deliver a lecture when he wants to make a point. It is much more effective if he works out a line of questioning that leads the children to discover it for themselves." This obviously demands a thorough knowledge of the structure of mathematical problems on the part of the teacher and an ability to break such problems down into logical steps of sufficient simplicity to be understood by the young learners. Obviously this demands a different kind of teacher than we happen to have at the moment. Moreover, taking a long-term view of the SEED project, Boehm points out that "SEED may begin to suffer for want of a standard curriculum. So far most teachers concentrate on a few topics that they themselves enjoy and think will appeal to young children. This is all very well for the first year or two, when the main objective is simply to encourage children to think mathematically. But when children change teachers or perhaps schools, they may be discouraged if they take up the same concepts for the second or third time." This calls for a more systematic development of mathematics curriculum than the SEED project has been able to evolve.

Boehm also finds little evidence to show that SEED methodology leads to basic attitudinal change. "Although SEED pupils make extraordinarily rapid progress in arithmetic (actually not taught in the program) and in algebra (taught in the program) there is no solid statistical evidence that they are much better off in reading and other subjects."

Part of Boehm's criticism was anticipated by Johntz, and this is reflected in his attempts to get mathematics specialists involved in the project. These specialists came from a wide background. Some like George Backus were University professors of mathematics. Others came from industrial and business firms. September 1970 issue of IBM-Magazine informs us of a number of IBM Research scientists and mathematicians who gave some of their own time to a SEED project. Dr. William A. Lester, Jr., a San Jose Research chemist who teaches algebra four times a week in San Jose's Olinder Elementary School, believes and demonstrates with his other IBM colleagues that "the best years for learning abstract mathematics are the early years of a student's education, not the ninth or tenth grade."

Johntz's demonstrations of the SEED techniques have been widely reported in many major national newspapers and magazines including Newsweek and the New York Times. Most of these journalistic evaluations have tended to present the SEED approach and methodology as a radical breakthrough in teaching disadvantaged students.

There are, however, only two "professional" evaluative studies of Project SEED which have effected a degree of methodological sophistication and rigor. Both these studies were commissioned by State Departments of Education, one in Michigan and one in California. The Michigan Study was contracted with the American Institute of Research to conduct an independent evaluation of Project SEED in the participating Public Elementary Schools in Michigan. The study was conducted during the academic years 1970-71 and 1971-72.

The Second Study was done by Professor R.P. Dilworth of California Institute of Technology for the California State Board of Education to evaluate the Mathematics Specialists Program in the state of California. These two evaluation studies will be reviewed below. We also report on a third evaluation study of the Community Teaching Fellowship program at Berkeley which achieved some interesting results.

Project SEED in Michigan was evaluated at the end of its first year of operation, and a summary of findings was published in October 1971. This preliminary study showed that

1) SEED students generally performed better on the standardized arithmetic achievement examination (Comprehensive Test of Basic Skills) than comparable control students. This result was statistically significant for fourth and fifth grade students. The SEED program seemed to be effective across the entire range of student ability and was equally effective for boys and girls.

2) In general the attitudes of students, classroom teachers, principals, and SEED instructors were very favorable to the general impact of the SEED program in their schools, more specifically

   a) SEED students in each of the four grades reported that they enjoyed their SEED class and that they "learned alot!"

   b) Regular classroom teachers of SEED students reported that:

      1. Project SEED has been successful in their classes.

      2. They now use the "discovery method" of instruction for arithmetic and other subjects more frequently than in previous years.

      3. Project SEED has improved the motivation of their students in arithmetic.

      4. They could identify students who they thought were poor students, who because of success in SEED classes, have become more successful.

   c) Principals of the participating schools also had favorable comments regarding stimulating student and teacher interest in learning and teaching of mathematics.

The design of this preliminary study called for a "product" evaluation of the outcome of the program and did not try to develop or test hypotheses about why the program was more successful in the fourth and fifth grades than in the third or sixth.

The 1971-72 study was designed to go beyond the preliminary study in terms of developing strategies to measure more adequately achievement prior to starting the program for experimental and control groups and comparing gains in achievement of students.

The basic design of the study called for:

1) Measuring change in arithmetic achievement for SEED and control students during the school year.
2) Assessing attitudes of students, classroom teachers, SEED teachers, and principals toward SEED program.
3) Obtaining judgements by teachers of their perception of the reasons for successful or unsuccessful implementation of the SEED program.
4) Obtaining judgements of both SEED and classroom teachers concerning students who effectively utilized SEED and students for whom SEED was ineffective.

The students were tested on the Comprehensive Tests of Basic Skills Arithmetic Sections both before and after exposure to SEED programs. Different levels of the test were used for different grades. The arithmetic subtests used dealt with arithmetic computation, concepts, and applications.

A short questionnaire was also administered to both groups of students at the time of post-test administration including items related to student attitudes towards various school subjects and their reactions to the SEED class. The control group was asked about their information regarding the SEED class.

Questionnaires were also administered to the principals, SEED teachers and the classroom teachers of both SEED and control classes.

1) The data showed that SEED students on the average performed better on a standardized arithmetic achievement test than did the control students. Gains in achievement (pre-test to post-test) indicated that SEED students on the average increased their scores more than control students. This was primarily due to increased computational skills of the SEED students.
2) Comparisons of arithmetic achievement for students with two years of SEED instruction with students having experienced only one year of instruction does not show marked difference. Therefore there is no evidence of positive cumulative effect of SEED teaching.
3) Another important finding of the study was that as measured by the arithmetic achievement test, SEED teachers and regular classroom teachers did not discriminate effectively between students who were profiting and students who were not profiting from participation in SEED classes.

4) Attitudes of the students, teachers, and principals as well as SEED instructors were all very enthusiastic and favorable to the project.

The data, however, did not specify those aspects of the program that were particularly effective in producing the favorable results. This specification of causal relationships is yet to be done. Similarly the evaluation study points out that, arithmetic achievement of SEED students notwithstanding, "behaviorally stated objectives dealing with basic attitudinal change need to be specified more clearly to determine the success of an innovative education experiment like SEED."

Professor Dilworth's evaluation of the Mathematics Specialist Project in California was structured around finding significant achievement in mathematics learning particularly in the area of whole numbers computation, fractions computation, word problems, whole number operations, intuitive geometry and pattern recognition. Comparisons were made regarding relative achievement of four categories of students, the integrated, the high percentage black, high percentage Spanish surname and low percentage minority groups across all the elementary grades. Comparisons were also made between the experimental groups and a control group on a pre-test and post-test basis. The following is selected from the summary report of the evaluation.

"The effectiveness of the use of specialists in teaching mathematics to elementary school pupils and the degree to which these pupils succeeded in learning abstract mathematical concepts were measured in terms of the performance of pupils on appropriate pretests and post-tests. These examinations were selected and supplied by the State Department of Education and were administered to pupils in experimental and comparison classes...

... Each class taught by a specialist was paired with a class which did not receive instruction from a specialist and which, if the district size permitted, was in a school in which a specialist did not teach. These classes were matched as closely as possible with respect to range of pupils' ability, socio-economic backgrounds, urban-suburban-rural characteristics, the number of pupils from non-English-speaking homes or ones in which English was spoken as a second language, and the mathematics training and experience of the regular teacher...

... Pupils who received supplementary instruction from specialists during the school year performed significantly better on measures of mathematical achievement than pupils who did not receive such instruction. The greatest amount of growth occurred in the areas of mathematical understanding.

The improvement in performance was greater and included more cognitive areas at grades two and three than at the intermediate grades. Although the achievement of the experimental classes was generally higher than that of the comparison classes at grades five and six, statistically significant gains were shown only on the pattern recognition scale. This scale, however, measures an important cognitive skill in mathematics and an area emphasized to a large degree by the specialists in their instructional program.

A statistically significant specialist effect was noted at grade five during the 1968-69 school year on the measure of material introduced specifically in the classes taught by the specialists. Open sentences, the integers, solution sets, order, and graphing were topics included in this scale.

The project was particularly effective in improving the mathematical achievement of pupils from disadvantaged regions. Pupils who attended schools in which the enrollment of pupils from minority groups was greater than 80 percent of the total enrollment (black or a combination of black and Spanish surname with black predominant) performed significantly better than pupils in the comparison classes. Although the improvement was greatest at grade two, the achievement of pupils in the experimental classes at grades three and five was consistently higher than that of pupils in classes in which specialists did not provide instruction. There was not a sufficient number of classes at grade six to accomplish the analysis.

The Stanford Achievement Test, Primary I and Intermediate I, Form Y, Test 2, Paragraph Meaning, was administered to pupils in classes that participated in the 1968-69 study. There was no specialist effect at either grade two or grade five."

More recently the Department of Mathematics of the University of California at Berkeley undertook a study of the Community Teaching Fellowship Program. The program provided a daily SEED-like mathematics enrichment program for the entire academic year to 37 classes in 19 elementary schools in 12 districts from Sacramento to San Diego. The study was conducted to measure both achievement and attitudinal changes in experimental groups of learners.

The researchers used not only standardized arithmetic tests like CTBS and SAT arithmetic W and X intermediate I, but also used a specially prepared criterion referenced test. This test was designed by mathematicians in the program to cover the topics taught during the year.

To establish a level of difficulty for the criterion referenced test a control group of 33 high school students entering the University of California at Berkeley Upward Bound program was administered the test.

The hypothesis was that the fifth grade students in the experimental group would have achieved roughly the same level of competence in the items on the test as a socio-economically similar group of high school students without the benefit of CTF program. The closeness of the means for the two groups tends to support the hypothesis.

On the standardized tests it was also found that a significantly greater percentage of the students in the experimental group gained on grade level than those in the control group.

The data also reveals that not only significantly larger numbers of students showed growth in understanding of mathematical concepts but that very few children were being "turned off" by mathematics taught in the experimental way. It was shown that when the class receives full CTF instruction, there is an actual reduction in the percentage of children who are losing ground with respect to grade level. The data shows that the students that receive the full CTF instruction always showed a mean growth of more than seven months.

It seems important to report on one essentially negative commentary on Project SEED. This commentary is entitled "Review of Some Project SEED Activities for the New York City Board of Education", and it is authorized by the (NCTM) Commission on Mathematics Education in the Inner-City. In this report the Commission sets out to review a film which had been produced by Project SEED. In its indignation over what it feels to be some serious misrepresentations in the film, the Commission unfortunately loses some of the objectivity and restraint that one might expect. The Commission does, however, raise some good questions concerning quality control, priorities, cost effectiveness, and goals of Project SEED. These concerns are especially noteworthy since they reflect the concerns of a number of professional mathematics educators as stated to this writer. There is, of course, the natural scepticism of professionals toward what they feel are amateurs. But more fundamentally there is the belief that Project SEED will not have a profound affect on the basic educational problems to which it addresses itself.

Finally an interesting but isolated research study was reported by Lyndall R. Wirtz, at the University of California at Berkeley. In this unpublished study Wirtz found that the SEED treatment significantly improved the performance of negro children on Raven's Progressive Matrices Test. Wirtz advances this as tentative evidence of weaknesses in Jensen's argument that education for the disadvantaged may have to proceed more along the lines of associative learning.

In summary it seems evident from the evaluations that have been reported here that Project SEED does have an impact. In each of the field evaluations described, SEED students showed significant gains over control students on one or more cognitive variables relating to mathematics achievement. These results do not speak to questions concerning cost-effectiveness nor to precedence over competing alternatives. Neither do they speak to the efficacy of Project SEED's claim to have a positive impact on the disadvantaged child's attitude and self concept. It is toward this latter issue that the remainder of this evaluation report is addressed.

THE GARY SEED EVALUATION

Project SEED in Gary started in 1970 and was in operation during the academic years 1970-71 and 1971-72. The project was operated co-operatively by Indiana University Northwest and the Gary School System. The following is a breakdown of experimental and control classes in the Gary School System.

