DOCUMENT RESUME

ED 037 800 | 24 | CG 005 275

AUTHOR Sieber, Joan E.; And Others

TITLE Teaching Children to Indicate Uncertainty and to Discriminate Between Problematic and Nonproblematic Statements.

INSTITUTION Stanford Univ., Calif. Stanford Center for Research and Development in Teaching.

SPONS AGENCY Office of Education (DHEW), Washington, D.C. Bureau of Research.

REPORT NO R&D-Memo-64

BUREAU NO BR-5-0252-0504

PUB DATE Mar 70

CONTRACT OEC-6-10-078

NOTE 29p.

EDRS PRICE EDRS Price MF-$0.25 HC-$1.55

DESCRIPTORS Behavior Patterns, Classroom Techniques, *Concept Formation, Concept Teaching, *Elementary School Students, Group Discussion, *Models, *Problem Solving, Research, *Teaching Methods

ABSTRACT

This study explores the efficacy of two methods of teaching students, modeling and concept formation, to express warranted uncertainty in classroom discussions and in written work. The subjects were fifth graders from a lower middle class background who were divided into four groups: (1) a control group, (2) a group that observed a model express warranted uncertainty and receive reinforcement, (3) a group receiving concept training, and (4) a group receiving both modeling and concept training treatment. Concept training proved effective in teaching students to discriminate between kinds of problematic situations on pencil and paper tests, and modeling proved effective in teaching expression of warranted uncertainty in group discussions. The treatments used herein are readily usable in the classroom by teachers. (Author)

Research and Development Memorandum No. 64

TEACHING CHILDREN TO INDICATE UNCERTAINTY AND TO DISCRIMINATE BETWEEN PROBLEMATIC AND NONPROBLEMATIC STATEMENTS

Joan E. Sieber, Marilyn Epstein,
Charles Petty

Stanford Center for Research and Development in Teaching

SCHOOL OF EDUCATION STANFORD UNIVERSITY

PA·24

ED037800

STANFORD CENTER
FOR RESEARCH AND DEVELOPMENT
IN TEACHING

Research and Development Memorandum No. 64

TEACHING CHILDREN TO INDICATE UNCERTAINTY AND TO DISCRIMINATE BETWEEN PROBLEMATIC AND NONPROBLEMATIC STATEMENTS

Joan E. Sieber, Marilyn Epstein,
Charles Petty

School of Education
Stanford University
Stanford, California

March 1970

Published by the Stanford Center for Research and Development in Teaching, supported in part as a research and development center by funds from the United States Office of Education, Department of Health, Education, and Welfare. The opinions expressed in this publication do not necessarily reflect the position, policy, or endorsement of the Office of Education. (Contract No. OE-6-10-078, Project No. 5-0252-0504.)

Table of Contents

Introductory Statement

The central mission of the Stanford Center for Research and Development in Teaching is to contribute to the improvement of teaching in American schools. Given the urgency of the times, technological developments, and advances in knowledge from the behavioral sciences about teaching and learning, the Center works on the assumption that a fundamental reformulation of the future role of the teacher will take place. The Center's mission is to specify as clearly, and on as empirical a basis as possible, the direction of the reformulation, to help shape it, to fashion and validate programs for training and retraining teachers in accordance with it, and to develop and test materials and procedures for use in these new training programs.

The Center is at work in three interrelated problem areas: (a) Heuristic Teaching, which aims at promoting self-motivated and sustained inquiry in students, emphasizes affective as well as cognitive processes, and places a high premium upon the uniqueness of each pupil, teacher, and learning situation; (b) The Environment for Teaching, which aims at making schools more flexible so that pupils, teachers, and learning materials can be brought together in ways that take account of their many differences; and (c) Teaching the Disadvantaged, which aims to determine whether more heuristically oriented teachers and more open kinds of schools can and should be developed to improve the education of those currently labeled as the poor and the disadvantaged.

The study reported in Research and Development Memorandum No. 64 was carried out by the Uncertainty Studies project. Two methods of teaching children to recognize when statements or situations require further exploration and when they may be regarded as factual were tested. How to teach children to make this distinction and thus develop their ability to think reflectively contributes directly to the aims of the Heuristic Teaching program, of which the project is a part.

Abstract

It has been observed that elementary school children tend not to identify problematic situations or to indicate uncertainty about such situations. To test two methods of teaching fifth-grade children to acknowledge warranted uncertainty, 32 boys and girls were divided into four groups. Group I received no training; Group II (concept learning) was taught to give examples of various types of problematic situations; Group III (observers of rewarded model) observed a well-liked student express warranted uncertainty about problematic issues in a class discussion, and receive praise for this behavior; Group IV received both of the above treatments. In subsequent group discussions, students in Groups III and IV more frequently expressed warranted uncertainty than students in Groups I and II. On a written test, students in Groups II and IV (concept learners) indicated uncertainty more frequently in group discussions, and were better able to discriminate between problematic and nonproblematic statements than subjects in Groups I or III. A delayed posttest indicated that the skills learned in Groups II and IV were fully retained three weeks later.

