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ABSTRACT

Curriculum development would be greatly aided if it could be demonstrated that certain instructional techniques have a generalization effect that encompasses several content settings. The evidence that transfer does occur within the learning process is strong enough to warrant this study into the generalization of science instruction. It was hypothesized that students receiving instruction in a certain science program would domonstrate competence in social studies, language arts, and fine arts equal to or greater than their competence in science. Subjects were 64 students randomly selected from grades 1, 2, 3, and 4 in the Oshkosh, Wisconsin Public Schools System, which uses Science - A Process Approach. The instruments used to obtain the objective measures of student competence were the Observing Process Hierarchy and the Science Process Instrument (AAAS, 1967). Analysis of the data tended to support the hypotheses of generalized competence in social studies, language arts, and fine arts. There were some reservations in the results of the third graders which may have been caused by unclear items or items in which wording or procedure was too complex. (MH)

A Study of the Ability of Primary School Children to Generalize Behavioral Competencies Specified for *Science-A Process Approach* to Other Content Settings.

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Currently vast sums of money are being spent by organizations, local, state and federal governments on the development of curricula. The elementary schools have not been ignored in this activity, as can be witnessed by the School Mathematics Study Group (1958), the Greater Cleveland Mathematics Project (1959), and the Science Curriculum Improvement Study (1962). Characteristically each of these projects deals with one content area and makes no assumptions with respect to competencies acquired in other disciplines. Indeed, this caution is appropriate if there is no evidence either to support the contention that competencies acquired in one content area can be used in another with no loss of efficiency, or, to indicate conditions under which variability in the extent of generalization occurs. Gagné, when speaking about an experimental science program for which behavioral objectives were being written, made the comment that the behaviors sought should "carry the promise of broad transferability across many subject areas." (1965). This was a conjecture on that author's behalf, it was not substantiated by data but deserves to be tested. The question can be raised, "Do the behaviors demonstrated in science generalize to other content areas in which instruction is given in the elementary schools but which is not specifically designed for the stated objectives?"

Related Literature

There can be little disputing the fact that transfer does occur within the learning process. It does not seem reasonable to argue that a human being acquired every specific piece of knowledge by means of a unique stimulus-response connection.

To this extent there is agreement among theorists (Ellis, 1965; Gagné, 1965) and practitioners (Marx, 1966), but certainly, this does not imply that there is agreement with respect to the details of transfer and generalization in learning.

After several years of describing transfer within a global framework (Roark, 1889; Babbitt, 1893) more precise work was conducted using a stimulus-response model (Ellis, 1965). In this situation the subject learned to respond in a particular way to a given stimulus. After the individual had reached criterion on the learning task a new stimulus was presented and typically the length of time was measured, or the number of trials required for the individual to associate the old response connection with the new stimulus was counted. The new stimulus-response connection always had to be learned with given practice. Transfer of training is the term applied when a new stimulus is connected to an old response after practice. Gagné (1965) was not referring to this transfer of training with his remark on transferability. Rather he was implying a transfer of applicability or generalizability of behaviors acquired without practice. The question thus becomes: "If a child has demonstrated that he has made a particular stimulus-response connection in one content area can he, without practice, demonstrate the same connection when the setting is changed to another discipline?"

Studies of stimulus generalization have employed several independent variables. The similarity of the stimuli has been a major concern. Various efforts have been made to determine the extent of stimulus similarity; the similarity of syllables, their meaning and their visual appearance have been assessed (Yum, 1931); the alikeness of syllables has been determined (Gibson, 1942; all elements of the first stimulus have been included in the second stimulus (Dienes, 1961); functional similarity has been described (Dietze, 1955); the number of attributes varied between the first and second stimulus has been controlled (Newman, 1956; Sechrist, 1965). There is a considerable agreement among researchers regarding the similarity of stimuli in stimulus generalization. The greater the similarity of the stimuli the greater is the potential, until a stage is reached when the connection is a random one in character. There seems sufficient evidence to accept this with respect to paired associate learning. It has been difficult to assess this conjecture in the classroom because of the difficulty of measuring stimulus similarity in non laboratory situations. One approach to this will be described in this paper using as a reference for similarity the behavioral description.