Classes Involved

	Experimental	Control
1970-71	8 Classes (1-5th grade-6-4th grade-1-3rd grade)	6 Classes (1-5th grade-4-4th grade-1-3rd grade)
1971-72	9 Classes (5-4th grade-3-5th grade-1-6th grade)	8 Classes (5-4th grade-2-5th grade-1-6th grade)

Total Numbers Of Students Involved

	Experimental	Control
1970-71	181	127
1971-72	213	185

The Experimental and Control classes were selected from the same school. All the schools involved are located in the inner city area. Students in the experimental and control classes did not differ significantly in I.Q., mathematics achievement scores, or age, as determined from school district records.

General Design and Rationale

The evaluation of Project SEED in Gary sought the impact of SEED instruction in three areas:

1. Changes of general self-concept and attitude in the children receiving SEED instruction,
2. Changes of subject-specific self-concept and attitude in these children,
3. Teacher attitude and changes of teacher behavior among homeroom teachers for SEED classes.

The original claims were that SEED instruction would change general self-concept and attitudes. It was felt, however, that four 45 minute classes per week for one or two school years might not be adequate exposure to effect measurable changes in the child's attitude toward self. It was for this reason that help was sought from Professors Gotts and Chase at Indiana University in Bloomington to develop subject-specific self-concept measures. The hope was that these measures which were attuned to specific subject areas in the elemtnary school curriculum (in particular arithmetic) would be more sensitive to SEED instruction.

The concern of many educators who have reviewed Project SEED is that funding may have little residual effect on school systems. That is, it was not clear if the schools and homeroom teachers involved in SEED classes would be any different after funding had run out than they were before funding. While there are many places that one could look for such impact, the decision was made to attempt to measure any change in the actual teaching style of the homeroom teachers in SEED classes (and also in the SEED instructors themselves).

Instrumentation

The three instruments listed below were chosen for the general attitude and self concept measures because they seemed to have face validity in the light of Project SEED's goals and because they had undergone fairly rigorous construct validation and pilot testing.

1. The Piers-Harris Children's Self Concept Scale consists of 80 items dealing with self image. The child is asked to respond yes or no to self image items. The higher the positive number of responses, the higher the self concept. The reliability and validity coefficients seem moderately high (Piers, E.V. and Harris, D.B. The Piers-Harris Children's Self-Concept Scale, Counselor Recordings and Tests; Nashville, Tennessee, (1969). See Appendix H for a copy of the test.

2. The Bialer-Cromwell Children's Locus of Control Scale contains 23 items involving the child's view of the locus of control of the situation. The child is asked to respond yes or no to situational items. The higher the number of positive (yes) responses, the higher the child's feeling of self control of the situation. (Bialer, I. "Conceptualization of Success and Failure in Mentally Retarded and Normal Children," Journal of Personality, (1961), 29, pp. 303-320. See Appendix I for a copy of the test.

3. Crandall Internal, External Locus of Control Scale asks the child to respond by selecting an appropriate ending to situational statements. Statements are scored either plus or minus, plus indicating internal control and minus indicating external or control from out-

side self.

The instrument yields three different sets of scores:

a. I^+ score - internal responsibility for success score.

b. I^- score - internal responsibility for failure score.

c. Total I score - internal responsibility score. Test-retest reliability has been reported to be around .70 and the test is found to have co-related significantly with achievement test scores. (Crandall, V.C., Kathovsky, W., and Crandall, V.J. "Children's Beliefs in Their Own Control of Reinforcements in Intellectual-Academic Achievement Situations." Child Development, (1965), 36, pp. 91-109. See Appendix J for a copy of the test.

In addition an oral interview report was developed by Mannan for use in the follow-up study with SEED children.

Since the type of subject-specific instrument that was needed did not seem to be available, the design and validation of three such instruments were supported as part of the evaluation project.

1. The Gotts Academic Self Concept test asks the child to choose a face from faces that range from sad to happy to indicate the child's reaction to being asked to do a subject-specific task or assignment. The school subjects covered include arithmetic, reading, spelling, art, and science. (See Appendix B for a copy of the test.)

2. The Chase Arithmorisk test confronts the child with 14 items which cause the child to choose between a high risk, high reward line of action and a low risk, low reward one relative to solving arithmetic

problems. (See Appendix G for a copy of the test.)

3. The Chase Level of Conceptualization Test asks the child to choose the most suitable response to an arithmetic question from a concrete response, an abstract response, and a distractor. (See Appendix E for a copy of the test.)

The validation of these instruments is reported in Appendices A, D, and F. Unfortunately, the untimely end of the Gary SEED Program prevented the use of the two Chase instruments in the evaluation program. They were, however, validated and are now available for use.

To assess the impact of SEED instruction on homeroom teachers and on SEED instructors the Flander's interaction analysis scale was modified by Mannan as indicated in the summary of findings from that part of the evaluation.

Procedures

The testing during the 1970-71 year was begun prior to the funding of this evaluation project and can be regarded as a pilot effort. The 1971-72 school year was the main year of testing, and during the 1972-73 school year some follow-up testing was done on former SEED children. During the 1970-72 period control classes were chosen for each SEED class from the same school and grade level. In all but those instances that are mentioned below pre-tests and post-tests were given for both the control and experimental groups. Data analysis for the pre-test - post-test comparison was done using analysis of covariance with pre-test scores as covariates.

During the 1971-72 school year the modified Flanders scale was used to make six teaching observations of each homeroom teacher, SEED instructor as well as of control teachers. At the end of that school year the homeroom teachers were interviewed.

In the 1972-73 school year a number of former SEED children were located, interviewed and retested using the Crandall test.

Figure 1 below indicates the outline of the testing sequence, Figure 2 indicates the sample sizes for the various test administrations, and Figure 3 provides some of the data collected.

Figure 1: Testing Schedule

	1970-71	1971-72	1972-73
Piers Harris	Pre-Post	Pre-Post	
Crandall	Pre-Post	Pre-Post	Post
Bialer-Cromwell	Pre-Post	Pre-Post	
Gotts	Post	Pre-Post	
Chase (Arithmorisk)		Post	
Chase (Conceptualization)		Post	
Mannan (Flanders)		6 times	
Teacher Interview		Post	
Child Interview			Post

Figure 2: Sample Sizes

	(Pilot) 1970-71	1971-72	(Follow-up) 1972-73
Piers-Harris	Ne3 = 24, Ne4 = 101, Ne5 = 49 } Ne = 174 Nc3 = 19, Nc4 = 80, Nc5 = 17 } Nc = 116	Ne4 = 118, Ne5 = 65, Ne6 = 27 } Ne = 210 Nc4 = 97, Nc5 = 45, Nc6 = 24 } Nc = 166	
Crandall	Ne3 = 28, Ne4 = 97, Ne5 = 48 } Ne = 173 Nc3 = 20, Nc4 = 76, Nc5 = 20 } Nc = 116	Ne4 = 110, Ne5 = 63, Ne6 = 21 } Ne = 194 Nc4 = 116, Nc5 = 42, Nc6 = 22 } Nc = 180	Ne6 = 96, Ne7 = 61 } Ne = 157
Bialer-Cromwell	Ne3 = 26, Ne4 = 23, Ne5 = 21 } Ne = 70 Nc3 = 22, Nc4 = 24, Nc5 = 0 } Nc = 46	Ne4 = 110, Ne5 = 62, Ne6 = 24 } Ne = 196 Nc4 = 112, Nc5 = 45, Nc6 = 24 } Nc = 181	
Gotts	Ne4 = 42, Ne5 = 24 } Ne = 67 Nc4 = 40, Nc5 = 21 } Nc = 61	Ne = 215 Nc = 166	
Chase Arithmorisk		Ne4 = 54, Ne5 = 26, Ne6 = 25 } Ne = 105	
Conceptualization		Ne4 = 54, Ne5 = 26, Ne6 = 25 } Ne = 105	
Mannan (Flanders)		Ne = 12 Nc = 11 Ns = 8	
Teacher Interview		Ne = 12	
Child Interview			Ne6 = 96, Ne7 = 61 Ne = 157

Ne = number of experimental subjects
Nc = number of control subjects
Nek = number of experimental subjects in grade k
Nck = number of control subjects in grade k
Ns = number of SEED instructors observed

Figure 3 Sample Means

	1970-71	1971-72	1972-73		
Piers-Harris	Meo = 60.12 Mel = 60.90 ΔMe = .78 Mco = 57.55 Mcl = 58.32 ΔMc = .77	Meo = 57.59 Mel = 59.81 ΔMe = 2.22 Mco = 57.79 Mcl = 60.03 ΔMc = 2.24			
Crandall	I+ I- I Meo=12.09 10.11 22.20 Mel=13.24 11.00 24.24 ΔMe= 1.15 .89 2.04 Mco=12.62 10.76 23.38 Mcl=13.26 11.81 25.07 ΔMc= .64 1.05 1.69	I+ I- I Meo=12.99 8.58 21.57 Mel=13.64 10.50 24.14 ΔMe= .65 1.92 2.57 Mco=12.82 9.51 22.33 Mcl=14.20 10.83 25.03 ΔMc= 1.38 1.32 2.70	1971-73* (Ne = 60) I+ I- I Meo=11.85 10.02 21.87 Mel=12.98 9.92 22.90 Me4=15.02 10.69 25.71	1972-73** (Ne = 111) I+ I- I Me2=11.52 8.89 20.41 Me3=13.59 10.60 24.19 Me4=14.67 10.75 25.42	1971-72-73*** (Ne = 14) I+ I- I Meo=11.48 9.23 20.71 Mel=13.59 8.66 22.25 Me2=14.40 8.13 22.53 Me3=13.48 9.79 23.27 Me4=14.48 10.48 24.96
Bialer-Cromwell	Meo = 12.55 Mel = 12.91 ΔMe = .36 Mco = 13.40 Mcl = 13.65 ΔMc = .25	Meo = 10.29 Mel = 10.26 ΔMe = -.03 Mco = 9.49 Mcl = 9.81 ΔMc = .35	*In this column means are given for 60 who had SEED in 1970-71 and were retested in 1973. Meo = 1970-71 Pre-test experimental mean Mel = 1970-71 Post-test experimental mean Me4 = 1973 retest experimental mean	**In this column means are given for 111 students who did not have SEED in 1970-71, who did have SEED in 1971-72 and who were retested in 1973. Me2 = 1971-72 Pre-test experimental mean Me3 = 1971-72 Post-test experimental mean	***In this column means are given for 14 students who had SEED in 1970-71, 1971-72, and were retested in 1973.

Meo = Pre-test mean experimental
Mel = Post-test mean experimental
ΔMe = Mean gain experimental
Mco = Pre-test mean control
Mcl = Post-test mean control
ΔMc = Mean gain control

Pilot Year Attitude Data

During the pilot year the Gotts Academic Self-Concept Test was validated (See Appendix A for the report), and the three general self-concept measures were administered on a pre-test - post-test basis to samples of various sizes. The following tables contain summaries of the data gathered. It is worth noting that partial achievement data was available during the pilot year and was helpful for validation of the Gotts instrument. Due to administrative impediments and a lengthy teacher strike the achievement data was not available during the 1971-72 academic year and is, therefore, not reported in this study.