Results indicate that concept learning is required for accurate discrimination of problematic statements, but that norm learning is required for public expression of warranted uncertainty; there was no significant transfer of norm learning to written performance, or of concept learning to group behavior. The data also show that children who are not trained to express warranted uncertainty tend to regard statements that seem not necessarily true as false, rather than as problematic.

TEACHING CHILDREN TO INDICATE UNCERTAINTY AND TO DISCRIMINATE BETWEEN PROBLEMATIC AND NONPROBLEMATIC STATEMENTS

Joan E. Sieber, Marilyn Epstein, and Charles Petty[1]

When a child is involved in a situation that is only partially familiar to him, will he respond if shown or asked about some aspect of the situation that he cannot explain? Studies indicate that middle-class children and adults whose uncertainty is aroused in this way spend more time inspecting the situation (Rothkopf & Bisbicos, 1967; Rothkopf, 1968), ask more questions (Berlyne & Frommer, 1966), learn more (Berlyne, 1954, 1966; Rothkopf, 1968; Paradowski, 1967), remember more (Berlyne & Frommer, 1966), indicate that they wish to know more (Berlyne, 1954), and develop more higher-order concepts (Smedslund, 1961; Bruner, 1967) about the situation than similar individuals who are exposed to a comparable situation but whose uncertainty is not aroused. Uncertainty, as the word is used here, refers to the state of having either no response or various plausible responses to a situation that one wishes to understand. Uncertainty about some matter does not mean total ignorance or evasion of it.

What happens to a person when he becomes uncertain, and why may uncertainty lead to inquiry, learning, and productive thinking? Uncertainty leads to a state of psychological and physiological disturbance. The uncertain individual feels in conflict about what he is to believe or do. Also, there is usually an increase in his heart rate (Lacey, J. I., Kagan, Lacey, B. C., & Moss, 1963), level of perspiration, and muscle tension (Berlyne, 1960). These and other physiological changes are believed to produce increased vigilance and perceptiveness. Berlyne has postulated that persons naturally seek to reduce such psychological and physiological disturbances by reducing their uncertainty. He argues

[1]Joan E. Sieber is Assistant Professor of Education, Stanford University, and Research and Development Associate at the Stanford Center for Research and Development in Teaching; Marilyn Epstein and Charles Petty are Stanford Undergraduate students.

that since the concomitants of uncertainty facilitate information acquisition, persons who are given an opportunity to develop their innate exploratory tendencies may learn to reduce uncertainty by acquiring and processing relevant new information. There are, of course, other ways of reducing uncertainty and its accompanying disturbances. These include ignoring the problem, rationalizing one of its hypothetical solutions on insufficient grounds (Calloway & Dembo, 1958; Jones, 1959; Berlyne, 1960; Sieber, 1969), or failing to recognize that a relevant problem exists at all (Sieber, 1964). Obviously, less productive thinking occurs if these latter ways of reducing uncertainty are used.

Most persons would probably agree that it is good pedagogy to create warranted uncertainty in students and then to help them obtain and organize the information they need in order to gain understanding. However, it is well-known that few teachers provide such experience. For example, Bellack, Kliebard, Hyman, and Smith (1966) observed that there is little questioning or expression of uncertainty by pupils or teachers in the classroom. The most common interaction pattern was one in which teachers asked questions to which students gave simple, factual answers. Teachers asked 80% of all the questions, and of all teachers' questions only 19% required students to give an explanation. Sixty-five percent of all student responses were in the form of simple answers.

Now, since teachers rarely try to arouse uncertainty, it becomes especially important to inquire what students do when they encounter problematic situations. One may readily observe that students are frequently involved in social and academic matters that are problematic (e.g., how to deal with an injustice among students, or how to determine the difference between living and nonliving things). In such situations, do they naturally experience uncertainty and engage in inquiry without assistance from the teacher? According to Bellack et al. (1966), students show little spontaneous verbal indication of uncertainty. Ziller and Long, (1965) administered to 327 children in grades two to seven a scale containing 30 statements, none of which were known to be true or false, e.g., "There is life on the planets." For each item, the children were instructed to respond by circling "yes," "no," or "don't know." Most of the children answered at least 65% of the items "yes," or "no," rather than "don't know." Sieber (1969) observed that, when questioned orally about problematic matters, sixth graders offered many answers, but in no case indicated that they did not know. These data indicate that unassisted students usually do not recognize problematic situations as such.