Experimental Design

Three hypotheses were formulated for this study.

Hypothesis One: Students who attain a specific level of behavioral competence, as determined by performance tasks for science, demonstrate acquisition of behaviors at the same level or higher when determined by performance tasks in social studies.

H_0: $P(SS \geq S) \leq 0.5$

H_1: $P(SS \geq S) > 0.5$

Hypothesis Two: Students who attain a specific level of behavioral competence, as determined by performance tasks for science, demonstrate acquisition of behaviors at the same level or higher when determined by performance tasks in language arts.

H_0: $P(LA \geq S) \leq 0.5$

H_2: $P(LA \geq S) > 0.5$

Hypothesis Three: Students who attain a specific level of behavioral competence, as determined by performance tasks for science, demonstrate acquisition of behaviors at the same level or higher when determined by performance tasks in fine arts.

H_0: $P(FA \geq S) \leq 0.5$

H_3: $P(FA \geq S) > 0.5$

Several terms used in these hypotheses need to be defined.

Students: The population in this investigation was all of the students in the first, second, third and fourth grades of the Oshkosh, Wisconsin Public Schools System. The system used the elementary school science materials published under the title Science - A Process Approach (AAAS-Xerox, 1967) for their science program. The sample space was a set of sixty-four first, second, third and fourth grade students randomly selected from the defined population.

Behavioral competence: This was any of the set of overt performances which a student had acquired and which was described in the Observing Process Hierarchy (AAAS-Xerox, 1967). Each of these was assessed by means of one item in each of the instruments used in this investigation.

Level of behavioral competence: In science this level was the level on the Observing Process Hierarchy at which a student demonstrated competence in science. A level of from one through ten was assigned by the performance of the child on the Science Process Instrument (AAAS, 1967). Level of behavioral competence in social studies, language arts and fine arts was defined in the same manner using corresponding instruments.

The evaluation instrument which provided the basic structure for the assessment procedure used in this investigation was the Science Process Instrument (AAAS, 1967). The instrument provided one assessment task for each performance objective described in the Observing Process Hierarchy. The social studies, language arts and fine arts instruments were developed by the investigator based on the model provided in the Science Process Instrument. The steps followed in the construction of these instruments were consistent with those followed for the model instrument construction and one item was provided in each of the content settings for each of the behaviors described in the Observing Process Hierarchy (Table One). Reliability and validity data were collected for all of the items and a level of 80% or greater was achieved for each of the items.

The investigator administered the tests to each of the children in the sample on an individual basis. A balancing procedure was employed in order to compensate for practice effect among the measures. When the data had been collected a modified version of the Sign Test for two correlated samples was used to analyze and test the significance of the data. If the level were higher for social studies than for science or if both levels were the same, then a + sign was assigned to the scores for the individual concerned. This tactic was employed because either a higher level or an equivalent level was of interest in the research hypothesis. If the score were lower for social studies than for science, then a - sign was assigned to the individual's score. A similar procedure was adopted for the language arts and fine arts scores. It was decided to reject the null hypothesis if the 0.05 level of significance was reached.

TABLE TWO

Items for One Behavior in the Observing Process Hierarchy

Level E - 3		Identifying and naming observable differences between objects.
Science	Materials	1. Three vials of clear water. 2. One vial of clear water and two of colored water.
	Questions	1. Tell me one way in which this looks different (point to the colored water) from regular water. 2. What can you observe that has changed from here (point to first set of vials) to here (point to second set of vials)?
	Responses	1. Identifies vials containing colored water. 2. Names color change.
Social Studies	Materials	Illustration of changes in letter forms during different historical periods.
	Questions	1. Point to any letters which look different from the way we write them today. 2. Tell me one way in which this looks different from the way it is written today. (Point to Greek letter S and present day capital S.)
	Responses	1. Identifies the letters which are different. 2. Names one characteristic which is different.
Fine Arts	Materials	Paintings of birds by three different artists: Nolde, Durer and Audubon.
	Questions	1. Tell me one way in which this painting is different from this. (Point to Nolde and Audubon paintings.) 2. (Point to the paintings by Nolde and Durer.) Show me the painting in which the small parts of the bird are shown more carefully.
	Responses	1. Names one difference. 2. Identifies the painting by Durer.