Table I

Analysis Of Covariance With Pre-Test As Covariate

Piers-Harris 1970-71

	DF	SS	MS	F
Treatment	1	641.2397	641.2397	4.9279 *
Grade	2	610.6518	305.3259	2.3464
Sex	1	161.8032	161.8032	1.2434
Treatment X Grade	2	246.1259	123.0629	0.9457
Treatment X Sex	1	0.0000	0.0000	0.0000
Grade X Sex	2	374.9492	187.4746	1.4407
Treatment X Grade X Sex	2	213.9160	106.9580	0.8219
Residual	281	36564.5493	130.1229	
Total	292	38813.2353		

* Significant at the .05 level

Table II

Analysis Of Covariance With Pre-Test As Covariate

Crandall I+ 1970-71

	DF	SS	MS	F
Treatment	1	2.1243	2.1243	0.4265
Grade	2	9.9460	4.9730	0.9984
Sex	1	0.1002	0.1002	0.0201
Treatment X Grade	2	95.1186	47.5593	9.5488 *
Treatment X Sex	1	1.2009	1.2009	0.2411
Grade X Sex	2	8.6860	4.3430	0.8719
Treatment X Grade X Sex	2	0.0000	0.0000	0.0000
Residual	278	1384.6203	4.9806	
Total	289	1501.7965		

* Significant at the .05 level

Table III

Analysis Of Covariance With Pre-Test As Covariate

Crandall I⁻ 1970-71

	DF	SS	MS	F
Treatment	1	0.6196	0.6196	0.0590
Grade	2	105.1427	52.5713	5.0133 *
Sex	1	25.5779	25.5779	2.4391
Treatment X Grade	2	79.0441	39.5220	3.7689 *
Treatment X Sex	1	3.0029	3.0029	0.2863
Grade X Sex	2	14.9893	7.4946	0.7147
Treatment X Grade X Sex	2	0.0000	0.0000	0.0000
Residual	277	2904.7095	10.4863	
Total	288	3133.0865		

* Significant at the .05 level

Table IV

Analysis Of Covariance With Pre-Test As Covariate

Crandall I 1970-71

	DF	SS	MS	F
Treatment	1	3.5820	3.5820	0.1817
Grade	2	183.6297	91.8148	4.6582 *
Sex	1	21.1198	21.1198	1.0715
Treatment X Grade	2	369.7355	184.8677	9.3793 *
Treatment X Sex	1	0.0000	0.0000	0.0000
Grade X Sex	2	41.8652	20.9326	1.0620
Treatment X Grade X Sex	2	0.0000	0.0000	0.0000
Residual	279	5499.1053	19.7100	
Total	290	6119.0378		

* Significant at the .05 level

Table V

Analysis Of Covariance With Pre-Test As Covariate

Bialer-Cromwell 1970-71

	DF	SS	MS	F
Treatment	1	17.7891	17.7891	0.8101
Grade	2	7.7264	3.8632	0.1759
Sex	1	11.2640	11.2640	0.5129
Treatment X Grade	2	7.3620	3.6810	0.1676
Treatment X Sex	1	7.1243	7.1243	0.3244
Grade X Sex	2	64.0216	32.0108	1.4577
Treatment X Grade X Sex	2	148.8005	74.4002	3.3881 *
Residual	103	2261.7725	21.9589	
Total	114	2525.8608		

* Significant at the .05 level

The data analyses presented in Tables I-V support our original fears that it was unrealistic to hope for significant impact on general self-concept by a treatment that occupies 10% of the child's class time for one year. There is not a strong indication of significance in favor of the experimental group. There is a weak significant gain on the Piers-Harris test, (see Table I) and there is a general trend in favor of the experimental group (see Figure 3: Sample Means). One does notice a significant treatment grade interaction on the Crandall scores (see Tables II, III, and IV). In this case the fifth graders gained more than the third or fourth. Certainly, this evidence is too skimpy to support it, but one could hypothesize greater impact of an abstract, conceptually-oriented program on children with higher level of conceptualization. It is regrettable that the Chase Level of Conceptualization Test was not available to aid a further investigation of this idea.

Evaluation Year Attitude Data

During the 1971-72 year the Piers-Harris, Crandall, Bialer-Cromwell, and Gotts instruments were all administered on a pre-test - post-test basis to all SEED and control classes. It may be worth noting that the school year was interrupted by a lengthy teacher strike, after the settlement of which, the full complement of class sessions was fulfilled. It is the judgment of the evaluators that this interruption did not materially affect the data. Summaries of the evaluation year data follow in Tables VI-X and in the Gotts paper which appears as Appendix C.

Table VI

Analysis Of Covariance With Pre-Test As Covariate

Piers-Harris 1971-72

	DF	SS	MS	F
Treatment	1	3.4316	3.4316	0.0000
Grade	2	1738.0849	869.0424	7.1608 *
Sex	1	168.4218	168.4218	1.3877
Treatment X Grade	2	981.1689	490.5844	4.0424 *
Treatment X Sex	1	515.3857	515.3857	4.2467 *
Grade X Sex	2	24.4462	12.2231	0.1007
Treatment X Grade X Sex	2	295.5966	147.7983	1.2178
Residual	374	45388.4170	121.3594	
Total	385	49114.9531		

* Significant at the .05 level

Table VII

Analysis Of Covariance With Pre-Test As Covariate

Crandall I+ 1971-72

	DF	SS	MS	F
Treatment	1	19.9921	19.9921	1.5880
Grade	2	21.4672	10.7336	0.8525
Sex	1	9.6006	9.6006	0.7625
Treatment X Grade	2	11.4110	5.7055	0.4532
Treatment X Sex	1	48.9434	48.9434	4.6819 *
Grade X Sex	2	26.9296	13.4648	1.0695
Treatment X Grade X Sex	2	38.7197	19.3598	1.5377
Residual	366	4607.7218	12.5894	
Total	377	4794.7857		

* Significant at the .05 level

Table VIII

Analysis Of Covariance With Pre-Test As Covariate

Crandall I 1971-72

	DF	SS	MS	F
Treatment	1	0.0831	0.0831	0.0114
Grade	2	9.5151	4.7575	0.6556
Sex	1	3.6784	3.6784	0.5069
Treatment X Grade	2	1.9068	0.9534	0.1313
Treatment X Sex	1	0.0954	0.0954	0.0131
Grade X Sex	2	11.2904	5.6452	0.7780
Treatment X Grade X Sex	2	23.0470	11.5235	1.5881
Residual	365	2648.4628	7.2560	
Total	376	2698.0795		

Table IX

Analysis Of Covariance With Pre-Test As Covariate

Crandall I 1971-72

	DF	SS	MS	F
Treatment	1	2.1110	2.1110	0.0889
Grade	2	241.3139	120.6569	5.0856 *
Sex	1	10.1943	10.1943	0.4296
Treatment X Grade	2	8.2907	4.1453	0.1747
Treatment X Sex	1	9.3890	9.3890	0.3957
Grade X Sex	2	13.5480	6.7740	0.2855
Treatment X Grade X Sex	2	112.3535	56.1767	2.3678
Residual	367	8707.0841	23.7250	
Total	378	9104.2849		

* Significant at the .05 level

Table X

Analysis Of Covariance With Pre-Test As Covariate

Bialer-Cromwell 1971-72

	DF	SS	MS	F
Treatment	1	10.7638	10.7638	0.4558
Grade	2	92.1006	46.0503	1.9504
Sex	1	11.5600	11.5600	0.4896
Treatment X Grade	2	6.7692	3.3846	0.1433
Treatment X Sex	1	40.8416	40.8416	1.7298
Grade X Sex	2	39.2064	19.6032	0.8302
Treatment X Grade X Sex	2	33.3452	16.6726	0.7061
Residual	366	8641.3176	23.6101	
Total	377	8875.9047		

One does not find a trend in the mean gains of the evaluation year data for the generalized self-concept instruments. One does, however, find some significant results concerning arithmetic self-concept as reported in the Gotts paper, (see Appendix C).

Arithmetic self-concept of control children was unchanged over the school year. In contrast, the SEED children increased significantly in a positive direction during their program participation ($p = .0039$) as determined by a repeated measures design analysis of variance. The SEED group's self-concept was unaffected in the areas of reading, spelling, science and overall academic self-concept, although their art self-concept became more negative ($p = .0042$).

Follow-Up Year Attitude Data (1972-73)

During the school year after Project SEED was terminated in Gary a follow-up study was made of children who had participated in Project SEED during the previous two years. Approximately 56% of the children were located, and were evaluated in two ways. The children were interviewed to ascertain any residual feelings that they had toward Project SEED. They were also tested on the Crandall instrument since it had seemed to be the most sensitive of the generalized self-concept measures. The interviews and the testing are reported separately below.

In oral interview sessions children in the experimental classes were asked to respond to the following questions:

1. What is your favorite subject?
2. What did you learn in Project SEED classes?

3. Did you like SEED classes? Why?
4. Were SEED classes like your regular math classes?
5. Do you feel that having participated in SEED classes has helped you in your math at the present time?

The results of the interview are tabulated below:

1. Favorite Subject -

Math	Reading	Spelling	Music	Gym	Science
56%	12%	8%	8%	8%	8%

2. What have you learned in SEED classes: (items mentioned by the children) *

Fractions	28%
Games	60%
Algebra	28%
Mini Add	16%
Alpha	12%
Symbol Letters	4%
Positive, Negative	16%
Don't Know	4%

* Some children indicated more than one item.

3. a) Did you like SEED classes?

Like	80%
Dislike	8%
Not Much	8%
Not Sure	4%

b) Why?

Played more games	12%
SEED teacher explained things	28%
More fun	36%
Had own book	16%

4. Were SEED classes like your regular math classes?

Similar	4%
Not Similar	84%
Not Sure	12%

5. Did participation help?

Helped	48%
Did Not Help	12%
Not Sure	40%

There seems to be a strong, positive recollection of SEED classes for most children which is reported directly and which is reflected indirectly in a residual positive feeling toward mathematics. There did seem to be some uncertainty in the children's minds as to the extent to which SEED had helped them in their other school work.

185 children were retested using the Crandall instrument. 60 of them had received SEED instruction in 1970-71 and not in 1971-72; 111 of them had received SEED instruction in 1971-72 only, and 14 had received SEED instruction in 1970-71 and 1971-72. Comparisons of the follow-up means of the different groups with each other and with their respective previous means show no significant effect due to length of treatment or recentness of treatment nor any erosion of attitude with time (see Figure 3).

Teacher Interview (1972-73)

The teachers of the SEED classes were also interviewed at the same time the children were interviewed. All the teachers agreed that the children enjoyed the SEED classes and seemed to have benefited from them. In terms of negative aspects of SEED, most teachers (7 out of 12) agreed on the following three aspects.

a. SEED teachers seem to repeat same things over and over.

b. SEED teachers did not have as much control as the regular teachers.

c. Sometimes children seemed to get restless and bored.

Teacher Behavior Observations (1971-72)

A prominent characteristic of the SEED teaching technique is the use of a guided discovery method that tends to minimize teacher information giving and maximize student participation. So, in an attempt to ascertain any potential lasting effects of Project SEED on the instruction in the Gary schools, a modified version of Flanders interaction analysis was used.

Flanders interaction analysis stipulates ten (10) different ways to classify classroom interaction. They are -

I. accepting feeling

II. praise or encouragement

III. accepting ideas

IV. asking questions

V. lecturing

VI. giving directions

VII. criticizing, justifying authority

VIII. student response - teacher initiated

IX. student response - student initiated

X. silence, confusion, classroom paper work, etc.

It was hypothesized that:

a. There would be a decrease for the experimental teacher in the categories V, VI, VII and an increase in the category IV.

b. In the student response area there would be, in the experimental classes, increases in categories VIII and IX, as compared with control classes.

c. SEED instructors would score higher in category IV and lower in categories V, VI, and VII than either the homeroom teachers or the control teachers and also that their classes would score higher in categories VIII and IX than those conducted by homeroom or control teachers.

To test these hypotheses, 6 sets of observations were made during the 1971-72 academic year. Each homeroom, control, and SEED instructor was video-taped 6 times during this period while teaching mathematics. The middle 25-30 minutes of the lesson was rated by trained observers using groupings of categories from the Flanders scale (IV; V, VI, VII; and VIII, IX). The averages of the percentages of class time used in these categories for the SEED, homeroom, and control teachers are reported below.

Category IV

Tape Number	1	2	3	4	5	6
SEED Teachers	38	36	37	32	29	26
Homeroom Teachers	21	28	26	27	31	32
Control Teachers	22	20	21	23	24	23

Percentage of class time used

Categories V, VI and VII

Tape Number	1	2	3	4	5	6
SEED Teachers	26	20	24	27	28	30
Homeroom Teachers	37	31	34	32	32	31
Control Teachers	36	38	39	35	38	39

Percentage of class time used

Categories VIII and IX

Tape Number	1	2	3	4	5	6
SEED Teachers	30	28	32	29	29	26
Homeroom Teachers	21	22	24	24	25	24
Control Teachers	22	20	21	18	21	21

Percentage of class time used

The trends in this data clearly support the hypotheses concerning homeroom teacher improvement with respect to all categories. Moreover, earlier observations of the SEED teachers find them superior (with respect to discovery teaching) to homeroom and control teachers in all categories. However, there is a surprising regression found among the SEED teachers to the point that in Category IV they fall far below the homeroom teachers by the sixth observation.