This raises two related questions. Why do students respond with certainty when it is inappropriate to do so? And, how can they be taught to identify and investigate the problematic situations they encounter? There is, as yet, little understanding of the cognitive processes involved in discriminating between problematic and nonproblematic situations. However, without being too specific about the nature of such processes, one may still ask why students fail to engage in them. One plausible explanation is that students fail to express warranted uncertainty because they have inadequate concepts of certainty and uncertainty. Given the infrequency of classroom discussions about problematic matters, students may have little opportunity to identify exemplars of problematic and nonproblematic statements. If this is the case, then expressions of uncertainty and correct discrimination between nonproblematic and problematic statements should increase if concepts of certainty and uncertainty are learned.

An alternative explanation is that concepts of uncertainty are rather well understood by students but that warranted uncertainty is rarely expressed in the classroom because it is socially unrewarding to do so. If this is the case, then expression of uncertainty and discrimination between nonproblematic and problematic situations should increase if students observe that such responses are socially rewarded. Another explanation is that both social motivation to express uncertainty and clear concepts of certainty and uncertainty are lacking in most students. Hence, relevant concept learning and social reward for expression of warranted uncertainty are complementary forms of training having additive effects in facilitating the expression of uncertainty and improving discrimination between problematic and nonproblematic situations.

The purpose of the present study was to evaluate the relative effectiveness of modeling and concept-learning procedures as means of teaching fifth-grade students to discriminate between nonproblematic and five types of problematic questions and to express uncertainty in a group discussion. Four conditions were designated, of which three were experimental. In Condition I, the control condition, subjects received no training. In Condition II, subjects were taught to give examplars of each type of problematic question. In Condition III, subjects observed a well-liked student who "modeled" correct identification of problematic questions and was socially reinforced for this by the experimenter. In Condition IV, subjects received both of the above treatments.

It was predicted that subjects in Conditions II, III, and IV would (a) more readily indicate uncertainty in a group discussion, and (b) more frequently express uncertainty and correctly discriminate between problematic and nonproblematic statements on a written test than control subjects. Further, it was hypothesized that concept learning (Condition II) would facilitate written performance more than modeling (Condition III), that modeling would facilitate expression of uncertainty in a group discussion more than concept learning, and that students in Condition IV would perform better in both a group discussion and a written test than subjects in Conditions I, II, and III.

Method

Subjects

Subjects were 16 boys and 16 girls from the middle- to lower-middle class socioeconomic range who attended fifth grade at a public elementary school in the Bay Area of California. Their mean IQ, as measured by the California Test of Mental Maturity (CTMM) was 103.0, and the standard deviation was 12.7. These pupils were assigned to a control group and three experimental groups as follows. All students from two fifth-grade classrooms were divided according to sex. Students of each sex were then ranked according to IQ. One of the four highest-scoring boys and one of the four highest-scoring girls were then randomly assigned to each of the four groups, followed by the next four of each sex, etc., until there were four boys and four girls assigned to each of the four groups.

Procedure

The experimenters were introduced to the students by their teachers. It was explained that the experimenters were Stanford students who would serve temporarily as teacher aides and would teach some interesting new things. The experimenters spent two afternoons in the classrooms completing scheduling arrangements with the teachers and becoming acquainted with the students.

The main aim of Condition II was to teach students to discriminate between the following six kinds of questions, the first of which is nonproblematic, and the rest of which are problematic:

(1) Questions that are not problematic to the person to whom they are addressed. E.g.: What is your name? What is the name of your school? Who is your best friend?

(2) Questions concerning things the respondent doesn't know, but someone else does. E.g.: How old am I? How tall is the school flagpole? Who lives two blocks from here in the third house from the corner?

(3) Questions concerning things no one knows, but for which there presently exist ways that one could discover the answer. E. g.: How many leaves are on that tree? How many words are in today's paper? What kind of birds are nesting in this tree?

(4) Questions concerning things no one knows, and no one knows how to discover at this time. E. g.: What is a sure cure for a common cold? How many stars are there in the sky? How many kinds of living things are there on the South Pole?

(5) Question requiring answers that are value judgments and are therefore not necessarily true for all persons. E. g.: What is the best-tasting food in the world? Is summer or winter the nicest time of the year? What kind of person should one choose as a friend?

(6) Questions concerning events that have not yet occurred, thus requiring answers that no one can presently give with total accuracy. E. g: When will the first man land on Saturn? What will we be doing this time next year? How tall will you be when you are fully grown?

Subjects in Condition II were taken individually by the experimenter to a pleasant place on the playground. After establishing rapport, the experimenter said, "We want to teach you and the rest of the class how to tell the difference between types of questions you can answer correctly and types of questions to which you can't be sure of the answer. There are a lot of things no one knows very much about. Also, some people know some things other people don't know. Can you ask me a question that you can answer but I can't?" Whether or not the subject answered satisfactorily, the experimenter asked him two questions which the experimenter could answer but the subject could not. The subject was then requested to ask a question he could answer but the experimenter could not. The subject was coached until he could ask at least one such question.