Level 3 - E (continued)

Language Arts	Materials	1.	Card A containing words "fell and "fall."
		2.	Card B containing words "pack" and "rack."
	Questions	1.	Point to any part or parts of these words which look different from one another. (Give child Card A.)
		2.	What difference can you see between these two words? (Give child Card B.)
	Responses	1.	Points to "e" and "a."
		2.	Names the "p" and the "r."

The Findings

Hypothesis One: Table Two presents the computational information used to test the statistical null hypothesis: $P(SS > S) \leq 0.5$

TABLE TWO

Data Used for Sign Test for Computation of Probability Levels to Test Hypothesis One

	Grade 1	Grade 2	Grade 3	Grade 4	Boys	Girls	Total
Sum of + signs	16	15	12	16	29	30	57
Sum of - signs	0	1	4	0	3	2	5
Z score ($N > 25$)					4.419	4.773	6.125
Probability	0.002	0.002	0.038	0.002	.00003	.00003	.00003
Decision (α =.05)	Reject	Reject	Reject	Reject	Reject	Reject	Reject

The α level of 0.05 was reached for the total group and for each of the categories analyzed. As a result of these findings the null hypothesis was rejected. The data do indicate that the levels reached on the social studies measure were higher, or the same as, those reached on the science instrument. The frequency with which the scores indicated this trend was significantly greater than that which would occur by chance alone.

Hypothesis Two: Table Three presents the computational information used to test the statistical null hypothesis: $P(LA > S) \leq 0.5$

TABLE THREE

Data Used for Sign Test for Computation of Probability Levels to Test Hypothesis Two

	Grade 1	Grade 2	Grade 3	Grade 4	Boys	Girls	Total
Sum of + signs	15	12	8	11	21	25	46
Sum of - signs	1	4	8	5	11	7	18
Z-score ($N > 25$)					2.298	5.83	3.375
Probability	0.002	0.038	0.598	0.105	0.110	0.0003	0.0005
Decision (α .05)	Reject	Reject	Retain	Retain	Retain	Reject	Reject

It can be observed from the data that the Sign Test indicated that the findings for the total group suggest that the null hypothesis should be rejected. When the smaller categories were analyzed, however, the findings suggest that the null hypothesis should be retained for Grades Three and Four and for the boys.

Hypothesis Three: Table Four presents the computational information used to test the statistical nyll hypothesis: $P(FA > S) \leq 0.5$

TABLE FOUR

Data Used for the Sign Test for Computation of Probability Levels to Test Hypothesis Three

	Grade 1	Grade 2	Grade 3	Grade 4	Boys	Girls	Total
Sum of + signs	16	15	11	16	27	31	58
Sum of - signs	0	1	5	0	5	1	6
Z score ($N > 25$)					3.712	5.126	6.375
Probability	.002	.002	.105	.002	.00011	.00003	.00003
Decision (α =.05)	Reject	Reject	Retain	Reject	Reject	Reject	Reject

From these data it can be observed that the students demonstrated competence at the same or higher level on the fine arts measure as on the Science Process Instrument. The frequency with which the scores indicated an upward trend was significantly greater for the total group than would occur by chance alone. The data relevant to the total group support the decision to reject the null hypothesis and in the smaller categories only the third grade does not provide evidence for the rejection of the null hypothesis.

Conclusions

In this investigation control was obtained over the extent of stimulus similarity by holding the stimulus cue, the question form, constant while the stimulus setting was changed. The form of the question was equivalent in both the criterion and the generalization items (Table One). The significant findings for each of the analyses are support for the belief that, at the primary grade levels, generalization is likely to occur when the critical parts of the stimulus are equivalent.