Summary Comments

The findings of the evaluation reported here will be disappointing to one who hoped to see clearcut proof that Project SEED either does or does not live up to its claims. However, the results of this study, together with those of various other formal and informal evaluations do seem to paint a fairly clear and consistent picture. Children who have been exposed to SEED instruction do somewhat better in mathematics than those who have not been exposed. Moreover, they do not seem to do worse in their other subjects. Children like SEED classes and this positive feeling in many cases transfers to mathematics in general. While the duration and intensity of SEED instruction does not seem sufficient to have a significant effect on a child's general concept of himself, there is evidence that SEED instruction makes the child feel better about himself as regards mathematics.

In addition to the direct benefits on children there are several peripheral or spin-off benefits that should be noted. Teachers and administrators like SEED. Generally they feel that it benefits their children, it gives teachers a chance to observe their children with another instructor and to reassess their own approaches and strategies, and it introduces some interesting new faces into the school. One should also not discount the influence that the SEED experience has had on trained mathematicians. Many have, at least, been awakened to some of the problems of mathematics instruction in the schools. Some have even been influenced to make career decisions in the direction of mathematics education.

One may ask why, if all of the above statements are true, Project SEED has not become a national education priority. SEED is expensive. It occupies "prime-time" hours of highly trained personnel. Moreover, it does not replace other personnel. Also, even though SEED seems to have some impact on the behavior of the homeroom teacher, there is little likelihood of the homeroom teacher replacing the SEED instructor. As a consequence, many professional educators feel that Project SEED is, at best, an ad hoc band-aid placed on deep wounds using funds that might partially support a more general cure. SEED supporters retort that at least SEED has some positive impact, whereas many educational innovations have little. Without pretending to resolve this difference, one can say that there is still a serious problem concerning educational priorities and the cost-effectiveness of Project SEED. However, on the basis of this study and others, there seems to be some justification for the homeroom teacher and administrator to cooperate with Project SEED when they can do so without making major sacrifices.

APPENDIX A

AN ARITHMETIC COMPETENCY MEASURE OF SELF-CONCEPT FOR ELEMENTARY SCHOOL CHILDREN[1]

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The present investigation sought to clarify the status of arithmetic self-concept in contrast to general academic self-concept in elementary school children. Combs and Soper (1967) had previously established for kindergarten and first grade children that the child's academic self-concept is already differentiated into particular areas of competency, e.g., reading, arithmetic. Their procedures for determining these variations were systematic observation and recording of child behaviors. Such data are difficult and expensive to collect and thus would be impractical to obtain in ongoing program evaluations, although their value to basic self-concept research is unquestioned.

Dil and Gotts (1971-72) developed in 1968 a self-report measure for use with low track students (low achievers). The procedure was relatively informal psychometrically, with the principal effort being directed toward determining the areas of self-conception which are criterial to the definition of self-adequacy in arithmetic. An experimental procedure was used concurrently to improve the arithmetic self-concept of these bottom level achievers. Techniques of modifying student attitudes toward arithmetic have been little studied (Aiken, 1970). Combining the study of techniques with that of attitude measurement development, as a research strategy, offers the possibility of obtaining validity checks on any new measure with reference to change as well as to preexisting status. This strategy is employed in the present study as well as in the work of Dil and Gotts (1971-72). Criterial aspects of arithmetic self-concept which were examined (Dil & Gotts, 1971-72) related to:

1) Estimates of the number of problems (types of problems identified) that one could complete correctly in a given time period.

2) Estimates of one's capacity to compete successfully with another child in solving problems at the chalkboard.

3) Estimates of one's own "smartness" (children's preferred term) in arithmetic.

4) Expressions of enjoyment about doing arithmetic.

5) Estimates of one's personal improvement in arithmetic performance.

Treated children improved during the course of the procedure in arithmetic self-concept in each of these five respects as well as showing what appeared to be valid evidence of preexisting status, as gauged by a tentative measure.

Procedure

The prior validation of the foregoing types of individually administered, self-reference statements as indices of an attitudinal component of arithmetic self-concept suggested that it would now be possible to formalize them into a group measuring instrument of more standard format. Brief self-reference statements centering around these issues were prepared. Wording of items was maintained at about a second to third grade listening comprehension level to guarantee that fourth and fifth grade low-achieving pupils would be able to understand them.

All children were enrolled in Title I-funded inner city schools. Mean Iowa Tests of Basic Skills reading comprehension level for the fourth graders ranged in three participating schools from 3.2 to 3.5 with medians being slightly lower. Children's arithmetic achievement levels ranged from 3.7 to 3.9. Medians again were slightly lower. National norms for these groups are 4.1 for reading and arithmetic, showing these schools to have a significant but not overwhelming lag behind norms. Four fourth grade (N = 82) and two fifth grade (N = 45) classes constituted the initial sample for testing the arithmetic self-concept items. One-half of the total sample, balanced by grade level, served as a control group while the other half participated in an experimental mathematics program, Project SEED. One experimental and one control class were selected from each of three schools to minimize effects due primarily to inter-school variations. Between classroom variations within schools were uncontrolled.

A subgroup of arithmetic self-concept items (N = 6) were assembled into a 26-item scale of academic self-concept, "About Me and My School work." They were interspersed with five items each of types dealing with reading, spelling, art, and science. Items drawn from arithmetic plus the other school areas were worded in parallel to equate them approximately for subjective difficulty of task performance. One parallel set of items was prepared to represent each of the five criterial areas of self-conception listed earlier. The 26-items of this first instrument taken together were designed to measure overall academic self-concept in elementary school children. The general form in which these items were stated rendered them appropriate as self-reference statements for at least grades two through six.

A second instrument bearing an identical title to the preceding one was prepared to measure arithmetic self-concept only. The items all were of type-1 of the earlier list of self-reference statements. The twelve items of this instrument were appropriate only to grades four through six, because they included references to some types of arithmetic problems which are not introduced in the curriculum until grade four.[3] They included examples of counting, addition, and subtraction problems that all fourth graders, who are at the median level for their grade, would have previously mastered.

They also contained problems of multiplication and division about which many fourth graders would feel less than self-confident.

Each item of the two instruments was stated in declarative form. The test administrator explained to the classroom groups that he would read aloud some things about them and their school work, and would then ask them to tell which answer choice best showed how the statement made them feel. Two samples were completed during which children were shown how to use a seven-point scale of subjective magnitude to represent how they felt about the statements. Subjective magnitude was jointly represented for them both verbally (i.e. 1. "very, very happy," 2. "happy," 3. "just a tiny bit happy," 4. "neither happy nor unhappy" or "don't have any feelings," 5. "only a tiny bit unhappy," 6. "unhappy," and 7. "very, very unhappy,") and pictorially with faces varying both in size and emotional expression to match the verbal definitions.

Boys received a sheet of line drawings of boys' faces and girls of girls' faces. Drawings were arranged from left to right in a row ordered 1 - 7 as defined above. Line drawings were completed to render the faces racially ambiguous so the form could be used in inner-city multi-racial classrooms. Each child kept this sheet in front of him and was advised to examine it whenever he made a response to the question of how he felt about the preceding statement. It was also explained to the children that they were using the faces to show how *they* felt. Children registered their choices by circling a number from the series (1 - 7) that appeared directly below each printed statement.

Separate instructions were given for completion of the overall academic self-concept form and the arithmetic self-concept form. The latter set of instructions emphasized that one was not to solve the arithmetic problems but was instead to think about a) whether he would like to work them and

b) whether he thought he would be able to do them correctly. Then he was to indicate how he felt. All questions were read aloud because children's listening comprehension usually exceeds their reading comprehension. Children were encouraged to follow along as the test administrator read. All forms were completed in the child's regular classroom with the teacher present.

Results and Discussion

Scale Properties

Correlations were computed between each item and the subscale to which it was assigned--either for overall academic self-concept or arithmetic self-concept. With 26 and 12 items, respectively, in these scales, the part-whole correlation phenomenon tends to be insignificant. Item to scale correlations for academic self-concept ranged from .24 to .57 (n = 126), with 25 of the correlations exceeding .41. Using the Cronbach alpha coefficient as an index of internal consistency, this yielded a reliability estimate of .87. For arithmetic self-concept, item-scale correlations ranged from .38 to .76 with 11 items exceeding .54. Alpha for this 12-item scale was .85. All 38 items were retained as satisfactory. A three-month stability coefficient for academic self-concept was .78 and for arithmetic .66.

A composite was also formed by summing the two scales. Alpha for the composite was .91. The general tendency was for items of the first scale to maintain the magnitude of their correlations to the new total, while arithmetic self-concept items were correlated at consistently lower levels with the composite than with their own scale. Overall, however, the actual magnitudes of correlations of arithmetic self-concept items with the composite were higher than were those of the academic self-concept items. The median item-composite correlation for arithmetic self-concept items was .54, whereas the median for academic self-concept items was .46. This suggests that the greater specificity of the arithmetic self-concept items permits a more precise sampling of the underlying self-reference attitudinal component. It is also true, however, that the six arithmetic statements which are embedded within the academic self-concept scale obtained a median correlation of .54 with the composite, so that, excluding them, the median item-composite correlations for the remaining, more deverse items was .45. What cannot be ruled out, then, is that the composite, now containing 18 items referring to arithmetic, is sufficiently saturated with that content to account for the higher correlations of arithmetic items to composite score.

From the academic self-concept scale, it is also noteworthy that items 21-26, which invite the child to tell a substitute teacher how smart he is in relation to the various academic areas, have a median correlation of .55 with the composite score. This supports the interpretation that self-adequacy is the essential construct being referenced by the total scale. When combined with the earlier remarks on the possible effects of specificity of item content, the tentative conclusion to be reached is that items inviting direct estimates of personal competency and those asking for estimates of one's capability to complete particular problems or tasks successfully more readily elicit self-reference responses that are relevant to the construct, self-concept in school.

<u>Validity of Scales</u>

Validity will be considered first in terms of the relationship between the self-concept measures and other standard tests. A further type of validity analysis begins by recognizing that the obtained correlation between a self-concept measure and some index of actual ability is partly a function of reality and partly of non-reality. It is a function of reality to the extent that the self-reference statements which one endoreses are congruent with his abilities, if abilities are a factor in the particular performance in question. Non-reality is evidenced both as overestimates and underestimates of self-concept as a function of one's abilities.

The experimental Ss were already participating in the SEED mathematics program at the time of the pre-test administration of "About Me and My School Work." This was of course a potential source of influence on any correlational results, so validity coefficients were computed for control Ss only. Validation variables were obtained from regular school-system scheduled administrations of the Lorge-Thorndike Intelligence Test, Iowa Tests of Basic Skills, and the Metropolitan Reading Tests. Because these are normally given in grade four, concurrent validity could be determined for only this grade level, based on children from two different schools. The number of control Ss varied from 35 to 37 for the various measures; the smallest n was used to determine degrees of freedom (33).

Arithmetic self-concept scores were consistently negatively related to achievement and intelligence. Since lower scores represent higher self-concept, the relationship of self-concept to achievement and intelligence was positive. All coefficients exceeded the .01 confidence level for being greater than zero order (Table 1). Academic self-concept was unrelated to any achievement or intelligence variable at the .05 level.

(Insert Table 1 about here.)

These results are congruent with the interpretation that the more general items of the academic self-concept scale were probably related to self-concept components less determined by actual ability and achievement, i.e., those related more to one's history of social-emotional development and, thus, likely more related to traditional self-concept indices. The arithmetic self-concept scale related more directly to the objective, perceivable facts of concurrent ability and achievement. The former measure, therefore, probably references the child's overall conception of himself as competent, whereas the latter yields an estimate of competence in very particularized school-related activities. Variation within the set of significant correlations was relatively small, so no significance tests were made for differences between pairs of these. However, it may be noted descriptively that the largest amount of variance was accounted for by intelligence, with math problem solving and reading scores assuming a closely grouped intermediate position of magnitude.