He was then told, "There are other kinds of questions to which no one knows the answer but we could figure out a way to find the answer." Since this and the subsequent questions were more difficult than the initial one, the experimenter first gave an example of one such question before asking the subject if he could generate another like it. Whether or not the subject answered satisfactorily, the experimenter asked two more questions of the same kind and explained how they were the same. The subject was then asked to give another example of the same kinds of question and was coached until he could give at least one. Identical procedures were used to teach each of the rest of the concepts.

Although the experimenters generally followed the above procedure, the details of each training session varied somewhat according to the ability and interest of the subject. The training criterion was reached when each subject was able to give at least one example of each of the five kinds of problematic questions. The training protocol in Appendix A exemplifies a typical session.

For Condition III, a bright, well-liked girl was chosen to be the model. She was trained as in Condition II and was also trained to give the appropriate answers to 18 questions about a short film. The questions about the film included three of each of the six kinds of questions used in Condition II. The film was about a restaurant; some examples of the questions were: "What is the waiter going to do?" "How many square feet of cloth are there in that tablecloth?" Subjects in Condition III and the model were then shown the film as a group. During the viewing, the film was stopped at various points and the experimenter asked the 18 questions.

For each question, three subjects were called on to answer according to a random order that was previously determined by assigning the students' alphabetically ordered names to sequential, randomly ordered numbers. If one or more of the three respondents answered the question with some appropriate indication uncertainty, the next question was raised. Otherwise, the model was called on and reinforced for the appropriate response. The experimenter reinforced all instances of appropriate uncertainty but was not critical of other kinds of responses. This procedure continued until all 18 questions had been answered.

In Condition IV, subjects first received individual training identical to that given in Condition II. They then received group training identical to that given in Condition III.

Subjects in Condition I, the control group, were chatted with individually by the experimenters and were shown the same movie that was shown in Condition III. They received no specific training, however.

About two hours after the training had been administered, subjects were again divided into their four groups. Each group was shown a film different from the one shown during the training of Conditions III amd IV. A group discussion of the film was held with subjects in each condition, in the course of which they were asked 15 questions concerning the film. The questions included three of each of the five kinds of problematic questions listed above. Three subjects were called on (again in a predetermined random order) to respond to each question. The experimenter was equally cordial and encouraging to each respondent. Responses were recorded and later tabulated according to whether uncertainty had been expressed.

On the following day, subjects from all four conditions were gathered into one group. They were told they would se. a film about an Egyptian boy and his camel and would then be asked to answer a questionnaire about the film. The questionnaire was handed out(for a copy, see Appendix B), preceded by directions including examples and explanations of the kinds of problematic and nonproblematic statements that appear on the questionnaire. These directions and explanations were carefully reviewed with the group. Students were then urged to read the questionnaire before viewing the film. There were 21 ques ons, three each of the five kinds of problematic statements, three false, and three true statements.

To test retention of whatever learning had resulted from the training, delayed posttests were planned. Due to conflicts with the school's schedule, a delayed posttest of group discussion behavior was not possible. However, three weeks after the first written posttest, a different film was shown to all subjects and a similar written questionnaire about that film was administered.

From each questionnaire the following data were obtained: (a) the number of "don't know" responses given, (b) the number of "don't know" responses that were correct, i.e., that were given to a problematic question and were accompanied by a correct reason for not knowing, and (c) the number of problematic statements that were answered "true" or "false."

Results

Tendency to indicate uncertainty in the posttraining group discussion varied with training, as predicted, but not all of the predicted differences were significant. As shown in Table 1, subjects who had observed a model receive praise for expressing warranted uncertainty in a group discussion expressed uncertainty more frequently in a subsequent group discussion than control subjects who had not observed the model ($\chi^2 = 13.27$, df = 1, $p < .001$. Subjects who had received only individual concept training expressed uncertainty in the subsequent discussion insignificantly more often than control subjects; moreover, they expressed uncertainty significantly less often than subjects who had observed a model ($\chi^2 = 4.44$, df = 1, $p < .05$). Subjects in Condition IV, who had both received concept training and observed a model, performed about the same as subjects who had only observed a model.

TABLE 1

Number of Responses in Which Uncertainty Was Expressed in Group Discussions

Condition	Number of Responses in Which Uncertainty Was Expressed
I Control	10[a]
II Concept training	17[a]
III Modeling	27[b]
IV Concept training and modeling	29[b]

Note: Cells with common superscripts are not significantly different at the .05 level.