The science tasks were the first questions to be administered to each of the individuals in the sample space. This was essential in order to determine the entry level for the other measures. It can be argued that a lower level of competence was demonstrated for the science items than for the items in the other content areas because at the time of testing in science each of the children was apprehensive in the new encounter with the tester. This suggestion, however, is difficult to support since the re-test scores for reliability group did not indicate any improvement.

The exception in the ability to generalize competencies was observed among the third grade group of students. Why did this group demonstrate no significant increase in competency level in social studies or fine arts when the other grades showed significant differences? An examination of the generalization items in which the third graders gave unacceptable responses suggests an explanation for this. In one item the illustrations may have lacked clarity and in another either the wording or the procedure to be used was too complex for the third graders.

Less successful results were observed with respect to the generalization of acquired behaviors from science to language arts. One possible explanation for this is the presence of mental set (Luchins, 1942). The students had acquired language arts behaviors in one particular form and were unable to break the set formed when required in a new situation. A second explanation could be that the behaviors for science were not appropriate to the language arts setting. This inappropriateness may have counteracted meaningfulness which would normally be associated closely with the language arts for young children. A difference can also be observed between the language arts items and the items for the other content areas. The other content areas use concrete situations to a greater extent than the language arts items. In fact the dependence on symbolism is essential because of the character of the content setting. Evidence has been offered by researchers to show that young children find it more difficult to acquire behaviors involving symbolism than behaviors involving concrete situations (Inhelder and Piaget, 1964; Bruner, 1966).

The findings from these investigations should be considered by both curriculum developers and school personnel. The independent development of curriculum at the elementary school level for separate content settings does not seem to be justifiable. Certain behaviors are common to various content settings. A useful contribution to curriculum development would be to identify a collection of common objectives for several content settings and for instructional materials to be developed for the specified behaviors using a variety of content settings. This does not preclude the existence of behaviors which are specific to a content setting and which must necessarily be taught within that discipline. Both school personnel and curriculum developers could aid efficiency of instruction by attending to the findings of this investigation.

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References Cited

AAAS, Commission on Science Education. Science Process Instrument, Observing Process. Washington, D. C.: American Association for the Advancement of Science, 1967.

Babbitt, S. H. Methods of Teaching The Modern Languages. Boston: D. C. Heath, 1893.

Bruner, Jerome S. et al. Studies in Cognitive Growth. New York: John Wiley and Sons, Inc., 1966.

Dienes, Zolton P. "On Abstraction and Generalization." Harvard Educational Review, 31: 281-301, 1961.

Dietze, Doris. "The Facilitating of Words on Discrimination and Generalization." Journal Experimental Psychology, 50: 255-260, 1955.

Ellis, Henry. The Transfer of Learning. New York: MacMillan Company, 1965.

Gagne, Robert M. Address entitled "Psychological Issues in Science -- A Process Approach," Washington, D. C. 1965. Printed in Psychological Bases for Science -- A Process Approach. Washington, D. C.: American Association for the Advancement of Science Commission on Science Education, 1965.

Gibson, Eleanor J. "Intra-List Generalization as a Factor in Verbal Learning." Journal Experimental Psychology, 30: 185-200, 1942.

Luchins, Abraham S. "Mechanization in Problem Solving: The Effect of Einstellung." Psychological Monographs, 54: Whole Number 248, 1942.

Marx, Ruth M. "The Eskimos -- A Study in Understanding." The Elementary School Journal, 66: 413-416, 1966.

Newman, Slater E. "Effects of Contiguity and Similarity on the Learning of Concepts." Journal of Experimental Psychology. 52: 349-355, 1956.

Roark, Ruric N. Method in Education. New York: American Book Company, 1889.

Sechrist, Lee and J. Schmerling Kaas. "Concept Difficulty as a Function of Stimulus Similarity." Journal Educational Psychology, 56: 327-333, 1965.

Yum, K.S. "An Experimental Test of the Law of Assimilation." Journal of Experimental Paychology, 14: 68-72, 1931.