To undertake the second kind of validity analysis requires that correlational comparisons be made between the experimental and control Ss. If the experimental treatments of Program SEED were successful, one might expect to observe a reduction in the contribution of non-reality factors to the relationship found between arithmetic self-concept and measures of ability and achievement. In view of the relative clarity with which the child probably perceives his ability level, if non-reality produced distortions appeared they could be expected to have operated to magnify the apparent relations between specific self-competency perceptions in arithmetic and ability measures, i.e., to have produced larger correlations. The non-reality of such perceptions becomes evident when one considers that there is no strong _a priori_ ground for predicting that direct arithmetic computations, such as those mentioned in the self-concept items, would relate strongly to general ability. That predicted relationship would only be made in view of reality distortions of a stereotyping nature in which the child's knowledge of his own general ability becomes generalized to his estimates of his specific competency for completing particular academic tasks, however relevant or irrelevant general ability may be to the tasks.

Correlations for the experimental Program SEED group between arithmetic self-concept and measures of ability and achievement were all non-significant

(Table 2). The number of cases varied from 41 to 56 on the various measures.

(Insert Table 2 about here.)

The zero order correlations were also found for academic self-concept.

Comparisons were next made of these correlations between the experimental (Table 1) and control (Table 2) groups, using formulas for testing the difference between two correlations for independent samples (Edwards, 1960). All six of the differences exceeded z values of 2.0, with a z of 1.645 being required to reject the hypothesis of the correlations not being different. The experimental program, thus, apparently did have the effect of reducing the non-reality derived relationship between ability and arithmetic self-concept. It may be observed descriptively that all of the correlations for the experimental group are zero order for arithmetic self-concept as well as for academic self-concept.

Conclusions

A psychometrically acceptable measure of arithmetic self-concept was constructed from items referring to whether the child could complete particular arithmetic problems correctly. Problems mentioned were those appropriate to that grade level. With only 12 items, internal consistency was .85 and test-retest over a two- to three-month period was .66.

Validity coefficients between arithmetic self-concept scores and six ability and achievement measures ranged from -.46 to -.57, all exceeding the .01 significance level. Discriminant validity was demonstrated by the failure of a more global measure, academic self-concept, to predict these same relationships. The arithmetic self-concept measure also successfully detected the effects of Program SEED upon a group of experimental children. A reduction was predicted of ability stereotyping effects upon child reactions to the specific computational tasks mentioned in the arithmetic self-concept scale; this was confirmed.

Further work with this arithmetic self-concept scale should center around examining the possible relations between it and six other arithmetic-related items within the academic self-concept scale. The six items of the academic self-concept which portray the child as telling a substitute teacher about his smartness also appeared to be related to the fundamental construct, conception of the self as adequate or sufficient. Possible expansion of this item group and readministration together with that of the arithmetic self-concept scale, would possibly clarify further the exact construct meaning of arithmetic self-concept.

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Footnotes

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2. The author's address during a postdoctoral internship for 1971-72 is: John F. Kennedy Child Development Center, University of Colorado School of Medicine, Container 2741, 4200 East Ninth Avenue, Denver, Colorado 80220.

3. A successful adaptation of this same format for use at grade one has been made by Nina Ronshausen as a part of a remedial tutorial program.

TABLE 1

CONCURRENT VALIDITY COEFFICIENTS FOR SELF-CONCEPT MEASURES OF CONTROL Ss

	Arithmetic Self-Concept	Academic Self-Concept
Verbal I Q	-.57**	-.12
Non -Verbal I Q	-.56**	-.03
Math Concepts	-.46**	-.17
Math Problem Solving	-.53**	-.25
Iowa Reading	-.51**	-.29
Metropolitan Reading	-.52**	-.11

** Significant at .01 level.

TABLE 2

CORRELATIONS FOR EXPERIMENTAL Ss FOLLOWING
PROGRAM SEED PARTICIPATION

	Arithmetic Self-Concept	Academic Self-Concept
Verbal I Q	.20	.06
Non-Verbal I Q	-.03	-.02
Math Concepts	.05	.12
Math Problem Solving	-.07	-.14
Iowa Reading	.05	-.02
Metropolitan Reading	.20	.03

APPENDIX B

Name ______________________________ Teacher & Room ______________________
First Middle Last

ABOUT ME AND MY SCHOOL WORK

Example 1. Very good. You did an excellent job. (How feel?)
1 2 3 4 5 6 7

Example 2. Your friend hurt his hand on the school grounds. (How feel?)
1 2 3 4 5 6 7

A You have 20 new arithmetic problems to finish before tomorrow. (How feel?)
1 2 3 4 5 6 7

B You have to read 20 pages from a story book before tomorrow. (How feel?)
1 2 3 4 5 6 7

C You have to learn 20 new spelling words before tomorrow. (How feel?)
1 2 3 4 5 6 7

D You have to draw 20 small pictures before tomorrow. (How feel?)
1 2 3 4 5 6 7

E You have to learn 20 new science facts before tomorrow. (How feel?)
1 2 3 4 5 6 7

F You are having an arithmetic contest in front of the class with children from your room, to see who is best at arithmetic. (How feel?)
1 2 3 4 5 6 7

G You are having a picture drawing contest in front of the class with children from your room, to see who is best at drawing. (How feel?)
1 2 3 4 5 6 7

H You are having a science contest in front of the class with children from your room, to see who is best at remembering science facts. (How feel?)
1 2 3 4 5 6 7

I You are having a spelling contest in front of the class with children from your room, to see who is best at spelling. (How feel?)
1 2 3 4 5 6 7

J You are having a reading contest in front of the class with children from your room, to see who is best at reading. (How feel?)
1 2 3 4 5 6 7

K Your parent asks if you like to study arithmetic at school. (How feel?)
1 2 3 4 5 6 7

L Your parent asks if you like to study art at school. (How feel?)
1 2 3 4 5 6 7

M Your parent asks if you like to study science at school. (How feel?)
1 2 3 4 5 6 7

N Your parent asks if you like to study reading at school. (How feel?)
1 2 3 4 5 6 7

O Your parent asks if you like to study spelling at school. (How feel?)
1 2 3 4 5 6 7

P Your teacher compares your daily work in arithmetic to the arithmetic work that you did earlier this year. (How does this comparison make you feel?)
1 2 3 4 5 6 7

Q Your teacher compares your daily work in spelling to the spelling work that you did earlier this year. (How does this comparison make you feel?)
1 2 3 4 5 6 7

R Your teacher compares your daily work in science to the science work that you did earlier this year. (How does this comparison make you feel?)
1 2 3 4 5 6 7

S Your teacher compares your daily work in reading to the reading work that you did earlier this year. (How does this comparison make you feel?)
1 2 3 4 5 6 7

T Your teacher compares your daily work in art to the art work that you did earlier this year. (How does this comparison make you feel?)
1 2 3 4 5 6 7

U You have to tell the substitute teacher how smart you are in arithmetic. (How feel?)
1 2 3 4 5 6 7

V You have to tell the substitute teacher how smart you are in science. (How feel?)
1 2 3 4 5 6 7

W You have to tell the substitute teacher how well you do on art work. (How feel?)
1 2 3 4 5 6 7

X You have to tell the substitute teacher how smart you are in reading. (How feel?)
1 2 3 4 5 6 7

Y You have to tell the substitute teacher how smart you are in spelling. (How feel?)
1 2 3 4 5 6 7

Z You have to tell the substitute teacher how smart you are in arithmetic compared to the smartest child in your room. (How feel?)
1 2 3 4 5 6 7

Name ________________________________ Teacher & Room ____________________
First Middle Last

ABOUT ME AND MY SCHOOL WORK

AA The teacher asks you to show the class how to add 117 (How feel?)
243
+768

1 2 3 4 5 6 7

BB The teacher asks you to show the class how to subtract 641 (How feel?)
-386

1 2 3 4 5 6 7

CC The teacher asks you to show the class how to multiply by 8's and by 9's.

1 2 3 4 5 6 7

DD The teacher asks you to show the class how to multiply 37 (How feel?)
x 6

1 2 3 4 5 6 7

EE The teacher asks you to show the class how to divide 6/1860 (How feel?)

1 2 3 4 5 6 7

FF The teacher asks you to count to 125 without making a mistake. (How feel?)

1 2 3 4 5 6 7

GG The teacher asks you to count to 50 by 2's without a mistake. (How feel?)

1 2 3 4 5 6 7

HH The teacher asks you to count to 100 by 5's without a mistake. (How feel?)

1 2 3 4 5 6 7

II The teacher asks how many times you will have to go to the store to bring home 10 large bags of potatoes if you can carry only one bag at a time. (How feel?)

1 2 3 4 5 6 7

JJ The teacher asks how many children were out during recess if there are four rooms with 29 children each and one room with 28 children. (How feel?)

1 2 3 4 5 6 7

KK The teacher asks how many pieces of cake you will need if you serve 12 people and want to have four pieces left for later. (How feel?)

1 2 3 4 5 6 7

LL The teacher asks you how many 1/2 oranges are there in 21 oranges. (How feel?)

1 2 3 4 5 6 7

APPENDIX C

SELF-CONCEPT EFFECTS OF PROJECT SEED UPON LOW-ACHIEVING ELEMENTARY SCHOOL PUPILS

Edward Earl Gotts
Indiana University

In an earlier report this writer detailed the development of an arithmetic competency measure of self-concept for elementary school children (Gotts, 1971). It was concluded that the instrument was psychometrically acceptable in its 12-item form. That study suggested that these items be combined with six others, which related to arithmetic competency, from within the overall academic self-concept scale. The present study examines further questions of the psychometric properties of this expanded, 18-item scale and investigates the effects upon self-concept of participation in Project SEED.

METHOD

Subjects

A total of 273 children who participated in the experimental program, Project SEED, were present for an initial testing with the academic self-concept instrument and became part of this study. They were from seven classrooms of fourth graders and two of fifth graders which were drawn from six different schools in Gary, Indiana. A control sample of 245 children from the same six schools contained children from six fourth grade, one fifth grade, and one sixth-grade classrooms. As in the initial study, the control sample appeared from preliminary analyses of fourth graders to be superior in achievement and self-concept, so comparisons were largely made of experimental children's terminal performance to their own initial performance.

Procedure

Of the experimental subjects, 215 were present for both pre-testing and post-testing of academic self-concept, which occurred in the fall and spring of school year 1971-72. Most of these children (196 for pre-testing; 197 for post-testing) also completed the Piers-Harris, a measure of children's generalized self-concept which includes a sizable representation of school-related items. Because of a teacher strike which came near the end of the post-testing period, only fragmentary achievement testing and IQ results were available. These were so limited as to obviate most statistical comparisons.

The academic self-concept scale was scored into its various subscales. During pre-testing the 18-item arithmetic self-concept scale had an internal consistency coefficient of .92 (alpha) and a mean of 48.53 for the combined sample of 518. A 5-item reading self-concept scale (alpha = .80) had a mean of 13.37; 5-item spelling (alpha = .81) mean 12.73; 5-item art self-concept (alpha = .78) mean 11.82; and 5-item science self-concept (alpha = .85) mean = 16.44. The combination of these scales, a 38-item scale of academic self-concept had an alpha coefficient of .96 and a mean of 102.88. A smaller mean, using the present scoring procedure, is reflective of a more positive self-concept. The school year plus Project SEED had the combined effect of increasing the variance for each of the above scales and thus increasing all the internal consistency coefficients. Changes in the means are discussed below.

RESULTS

Arithmetic self concept of control children was unchanged over the school year, whereas they declined slightly in overall academic self concept. This decline was not prominent in any of the academic self-concept subscales but rather an accumulation of small changes. In contrast, the experimental SEED children who tended initially to be lower than the controls in arithmetic self concept increased significantly in a positive direction during their program participation ($p = .0039$), as determined by a repeated measures design analysis of variance. The SEED group's self-concept was unaffected in the areas of reading, spelling, science, and overall academic self-concept, although their art self-concept became more negative ($p = .0042$).