Regarding the three measures of performance on the first written posttest, as predicted, on all three measures the most learning was evinced by subjects in Condition IV. Conditions II, III and I followed in that order. The Kruskal-Wallis one-way analysis of variance indicated that not all of these differences were significant, however. As Table 2 indicates, significantly fewer "don't know" responses were given by subjects in Condition I than by subjects in Condition II (χ^2 = 3.86, df = 1, $p<.05$) or Condition IV (χ^2 = 4.27, df = 1, $p<.05$) but Conditions I and III did not differ significantly. With regard to the correctness of "don't know" responses, control subjects were significantly less often correct than subjects who had received concept training (for Condition I, χ^2 = 3.94, df = 1, $p<.05$; for Condition III, χ^2 = 4.28, df = 1, $p<.05$), but did not differ significantly from subjects in Condition II. Finally, subjects who had received concept training gave significantly fewer "true" or "false" responses to problematic statements than control subjects, (comparing Condition I and II, χ^2 = 4.46, df = 1, $p<.05$, and comparing Condition I and IV, χ^2 = 8.52, df = 1, $p<.01$).

As indicated in Table 3, the observed differences between groups on the delayed written posttest paralleled almost exactly the differences that were observed in the first written posttest: control subjects gave fewer "don't know" responses than subjects in Condition II (χ^2 = 6.17, df = 1, $p<.02$) or Condition IV (χ^2 = 7.24, df = 1, $p<.01$, but did not give significantly fewer "don't know" responses than subjects in Condition III. However, only subjects in Condition II gave significantly more correct "don't know" responses than control subjects (χ^2 = 6.17, df = 1, $p<.02$). Finally, the number of problematic statements answered "true" and "false" by control subjects was significantly greater than the number of such responses given by subjects in Condition II (χ^2 = 5.31, df = 1, $p<.05$) of Condition IV (χ^2 = 7.73, df = 1, $p<.01$), but did not differ significantly from the number of such responses given by subjects in Condition III.

TABLE 2

Means for Three Measures of Performance on First Written Posttest

Measures	Condition				Means for All Training Conditions (N=22)
	I Control (N=7)	II Concept Training (N=8)	III Training by Model (N=7)	IV Combined Training (N=7)	
"Don't know" responses	11.28^{a}	13.75^{b}	12.71^{ab}	14.86^{b}	13.77^{b}
Correct "don't know" responses	6.43^{a}	9.00^{b}	7.85^{ab}	9.57^{b}	8.81^{ab}
Problematic statements answered"true" or "false"	4.43^{a}	1.63^{b}	2.57^{ab}	0.86^{b}	1.69^{b}

Note--Within each row, cells with common superscripts are not significant at the .05 level.

TABLE 3

Means for Three Measures of Performance on Delayed Written Posttest

	Condition				Means for All Training Conditions (N=18)
	I Control (N=6)	II Concept Training (N=7)	III Training by Model (N=5)	IV Combined Training (N=6)	
"Don't know" responses	12.83^{a}	15.14^{b}	14.40^{ab}	14.80^{b}	14.78^{b}
Correct "don't know" responses	6.33^{a}	9.86^{b}	9.40^{ab}	8.00^{ab}	9.09^{ab}
Problematic statements answered "true" or "false"	2.50^{a}	0.71^{b}	1.20^{ab}	1.00^{b}	0.97^{b}

Note: Within each row, cells with common superscripts are not significant at the .05 level.

Discussion

The results generally support the thesis that the expression of uncertainty by school children is influenced by both (a) belief that expression of uncertainty will be socially rewarded and (b) understanding of concepts of certainty and uncertainty. Subjects who had observed a model receiving praise for public expression of uncertainty expressed uncertainty during group discussion more frequently than control subjects who had not observed such a model. And, subjects who had been taught to discriminate between nonproblematic and five types of problematic statements more correctly discriminated between such statements and more frequently expressed uncertainty on a written test than subjects who had not learned these discriminations.

What was surprising, however, was that there was no significant degree of transfer from social-norm learning (Condition III) to performance on the written test, or from concept learning (Condition II) to performance in group discussions. These data imply that correct understanding or problematic matters does not necessarily predispose one to express uncertainty in group discussions. Likewise, knowledge that the expression of uncertainty is socially rewarded may increase neither the frequency nor the accuracy with which uncertainty is expressed privately in writing. Since the teaching of the norm of expressing uncertainty (Condition III) and the method of teaching concepts of certainty and uncertainty (Condition II) are not mutually exclusive (e.g., modeling included some discussion of concepts of uncertainty, and concept training involved some reinforcement for expression of uncertainty), it would not have been surprising if Condition III training (modeling) had improved written performance and Condition II training (concept learning) had increased expression of uncertainty in group discussions.

We can only speculate as to why transfer did not occur. One conjecture is that the skills required for successful transfer were not learned. In the case of Condition III subjects, perhaps all that was learned was that it is desirable to express uncertainty when at all in doubt in group discussions. They probably did not learn to make the distinctions that were explicitly taught in Condition II. Unfortunately, data are not available on the extent to which subjects trained in Condition II learned to discriminate between types of problematic issues in group discussions; students' responses in the group discussions were too incomplete to be coded reliably according to the categories used by the model or in the written posttests. In the case of Condition II, subjects' transfer of the newly learned concept to the group discussion may have failed to occur because these subjects felt too unsure of their new knowledge to risk applying it before their peers. Indeed, Condition II subjects had good reason to doubt their new ability; they attained only 71% and 77% accuracy on the two respective posttests. However, whether transfer would have occurred if training had been more thorough remains an empirical question.