A correlational analysis of the available measures for the SEED group was performed, with variable numbers of cases for particular comparisons. Stability coefficients across the school year for self-concept components were: arithmetic (.46), reading (.45), spelling (.46), art (.40), science (.43), and overall (.46). These values fell on the average at positions median to the intercorrelations of the scales among themselves within a particular testing occasion. Reading self-concept tended to have the most consistently higher positive relations to the other components (median $r = .50$). Art self-concept had the most consistently lower positive relations to the other components (median $r = .33$). The foregoing comparisons were all based on 215 cases and all are hence significant correlations.

The question of the relation of academic self-concept and its various components to generalized self-concept was tested by comparing scores from these measures with the Piers-Harris. Concurrent administrations yielded low correlations (range -.04 to -.34), with the arithmetic and spelling components being most highly related to the Piers-Harris. Arithmetic self-concept alone was as highly related to the Piers-Harris as was overall academic self-concept during both testing occasions. It will be recalled that a low score on academic self-concept reflects a positive direction, as does a high score on Piers-Harris, so the negative correlations are as were to be expected. Non-concurrent administrations produced even smaller relations in each instance. Either 196 (pre-) or 197 (post-) children were involved in these comparisons.

Tested reading achievement (n = 75) was positively related to arithmetic self-concept during post-testing only (vocabulary r = -.38, comprehension r = -.39). No other self-concept components were significantly related to reading achievement. The number of children who completed math achievement testing (n = 31) was too small to permit any meaningful analyses.

DISCUSSION

It is first evident that Project SEED was successful in improving the arithmetic self-concept of participants while leaving unaffected their overall academic self-concept. It is unfortunate that the teacher strike prevented the concurrent collection of math achievement data, since these in conjunction with the present finding would have served further to clarify the nature of the changes in self-concept, e.g., whether they were most prominent in those children who were most improved in actual achievement. The finding of a significant drop in art self-concept was intriguing in connection with the arithmetic self-concept finding. It may suggest that children who shift their emotional investment more heavily into an area such as arithmetic do so at the expense of other areas such as art, at least temporarily. This would be consistent with the interpretation that compensation is a healthy psychological adaptive mechanism available to upper elementary level children. This interpretation could again have been tied down more firmly had actual achievement data in math been available.

The somewhat higher than desirable intercorrelations among the academic self-concept component scales relative to their respective stability coefficients is suggestive of method-specific variance in the item format itself. This would be generally consistent with the attitude research literature which reveals consistent method-specific variance with intensity-estimate item formats. Fortunately the actual self-sentiment variance present seems to be sufficient to permit detection of group differences. This may not, however, provide evidence supporting the use of this as a measure of individual cases. The use of this format as an individual measure has been demonstrated, nevertheless, by Nina Ronshauser in a study mentioned in the prior report (Gotts, 1971).

The finding of consistently more positive relations of reading self-concept and of less positive relations of art self-concept to the other components reflect the relative degrees of centrality of these components to the overall outlook of the child toward his ability to learn. Feeling more adequate as a reader undoubtedly contributes significantly to the impression of being able to handle other academic work, most of which (e.g., science, math) requires adequate reading skills. Art in this sense probably contributes to the child's self-expression and sense of well being but is not as likely to increase his sense of confidence in himself as "academically adequate." The initially non-significant relation of arithmetic self-concept to actual reading achievement, which then became significantly positive following participation in Program SEED would be an example of the foregoing. That is, it appears supportable from this correlational finding to infer that children whose reading ability was higher were better able to convert this into gains in arithmetic and hence in arithmetic self-concept. Again it is not possible to confirm this interpretation because of the missing data on actual arithmetic gains in achievement.

It can be said with confidence that the academic self-concept measures tap into a different response system than does the Piers-Harris. In view of the fact that both are self-report type instruments, their relative independence contributes to the construct validity of the present instrument as a measure of a more limited component of self-concept than "generalized self-concept." Further, the success of the arithmetic self-concept component in detecting a math program effect which was not reflected in overall academic self-concept again contributes to the impression that it is possible, even within the common constraints of self-report, to identify progressively more particular components of self-concept which are relatable to particular life-experiences of the child. The drop in art self-concept, interpreted in terms of compensatory behavior, also strengthens this line of evidence. Incidentally, the small but significant relations between the Piers-Harris and both arithmetic and spelling self-concept may suggest that adequacy in these two specific areas contributes more to a positive generalized self-concept than does the child's overall academic self-concept. This seems reasonable for this sample of educationally low achieving children who probably, in line with much other evidence, do not hold overall academic self-concept in a high position in the hierarchy of self-perceptions which collectively constitute one's personal, generalized self-concept. If this observation is accurate, then perhaps one route to making the generalized self-concepts of low achieving children more positive is to promote by appropriate instructional means greater adequacy in those areas where these children are most often reminded of their inadequacy by reality (i.e., by arithmetic when attempting to deal with everyday monetary exchanges and such, and by spelling when attempting to write letters or engage in other expressive, written verbal communications).

CONCLUSIONS

The instrument titled "About Me and My School Work" which was used to evaluate program effects of Project SEED appears to be a valid and differential indicator of such program effects. Further evidence on the measure's direct relation to changes in objectively tested achievement level await additional research. The instrument, in its present form, appears most suitable for measuring program-related changes in overall academic self-concept and its components among fourth through sixth grade children with low achievement records relative to national norms.

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APPENDIX D

CONCEPT FORMATION THEORY AS A BLUE PRINT FOR ASSESSING ARITHMETIC CONCEPTS

By
Clinton I. Chase

A Report on Test Development
Supported by the S.E.E.D. Project

June 1973

Introduction

Educators have for some time spoken about tieing methods of instruction to theories about how children learn. However, few attempts have been made to construct tests which would allow a teacher to identify a child's stage in the learning process described by theory. For example, Gagné (1965) described learning as advancing through eight stages from stimulus response to problem solving. Achievement tests do not attempt to provide a teacher with information as to where the child is in this hierarchy of stages. This study attempted to adapt the conditions layed out by learning theorists to the building of an achievement test in arithmetic.

An early attempt to identify qualitatively differentiable stages in the development of a concept was made by Reichard, Schneider, and Rapaport (1944). These investigators concluded that concepts progressed through three levels. Children first grasped the concrete characteristics of a concept. Next they perceived the functional or usage aspect of the concept. Finally, children reached the abstraction involved where all members of a category were identified by their common characteristics.

Several attempts have been made to utilize Reichard, Schneider, and Rapaport's structure in scoring intelligence tests (Gerstein 1949, Kruglov 1953). These efforts were only moderately successful. Braun (1981) partly explained this lack of success by showing that level of concept attainment was not clearly tied to classical intelligence test scores.

However, in the assessment of children's arithmetic vocabulary (Chase 1961), in assessment of reading skill (Chase 1968), and in general vocabulary (Russell and Saadeh 1962) some success has been achieved using the Reichard et al. formulation. Each of these studies provided a stimulus concept followed by alternatives each of which represented a different level of the concept. Children selected what they believed was the "best" response. It was assumed that they would select the conceptual level at which they were operating.

The procedure of adapting test items to concept levels appears at least to have some promise in developing achievement tests. The purpose of this study was to expand on previous research in an effort to further explore the utility of the procedure.

Procedure

A list of 14 terms of arithmetic meaning and significance were acquired from Marsten's (1953) count. For each word three alternative responses were devised. One response represented an abstract definition of the work, modeled somewhat after

Gagné's concept level. A second option represented a concrete definition. A third response was a distractor. The structure of options was based on the advice of two competent judges. Options were randomly arranged in the test.

For each item the student was asked to select the response which he believed was the best definition of the term presented. The assumption was that the student would choose the level of the concept most like the level on which he was functioning.

The test was given to 105 students altogether, 54 fourth graders, 26 fifth, and 25 sixth graders. Two analyses were done: an internal statistical analysis showing item-total correlations and a criterian analysis to see if more capable students do in fact score higher (choose more abstractions) than do less capable students. The test was scored giving two points for the abstraction, one for the concrete option, and none for the distractor.

In the internal analysis each of the 13 items on the test was correlated with scores on the total test. This procedure should show the extent to which a given item is reflecting the ability that is assessed by the total test. To the extent that a given item correlates with the total score, it is accepted as measuring the construct reflected by the total test.

The item-total correlations are given in Table 1. All items correlated moderately well with the total score, indicating that all items are participating positively in the assessment of whatever is indicated by total scores.

Table 1. The Correlation of Item Scores with Total Scores

Item Number	Item-Total r
1	.45
2	.66
3	.56
4	.41
5	.51
6	.35
7	.34
8	.41
9	.40
10	.51
11	.50
12	.30
13	.34
14	.48

Several additional internal analyses were completed. Responses were tabulated across the three alternatives for each item. The attempt was to show whether or not each option was indeed plausible for some students. For every item except one, students divided themselves among the three options. No one chose the distractor for item 10 and only two chose it for item 4. In all other items the distribution of choices among options appears reasonably even. The distribution of selections across each option for each item is given in Table 2.

Table 2. Distribution of Selections of Options for Each Item

Item No.	Abstract Opt.	Concrete Opt.	Distractor
1	35	32	32
2	45	7	49
3	44	9	48
4	61	37	2
5	58	45	17
6	9	77	9
7	37	29	34
8	35	21	44
9	52	40	8
10	76	24	0
11	58	12	30
12	56	39	5
13	22	53	25
14	63	27	10

Lastly, reliability was computed by means of Cronbach's alpha technique. The resulting figure was .68, indicating a moderately reliable test. Alpha is an internal consistency procedure and indicates the extent to which a person's behavior is expected to be consistent from item to item. The distribution of responses shown in Table 2 would suggest that only moderate consistency across items would be expected.

If the test is indeed reflecting differences in concept levels, students who are most proficient in arithmetic should have chosen the higher concept level more often than students who are less proficient. Also, students in higher grades, being more mathematically experienced, should select the higher concept more often than students in lower grades. Therefore, teachers were asked to select their five most proficient and five least proficient students in arithmetic. Across the three grade levels this produced 30 students. However, data were available on only 28 of these.

A 2 x 3 analysis of variance was completed on the Arithmetic Concept scores, with two levels of proficiency and three grade levels as the variables of classification. The results are provided in Table 3.

Table 3. ANOVA for Arithmetic Concept Scores

Source	M.S.	df	F
Proficiency	227.57	1	20.32**
Grade level	194.34	2	17.35**
Interaction	.22	2	.02
Within cells	11.20	22	

**Significance beyond the .01 level

The data do indeed show that the more proficient students across all grades selected more higher-level concepts than did less proficient students. The data also show a grade level relationship, but the fourth and fifth grades are not different from each other. The sixth graders produced the largest mean score, a condition predicted from the construct behind the test. Group means are in Table 4.

Table 4. Means of Grade Levels and Proficiency Groups

Grade	Prof. Group Most	Least	Total Means
4	17.40	11.60	14.50
5	16.50	10.50	13.50
6	24.60	19.20	21.90
Total Means	19.50	13.77	

It is difficult to say why the fifth graders did not perform better than the fourth graders. Several hypotheses may be proffered. It may be that many of the concepts were at a point where work in the sixth grade advanced them into the abstract level. It may also be that the fifth grade chosen for this study was a unique one which was not prepared as well in arithmetic as some other fifth grades. Another hypothesis is that the fifth grade class may not have been motivated to work on the test as well as other classes.

Conclusions

An arithmetic vocabulary test was built in which three response options were given for each item. One response was a concrete definition of the term, one an abstract definition, and the third was a distractor. Students were asked to select the one that they believed best described the term. One point was given for the concrete option, two for the abstraction.

Older, more arithmetically experienced students were hypothesized to select more abstractions than would younger students; and the more proficient students in arithmetic were hypothesized to choose more abstractions than less proficient students. Both hypotheses were confirmed.

Item reliabilities and test reliability were moderate and satisfactory for general group use of the test.

The procedure appears to have promise for a more detailed assessment of mathematical concepts.

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APPENDIX E

ARITHMETIC VOCABULARY

NAME ______________________ SCHOOL ______________________ BOY ____

GRADE ______________________ GIRL ____

INSTRUCTIONS: This is a test to see how well you know the meanings of some words we use in arithmetic. After each word you will find three meanings. Select the ONE answer that you think tells best what the word means. Sometimes more than one answer will seem to be correct. If more than one answer does seem right, select only the ONE answer that best describes the word and place an X on the line in front of the answer you have chosen.

EXAMPLE:

Inch:

____a) you use it to measure with
____b) the width of a man's hand is about an inch
__X__c) it is a unit of measurement equal to one-twelfth of a foot

In the Example the c) answer is the best answer, since it most accurately describes what an inch is. The a) answer may also be considered correct, but it does not describe an inch as well as the c) answer, so c) was selected.

Remember to select only the one answer that you think is the best one. Work carefully but do not spend too much time on any one item.

DO NOT TURN THIS PAGE UNTIL YOU ARE TOLD TO DO SO

Check only the ONE BEST answer

1. COUNT

____ a) like 1, 2, 3, 4, ...etc.
____ b) to repeat numbers in a set order from small to large
____ c) to say numbers, one right after another

2. SMALLER

____ a) less in size or amount
____ b) a pencil is <u>smaller</u> than a baseball bat
____ c) something that is little

3. AVERAGE

____ a) add up all the amounts and divide by the number of things you added, and you will have the <u>average</u>
____ b) if John has 20¢, Jack 15¢ and Bill has 11¢, the <u>average</u> is 23¢
____ c) average is the total amount you have

4. SUM

____ a) when you have so many things
____ b) if you add 4, 2, 3 the <u>sum</u> is 9
____ c) the total amount of something

5. ADDITION

____ a) the combination of quantities into a total amount
____ b) 7 + 3 = 10, that's <u>addition</u>
____ c) counting how many of something

6. FRACTION

____ a) it is the answer when you divide
____ b) an amount less than one
____ c) 1/4, 2/3, 4/5 are all <u>fractions</u>

GO ON TO NEXT PAGE

7. ACRE

____a) when you measure land the blocks you divide it up in are called <u>acres</u>
____b) a square measure of land surface
____c) a measure of length of a piece of ground

8. QUOTIENT

____a) when you divide 8 by 2 the <u>quotient</u> is 4
____b) in a division problem the number you divide by is the <u>quotient</u>
____c) the result of dividing one number by another

9. AREA

____a) the amount of surface a thing has
____b) if I have a floor that is 10 feet long and 8 feet wide
____c) the number of cubic inches in a box

10. DECIMAL

____a) a ten year period of time
____b) when you have a numeral like 8.4, the dot is the <u>decimal</u>
____c) a dot in a numeral tells us that the figures to the right are tenths, hundredths, etc.

11. DOZEN

____a) any group of 12 objects
____b) 12 eggs is a <u>dozen</u>
____c) equal to 4 quarts

12. DIMENSIONS

____a) if I have a box 2 inches wide, 3 inches long and 5 inches high, these figures are its dimensions
____b) the size of an object is its dimensions
____c) the length, width and height of an object.

GO ON TO NEXT PAGE

13. DENOMINATOR

____a) in the fraction 1/4 the 4 is the denominator
____b) the answer to a division problem
____c) the numeral in a fraction that shows how many equal sized parts the whole is divided into.

14. CHANGE

____a) on a sale, the difference between the price of something and a larger amount of money given to pay for it.
____b) if an ice cream cone costs 15¢ and you give the clerk a quarter, your change is 10¢
____c) the amount of money you are paid for something

15. MORE

____a) a group of objects all taken together
____b) being greater in amount
____c) 8 is more than 6

APPENDIX F

THE ARITHMORISK GAMES

by
Clinton I. Chase

A report on test development
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THE ARITHMORISK GAMES

The concept of risk taking involves the willingness to attempt to gain when failure may in fact result in loss. Some people are more willing to take a chance than others. The risk involved presumedly does not appear to be as threatening to some persons as to others, hence some will gamble, while others will not. Presumedly willingness to take a risk can be measured. The intent of this study was to begin initial phases of developing a test to assess willingness of elementary school children to take risks in their work in arithmetic.

It is argued that some degree of willingness to take risks is an aid to functioning in mathematics. The student must be willing to try alternative strategies for solution of a problem, even though he may end up in error and frustration. If this is so, it may in fact be reasonable to interject into remedial mathematics work some training intended to expand ones willingness to launch out and explore ideas at the risk of making mistakes and receiving the consequences of mistakes found in many classrooms.

Kogan and Wallach (1960) found that persons less certain of their judgments conceived of risk taking, as shown by a semantic differential, as more hostile, cold, and tense than did more confident people. Also, Slakter (1969) found a moderate, positive correlation between willingness to take a risk and achievement. It may well be that willingness to take risks is associated with a feeling of assurance that success is likely. But it also may be that risk taking behavior and ability to succeed are interactive variables. In any case, ability to manipulate relevant ideas appears to be a reasonable criterion against which to assess a risk taking test.

Several studies (Wallach and Kogan 1959, Winder and Wurtz 1954) have also shown that masculinity was associated with a willingness to take risks in working with academic content? If so, sex of subject may be a second variable against which a risk taking test could be assessed.

The data submitted by Coombs and Pruitt (1960) and Royden, Suppes and Walsh (1959) support the idea that risk taking tendencies are not a dichotomized variable. Instead different individuals are willing to take different amounts of risk. A scale that intends to assess risk, then, will have to contain items which vary the risk involved from "small" to "large" amounts of risk.

Is it likely that children who are willing to take risks in quantitative matters are also likely to be risk takers and gamblers in general behavior? Slovic (1964) appears to think not. Instead he argued for a multidimensional view of risk taking. A risk taken on one dimension may well not be a risk taken on another. Therefore, scales should be oriented toward the behavioral area specifically to be observed.

In summary, it appears that a risk taking test should involve taking a variable amount of chance where a loss may be involved for failure to succeed, that achievement and sex may be relevant concomitants of willingness to take a risk, and that risk taking behavior is probably not a general trait, but somewhat specific to a given area of endeavor. The procedure employed in developing the Arithmorisk test followed these guidelines.

Procedure

Fourteen items were developed involving arithmetic situations. Each situation included two options: the student could choose to take a challenge of dealing with problems with greater complexity and a chance for greater reward, or he could choose to avoid the challenge with less reward.

The items were administered to 54 fourth graders, 26 fifth, and 25 sixth graders. Teachers of these classes were asked to submit names of the five most proficient students in mathematics and the five least proficient students. Tests were scored giving one point to the alternative that involved the risk, nothing for the alternative that involved no risk.

From the literature it appeared reasonable to hypothesize that the more proficient students would be willing to take risks that the less proficient students would not take. Therefore, scores of the proficient students were compared with the less proficient ones, to see if in fact the test did produce scores in the hypothesized direction.

A second procedure involved comparing scores based on sex of the child. Since masculinity has been shown to be related to willingness to take risks, it is hypothesized that male students will produce a higher score than female students.

The claim is presented that the Arithmorisk Games have content validity and that they produce scores which are consistent with predictions tied to the character of risk taking individuals in other studies. In addition, psychometric analyses were made including item analyses and reliability estimates.

Results

Analysis of variance was applied to the data to test the hypotheses that more able students would be more "risky" than less able students, and that males would produce higher scores than females. A 2 x 2 design was used with most and least proficient on one dimension, and males and females on the other. The analysis is shown in Table 1.

Table 1. ANOVA for the proficiency x sex analysis

Source	ss	df	F	P
proficiency	34.46	1	3.91*	.053
sex	.00	1	.00	.99
interaction	9.80	1	1.11	.30
error	[illegible]	33		

The difference between more and less proficient students was significant at essentially the five percent level. The sex difference failed to materialize. Means for the above analysis are given in Table 2.

Table 2. Means of proficiency by sex groups .

	Proficiency	
	Most	Least
Males	12.69	9.5
Females	11.57	10.60

The unpredicted mean of the least proficient females appears to have complicated the results. From the literature, this group would have been predicted to be the least risky of all. However, they actually scored higher than did the least proficient males. It may be that our culture expects males to be quantitatively more adept and they wish to avoid situations which may point up their deficiency. An additional hypothesis will be submitted later which may also explain this finding.

Two internal analyses were completed on the test: one analysis was done on the entire group of 105 combined fourth, fifth and sixth grades, and a second analysis was done separately by grade levels. The item-total score correlations are given in Table 3, along with percent of students choosing the "risky" option.

Table 3. Correlation of items with the total score, and percent of students choosing the "risky" option.

Item No.	Correlation Total Group	4th	5th	6th	Percent Total Group	4th	5th	6th
1	.24	.32	-.03	.38	87.6	85.2	84.6	96.0
2	.49	.29	.44	.72	46.7	55.6	23.1	52.0
3	.35	.25	-.15	.78	66.7	72.2	76.9	44.0
4	.66	.61	.21	.84	41.9	46.3	19.2	56.0
5	.29	.19	.14	.64	68.6	70.4	84.6	48.0
6	.63	.62	.29	.70	48.6	59.3	23.1	52.0
7	.40	.27	.39	.79	69.5	70.4	84.6	52.0
8	.39	.43	.62	.42	41.9	46.3	46.2	28.0
9	.43	.26	-.19	.80	71.4	81.5	53.9	68.0
10	.63	.71	.18	.65	50.5	59.3	30.8	52.0
11	.59	.61	.30	.75	55.2	57.4	26.9	80.0
12	.33	.23	.28	.63	81.9	81.5	76.9	88.0
13	.59	.59	.15	.71	48.6	53.7	23.1	64.0
14	.64	.66	.29	.63	47.6	59.3	11.5	60.0

The item data show the test to be working rather well in the fourth and sixth grades, but rather poorly in the fifth grade. In fact the fifth graders appear to have fallen into random behavior on many items. A reliability coefficient for that level was insignificant, bearing out this hypothesis. The KR21 reliability for the sixth grade was .92, and .70 for the fourth grade.

It appears that a response style in favor of the a) or first option appeared among fifth graders, and slightly among fourth graders. The items may have posed too difficult a reading task for these two levels, forcing the children into a response style.

This response style may also have boosted the score of the least able females, noted above. It could not, however, account for the full magnitude of their scores which averaged above 10 points. An a) response style would have produced a score of only 6 out of 14 possible points, since six "risky" options appeared in the a) position. It is interesting to note, however, that the mean for the fifth graders was 6.65, just slightly over the a) response style score. Also, their standard deviation was 1.26, indicating that the range of scores was very small. Again this provides evidence for the response style hypothesis. One may also wonder about the teacher's instructions to the fifth grade class when administering this test.

Conclusions

The Arithmorisk Games appear to have content validity, and discriminate as predicted between able and less able arithmetic students. However, they did not discriminate as predicted between males and females. This appears to be largely due to the "risky" scores of the low achiever females.

The internal analysis of the test shows satisfactory item-total correlations and reliabilities for the fourth and sixth grades, but appears to reveal a clear first-option response style in the fifth grade data. Further field testing of the instrument is needed to verify this hypothesis.

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APPENDIX G

Name ____________________________
(first) (last)

Boy_____ Girl_____

Grade _____

CHILDREN'S ARITHMORISK GAMES

On the next few pages you will find some short stories. After each story you are asked to choose one of two things to do. Here is an example:

John likes watching TV. He also likes candy. John's mother says, "John, if you will turn off the TV and do your arithmetic problems right now, I'll give you a candy bar." If you were John would you

____a) turn off the TV, do your arithmetic and take the candy, or

____b) watch TV and not get the candy.

Make your choice by putting an __X__ in front of the thing you would do if you were John.

The rest of the stories are like this. Make your choice and mark it with an __X__ on the line in front of it.