It has been conjectured, thus far, that subjects in Condition II learned, albeit imperfectly, some concepts about types of problematic statements and that subjects in Condition III learned to indicate uncertainty in group discussions when in doubt. An interesting question that remains is, how did they formerly regard problematic and nonproblematic statements?

To pursue this question, the data from Conditions I, II, and III were cast into confusion matrices which are shown in Table IV. Although data are too thin to permit elaborate analyses, some things are readily apparent: (a) Subjects in all three groups quite accurately identified true and false statements. (b) Control subjects (Group I) tended to consider untrue statements as false. A χ^2 test comparing the number of correct and incorrect "false" responses by subjects in the control and concept training conditions indicated that groups differed significantly in this respect ($\chi^2 = 8.34$, df = 1, $p = < .01$). (c) Trained subjects, especially Condition II subjects, were generally more willing to indicate uncertainty, and more accurate in doing so.

Untrained subjects seem to tend strongly to consider apparently true statements as true, and any other statements as false, while subjects who have been trained to categorize some statements as problematic are likely to test statements that are not obviously true against this third category.

It may be concluded that, given the norms and training that prevail in most classrooms, specific training is required to enable students to develop warranted uncertainty, or, to use Bruner's terminology, "problem-finding skills." Modeling and concept training were effective enough to warrant their further use

TABLE 4

Types of Correct and Incorrect Responses Made by Subjects in Conditions I, II, and III on the First Posttest

Condition	Response Category Used by Subject	Correct Responses T	F	Don't Know 1	2	3	4	5	Number of Responses by Category Used	Number of Errors by Category Used	Number of Correct by Category Responses
I Control Group (N=7)	DK 5	0	0	0	1	1	0	8	10	2	8
	DK 4	0	0	2	3	1	5	0	11	6	5
	DK 3	2	0	1	1	9	2	1	16	7	9
	DK 2	1	0	1	12	1	2	2	19	7	12
	DK 1	0	2	6	3	3	2	4	20	14	6
	False	0	19	9	2	4	9	3	46	27	19
	True	18	0	3	0	2	1	1	25	7	18
									147	70	77

Condition	Response Category Used by Subject	Correct Responses T	F	Don't Know 1	2	3	4	5	Number of Responses by Category Used	Number of Errors by Category Used	Number of Correct by Category Responses
II Concept Training (N=8)	DK 5	0	0	0	0	0	2	16	18	2	16
	DK 4	1	0	0	0	3	13	1	18	5	13
	DK 3	0	1	1	5	14	2	4	27	13	14
	DK 2	0	1	8	17	2	3	1	32	15	17
	DK 1	0	0	12	1	1	0	1	15	3	12
	False	0	22	0	1	2	3	1	29	7	22
	True	23	0	6	0	0	0	0	29	6	23
									168	51	117

Continued on Next Page

TABLE 4 (Continued)

Types of Correct and Incorrect Responses Made by Subjects in Conditions I, II, and III on the First Posttest

Condition	Response Category Used by Subject	Correct Responses T	F	Don't Know 1	2	3	4	5	Number of Responses by Category Used	Number of Errors by Category Used	Number of Correct by Category Responses
III Modeling (N=7)	DK 5	0	0	1	0	0	0	7	8	1	7
	DK 4	0	0	0	1	1	12	0	14	2	12
	DK 3	0	1	0	4	14	3	1	23	9	14
	DK 2	0	1	5	10	0	2	1	19	9	10
	DK 1	0	0	13	4	2	0	6	25	12	13
	False	1	19	2	1	3	3	4	33	14	19
	True	20	0	1	0	1	1	2	25	5	20
									147	52	95

in the classroom. It would seem especially useful to develop for each curriculum area written tests that are similar in format to the written subtests used in this experiment. In some preliminary attempts to use such tests, teachers have found them stimulating to students.

But the devising of such tests is difficult; it forces teachers to sharpen their awareness of problematic matters. Parenthetically, it is hoped that teachers who have developed skill in writing tests like the ones used here (hence in discriminating between nonproblematic and types of problematic situations) will more frequently discuss problematic matters in class. The teacher, then, rather than a "well-rehearsed" student, could serve as the initial model. He could express warranted uncertainty in class discussions and reinforce all students who did likewise.

But when such techniques as modeling and concept learning have been employed, and the expression of uncertainty becomes more frequent, what else happens? Do students learn more? Do habits of inquiry develop? How do teachers adapt to the new patterns of discussion? These complex and challenging problems remain for teachers and educational researchers to explore.