Now turn the page and start working.

1. Imagine that you could get money for correct answers on arithmetic problems, but you get no money if an answer is wrong. Would you

_____a) try a hard problem where the right answer pays $2.

_____b) try an easy problem where the right answer pays 50¢.

2. Imagine that the teacher tells you that you must solve all your arithmetic problems before going out to recess. You have your choice of one of the following. Which one would you choose?

_____a) 15 somewhat easy problems

_____b) 5 harder problems

3. Imagine that it is report-to-parents time, and you are doing "just fair" work in arithmetic so far. The teacher says, "I'll report you as doing well if you can solve these 7 hard problems, but if you miss even one, I'll report you as doing poorly. Would you

_____a) try the hard problems with a chance of being reported as "doing well."

_____b) not try the problems and take a "just fair" mark.

4. Imagine I have a group of 10 arithmetic problems. Number 1 is the easiest, 2 in the next easiest, and so on up to 10 which is a very hard problem. If you tell me how many of these ten problems you want to try, I will give you $1.00 for each one you get right. However, if you miss any problems you try you get nothing. How many problems would you be willing to try?

_____a) I think about 4 or less.

_____b) I think I'd try 5 or more.

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5. Imagine that I will give you <u>half a day</u> off from school if you write a good ten-page story on the history of Washington, D.C. I will give you a <u>whole day</u> off if you correctly solve 12 hard arithmetic problems. If either job is not done well, you get no time off. What would you likely choose?

_____a) the arithmetic problems

_____b) the 10-page story

6. Suppose you have just won a prize at throwing darts at the carnival. The man tells you he will double the prize if you can do an arithmetic problem for him at 30 seconds. You get no prize at all if you miss the problem. Would you

_____a) take your prize, and not try the problem.

_____b) try the problem in hopes of doubling your prize.

7. I have two lists of arithmetic problems. One list has 10 hard problems. The other list has 10 easy problems. a) I will give you 5 minutes free time for each of the easy ones you get right, but take 5 minutes of free time away for each easy one you get wrong. b) I will give you ten minutes free time for each hard problem you get right, and take back 15 minutes for each hard problem you get wrong. Would you

_____a) try the hard problems with a possible total free time of 1 hour 40 minutes, or

_____b) try the easy problems with a total possible free time of 50 minutes.

8. I have two jobs for a child for a while this summer. One job pays <u>$1.25</u> an hour putting boxes on different shelves. The other job is adding and subtracting numbers of items that come in and go out of the store room. This job pays <u>$1.70</u> per hour, but one mistake and you lose the job. Would you

_____a) take the shelving job for $1.25 per hour, or

_____b) take the adding and subtracting job for $1.70 per hour.

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9. Suppose your teacher tells you that your report card will be marked one of two ways. You may work ten hard problems each week for six weeks. If you get <u>half</u> of these correct you will get an "excellent" mark on your card. If you get less than half right your mark will be "average." Or you can work ten rather easy problems each week for six weeks. If you get these right you will get a "good" mark on your report card. If you miss more than one problem a week your mark will be "fair." Would you

_____a) take the hard problems hoping for an "Excellent."

_____b) take the easy problems and settle for "Good."

10. I am passing out candy bars for good work in arithmetic. I have two lists of problems. One list has ten hard problems; the other one has ten easy problems. I'll give <u>one</u> candy bar for <u>each</u> problem correctly solved on the hard list. I'll give <u>one</u> candy bar for <u>two</u> problems solved on the easy list. Would you

_____a) try the easy list with 5 candy bars almost a sure thing, or

_____b) try the hard list hoping to get more than five problems correct (and more than five bars).

11. Before going out to recess today you must finish your arithmetic problems. You have your choice of one of the following. Which would you choose?

_____a) 25 easy problems

_____b) 5 hard problems

12. Suppose I am going to pay you for getting arithmetic problems right. On one set of 5 hard problems I will pay $2 for each problem correct. On the other set of 5 not-so-hard problems I will pay only 50¢ for each problem correct. Would you

_____a) choose the 5 hard problems.

_____b) choose the 5 easy problems.

GO ON TO NEXT PAGE

13. Suppose your teacher is about to make up your report card for your parents. She says you are now doing about "satisfactory" in arithmetic. She says if you will work ten more problems in your usual arithmetic book, and get them right, she will report "good" for you in arithmetic. But if you do poorly on the 10 problems she may even report a "poor" for you. Would you

_____a) take the "satisfactory" and not try the problems.

_____b) try the problems, hoping for a "good."

14. Suppose I give candy bars for correct problems. I give everybody one bar to begin with. If you work 10 not-too-hard--not-too-easy problems in 15 minutes I'll give you 3 more bars. If you do not get the problems done in 15 minutes I'll take back the bar I gave you to begin with. Would you

_____a) take the one bar and not try the problems.

_____b) try the problems in hopes of getting the three extra bars.

CLOSE THE BOOKLET

APPENDIX I

BIALER-CROMWELL
QUESTIONNAIRE FOR KIDS

This is not a test. We are just trying to find out how kids your age think about certain things. We are going to ask you some questions to see how you feel about these things. There are no right or wrong answers to these questions. Some kids circle "YES" and some kids circle "NO." When you read a question, if you think your answer should be yes or mostly yes, circle "YES." If you think your answer should be no or mostly no, circle "NO." Remember, different children give different answers, and there is no right or wrong answer. Just circle "YES" or "NO" depending on how <u>you</u> think the question should be answered.

1.	When somebody gets mad at you, do you usually feel there is nothing you can do about it?	YES	NO
2.	Do you really believe a kid can be whatever he wants to be?	YES	NO
3.	When people are mean to you, could it be because you did something to make them be mean?	YES	NO
4.	Do you usually make up your mind about something without asking someone first?	YES	NO
5.	Can you do anything about what is going to happen tomorrow?	YES	NO
6.	When people are good to you, is it usually because you did something to make them be good?	YES	NO
7.	Can you ever make other people do things you want them to do?	YES	NO
8.	Do you ever think that kids your age can change things that are happening in the world?	YES	NO
9.	If another child was going to hit you, could you do anything about it?	YES	NO

10. Can a child your age ever have his own way? YES NO
11. Is it hard for you to know why some people do certain things? YES NO
12. When someone is nice to you, is it because you did the right things? YES NO
13. Can you ever try to be friends with another kid even if he doesn't want to? YES NO
14. Does it ever help any to think about what you will be when you grow up? YES NO
15. When someone gets mad at you, can you usually do something to make him your friend again? YES NO
16. Can kids your age ever have anything to say about where they are going to live? YES NO
17. When you get in an argument, is it sometimes your fault? YES NO
18. When nice things happen to you, is it only good luck? YES NO
19. Do you often feel you get punished when you don't deserve it? YES NO
20. Will people usually do things for you if you ask them? YES NO
21. Do you believe a kid can usually be whatever he wants to be when he grows up? YES NO
22. When bad things happen to you, is it usually someone else's fault? YES NO
23. Can you ever know for sure why some people do certain things? YES NO

APPENDIX J

CRANDAL INTERNAL-EXTERNAL LOCUS OF CONTROL SCALE

NAME ______________________________

SCHOOL ______________________________

AGE ______________ SEX ______________

GRADE ______________________________

DATE ______________

1. If a teacher passes you to the next grade, would it probably be
___ a. because she liked you, or
___ b. because of the work you did?

2. When you do well on a test at school, it is more likely to be
___ a. because you studied for it, or
___ b. because the test was expecially easy?

3. When you have trouble understanding something in school, is it usually
___ a. because the teacher didn't explain it clearly, or
___ b. because you didn't listen carefully?

4. When you read a story and can't remember much of it, is it usually
___ a. because the story wasn't well written, or
___ b. because you weren't interested in the story?

5. Suppose your parents say you are doing well in school, is this likely to happen
___ a. because your school work is good, or
___ b. because they are in a good mood?

6. Suppose you did better than usually in a subject at school. Would it probably happen
___ a. because you tried harder, or
___ b. because someone helped you?

7. When you lose at a game of cards or checkers, does it usually happen
___ a. because the other player is good at the game, or
___ b. because you don't play well?

8. Suppose a person doesn't think you are very bright or clever
___ a. can you make him change his mind if you try to, or
___ b. are there some people who will think you're not very bright not matter what you do?

9. If you solve a puzzle quickly, is it
___ a. because it wasn't a very hard puzzle, or
___ b. because you worked on it carefully?

10. If a boy or girl tells you that you are dumb, is it more likely that they say that
___ a. because they are mad at you, or
___ b. because what you did really wasn't very bright?

11. Suppose you study to become a teacher, scientist, or doctor and you fail. Do you think this would happen
___ a. because you didn't work hard enough, or
___ b. because you needed some help, and other people didn't give it to you?

12. When you learn something quickly in school, is it usually
___ a. because you paid close attention, or
___ b. because the teacher explained it clearly?

13. If a teacher say to you, "Your work is fine," is it
___ a. something teachers usually say to encourage pupils, or
___ b. because you did a good job?

14. When you find it hard to work arithmetic or math problems at school, is it
____ a. because you didn't study well enough before you tried them, or
____ b. because the teacher gave problems that were too hard?

15. When you forget something you heard in class, is it
____ a. because the teacher didn't explain it very well, or
____ b. because you gave the best answer you could think of?

16. Suppose you weren't sure about the answer to a question your teacher asked you, but your answer turned out to be right. Is it likely to happen
____ a. because she wasn't as particular as usual, or
____ b. because you gave the best answer you could think of?

17. When you read a story and remember most of it, is it usually
____ a. because you were interested in the story, or
____ b. because the story was well written?

18. If your parents tell you you're acting silly and not thinking clearly, is it more likely to be
____ a. because of something you did, or
____ b. because they happen to be feeling cranky?

19. When you don't do well on a test at school, is it
____ a. because the test was especially hard, or
____ b. because you didn't study for it?

20. When you win at a game of cards or checkers, does it happen
____ a. because you play real well, or
____ b. because the other person doesn't play well?

21. If people think you're bright or clever, is it
____ a. because they happen to like you, or
____ b. because you usually act that way?

22. If a teacher didn't pass you to the next grade, would it probably be
____ a. because she "had it in for you," or
____ b. because your school work wasn't good enough?

23. Suppose you don't do as well as usual in a subject at school. Would this probably happen
____ a. because you weren't as careful as usual, or
____ b. because somebody bothered you and kept you from working?

24. If a boy or girl tells you that you are bright, is it usually
____ a. because you thought up a good idea, or
____ b. because they like you?

25. Suppose you became a famous teacher, scientist or doctor. Do you think this would happen
____ a. because other people helped you when you needed it, or
____ b. because you worked very hard?

26. Suppose your parents say you aren't doing well in your school work. Is this likely to happen more
____ a. because your work isn't very good, or
____ b. because they are feeling cranky?

27. Suppose you are showing a friend how to play a game and he has trouble with it. Would that happen

____ a. because he wasn't able to understand how to play, or

____ b. because you couldn't explain it well?

28. When you find it easy to work arithmetic or math problems at school, is it usually

____ a, because the teacher gave you especially easy problems, or

____ b. because you studied your book well before you tried them?

29. When you remember something you heard in class, is it usually

____ a. because you tried hard to remember, or

____ b. because the teacher explained it well?

30. If you can't work a puzzle, is it more likely to happen

____ a. because you are not especially good at working puzzles, or

____ b. because the instructions weren't written clearly enough?

31. If your parents tell you that you are bright or clever, is it more likely

____ a. because they are feeling good, or

____ b. because of something you did?

32. Suppose you are explaining how to play a game to a friend and he learns quickly. Would that happen more often

____ a. because you explained it well, or

____ b. because he was able to understand it?

33. Suppose you're not sure about the answer to a question your teacher asks you and the answer you give turns out to be wrong. Is it likely to happen

____ a. because she was more particular than usual, or

____ b. because you answered too quickly?

34. If a teacher says to you, "Try to do better," would it be

____ a. because this is something she might say to get pupils to try harder, or

____ b. because your work wasn't as good as usual?