References

Bellack, A. A., Kliebard, H. M., Hyman, R. T., & Smith, F. L. The language of the classroom. New York: Teachers College Press, Columbia University, 1966.

Berlyne, D. E. Conditions of prequestioning and retention of meaningful material. Journal of Educational Psychology, 1966, 57, 128-132.

Berlyne, D. E. Conflict, arousal and curiosity. New York: McGraw-Hill, 1960.

Berlyne, D. E. An experimental study of human curiosity. British Journal of Psychology, 1954, 45, 256-265.

Berlyne, D.E., & Frommer, F.D. Some determinants of the incidence of children's questions. Child Development, 1966, 37, 177-189.

Bruner, J.S. On the conservation of liquids. In J.S. Bruner, R. R. Olver, & P. M. Greenfield (Eds.), Studies in cognitive growth. New York: Wiley, 1967. Pp. 183-207.

Calloway, S., & Dembo, D. Narrowed attention. A.M.A. Archives of Neurological Psychiatry, 1958, 79, 74-90.

Jones, A. The efficiency of utilization of visual information and the effects of stress. Journal of Experimental Psychology, 1959, 58, 428-432.

Lacey, J. I., Kagan, J., Lacey, B. C., & Moss, H. A. The visceral level: Situational determinants and behavioral correlates of autonomic response patterns. In P. H. Knapp, (Ed.), Expression of the emotions of man. New York: International Universities Press, 1963.

Paradowski, W. Effect of curiosity on incidental learning. Journal of Educational Psychology, 1967, 58, 50-55.

Rothkopf, E. Z. Learning from written instructive material: An exploration of the control of inspection behavior by test-like events. American Educational Research Journal, 1966, 3, 241-250.

Rothkopf, E. Z. Textual constraint as a function of repeated inspection. Journal of Educational Psychology, 1968, 59, 20-25.

Rothkopf, E. Z., & Bisbicos, E. E. Selective facilitative effects of interspersed questions on learning from written materials. Journal of Educational Psychology, 1967, 58, 56-61.

Sieber, J. E. Lessons in uncertainty. Elementary School Journal, 1969, 69, 304-312.

Sieber, J. E. Problem-solving behavior of teachers as a function of conceptual structure. Journal of Research in Science Teaching, 1964, 2, 64-69.

Smedslund, J. The acquisition of conservation of substance and weight in children. Journal of Psychology, 1961, 2, 156-160.

Ziller, R. C., & Long, B. H. Some correlates of the "don't know" response in opinion questionnaires. Journal of Social Psychology, 1965, 67, 139-147.

APPENDIX A

Sample Protocol of a Concept Learning Session

(After introductions and informal remarks to gain rapport, the experimenter and a student sat down in a comfortable place by the playground and concept training began.)

E: We want to teach you and the rest of your class how to tell the difference between types of questions you can answer correctly and types of questions to which you can't be sure of the answer. There are a lot of things no one knows very much about. Also, some people know things others don't know. Can you ask me a question which you can answer but I can't?

S: (After a brief pause) How old is my oldest brother?

E: I don't know. That was a good question. There are a lot of things some people know but others don't. For example, how high is that flagpole? The man who built it might be able to tell us. Who lives in the house across the street?

S: I don't know.

E: Do you think anyone knows?

S: Yes -- the people who live there.

E: Mm-hmm. Can you ask me another question someone could answer but I can't?

S: How many brothers do I have?

E: Good. There are other kinds of questions to which no one knows the answer, but we could figure out a way to find the answer. For instance, how many words are there in today's newspaper? Probably no one knows, but is there a way we could discover the correct answer for ourselves?

S: We could sit down and count them all if we were crazy enough. (Both laugh)

E: Can you ask me a question no one can answer but for which we could find out the answer?

S: How many stars are there in the sky?

E: How would you find out the answer?

S: I think you could find out because this morning we took a field trip to the astronomy department of a junior college, and the man there told the class there were as many stars in the sky as there are grains of sand on the earth.

E: So you'd count all the grains of sand?

S: I guess so.

E: How did that man know that the number of stars equals the number of grains of sand?

S: I don't know. Maybe he just meant that there are a lot of stars.

E: Maybe so. It would be a good idea to ask him. As far as I know, no one really has any idea how many stars there are because our telescopes aren't good enough to see them all. But experts know there are a lot of them. Can you think of anything else no one knows, but that we could find out right now if we wanted to?

S: How many hairs on my head?

E: Good one ! Shall we start counting? (Both laugh) Now, there are some things no one knows and no one can even find out. I think you already asked a question like that--"How many stars are there?" Another question like that would be, "Is there life on Mars?" or "What is a sure cure for a head cold?" Can you think of any questions like these?

S: Mmm (long pause).

E: Can you think of subjects you've learned in school that involve some things that man still doesn't understand very well?

S: Oh, well, where does gravity come from?

E: That's good. Scientists have some ideas but they don't know for sure what the answer is, do they? There are other kinds of questions that you can only answer for yourself but you can't give a sure answer for other people. These are value judgments. You can tell how you feel about some things, but those feelings aren't necessarily true for everyone else. For example, what is the best tasting food in the world?

S: Ice cream.

F: That's my favorite food too, especially chocolate ice cream. Ice cream is our "best tasting food" but can we say that ice cream is the best food in the world for everyone?

S: No.

E: The answer to that question is just a matter of the way you yourself feel, but other people may feel differently. Another question like that would be, "Is green the prettiest color?" Can you think of a question like this?

S: Who is the nicest person in the world?

F: That's a good example. Now there is one other type of question we're going to talk about. It's one that no one can answer because it is about an event that hasn't happened yet. For example, when will the first man land on Saturn?

S: I don't know, but probably pretty soon.

E: For some questions about future events, we can often make some very good guesses about the answer, but we never can be completely certain what the answer is. Can you think of one of these kinds of questions?

S: Will I be living in California next year?

E: That's good. Another question like this would be, "How tall will you be when you are grown up?"

APPENDIX B

First Written Posttest

Directions: Read the following statements. Then circle True, False, or Don't Know, depending on whether you think the statement is true or false or you don't know. If you circle Don't Know, also circle one of the numbers that follow, to explain why you don't know. The meanings of the numbers are:

1. You don't know but you could find out from some other person in the world.
2. No one knows but someone could find out.
3. No one knows how to find out the answer to this question.
4. This is a value statement. It is just the way someone feels about something. It is not true or false.
5. No one knows because it hasn't happened yet.

Examples:

1. One plus one equal two. (This mathematical equation is always true.)	True	False	Don't Know	1 2 3 4 5
2. There are 25 hours in one day. (This statement is false, because there are always 24 hours in one day.)	True	False	Don't Know	1 2 3 4 5
3. The population of Waterville, Ma. is 53,120. (You don't know, but someone who works in Waterville's City Hall probably does.)	True	False	Don't Know	1 2 3 4 5
4. There were 200,500 words printed in last night's paper. (Nobody bothered to count, but if you wanted to find out, you could always count the words yourself.)	True	False	Don't Know	1 2 3 4 5
5. Camels like rock-and-roll better than opera. (This could be true, but since we cannot ask camels, we cannot know for sure.)	True	False	Don't Know	1 2 3 4 5

6.	Red is prettier than blue. (Though some people think so, others disagree. It is really a matter of opinion, neither true nor false.)	True	False	Don't Know	1 2 3 4 5
7.	A man will land on Saturn in 1980. (Even if some people think that this is likely, we cannot know for sure since it hasn't happened yet.)	True	False	Don't Know	1 2 3 4 5

1.	Camels are used in hot, dry places.	True	False	Don't Know	1 2 3 4 5
2.	All animals like hot climates.	True	False	Don't Know	1 2 3 4 5
3.	The basket over Mother Camel's nose is comfortable.	True	False	Don't Know	1 2 3 4 5
4.	Ali's turban is made of silk.	True	False	Don't Know	1 2 3 4 5
5.	Baby camel preferred to play with his little camel friend rather than with Ali.	True	False	Don't Know	1 2 3 4 5
6.	Ali has 63,474 hairs on his head.	True	False	Don't Know	1 2 3 4 5
7.	Ali's father is a very young man.	True	False	Don't Know	1 2 3 4 5
8.	The camel is the ugliest of all animals.	True	False	Don't Know	1 2 3 4 5
9.	Ali will be a farmer when he grows up.	True	False	Don't Know	1 2 3 4 5
10.	There are 10,243 gallons of water in the pond in front of the village.	True	False	Don't Know	1 2 3 4 5
11.	Baby camel often has pleasant dreams.	True	False	Don't Know	1 2 3 4 5
12.	Camels make the ugliest noise of all animals.	True	False	Don't Know	1 2 3 4 5
13.	Ali has his own bedroom at home.	True	False	Don't Know	1 2 3 4 5
14.	All camels in the market are healthy.	True	False	Don't Know	1 2 3 4 5
15.	Ali will always live in the desert.	True	False	Don't Know	1 2 3 4 5
16.	The desert is the best place in the world to live.	True	False	Don't Know	1 2 3 4 5

17. Food is stored in a camel's hump.	True	False	Don't Know	1 2 3 4 5
18. The length of the average step baby camel takes is three feet.	True	False	Don't Know	1 2 3 4 5
19. Camels may be bought in camel markets.	True	False	Don't Know	1 2 3 4 5
20. Ali was afraid of sand storms when he was young.	True	False	Don't Know	1 2 3 4 5
21. Baby camel will never again get sick in a sand storm.	True	False	Don't Know	1 2 3 4 5