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Analysis and Evaluation Questions: Their Effects Upon Critical Thinking¹

FRANCIS P. HUNKINS *

OVER the years educators have advocated that one way to stimulate thinking among pupils is the effective use of questions (Burton, 1929, 1960; De Garmo, 1911; Hall and Hall, 1916). At present educators are still advocating the use of effective questions and questioning strategies to stimulate thinking—an inquiring mind (Loughlin, 1961; Taba, 1962; Wellington and Wellington, 1962).

Despite effective questioning being advocated and equated with effective teaching, the past half-century has provided little empirical research on questions and questioning. Most research that has been conducted indi-

cates that most teachers' questions are low on the cognitive-emphasis scale (Adams, 1964; Clegg, 1967; Davis and Tinsley, 1967; Floyd, 1960; Tinsley and Davis, 1969). The majority of teachers do not ask questions designed to elicit pupils' thinking.

Prior to making a statement about a specific questioning strategy, it seemed necessary to this investigator to determine how various types of questions would affect pupils' thinking. Thus this study sought to determine whether a dominant use in social studies text-type materials of analysis and evaluation questions, as defined by Bloom's *Taxonomy*, would effectively stimulate the development of sixth-grade pupils' critical thinking.

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* Francis P. Hunkins, Associate Professor of Education, University of Washington, Seattle

Critical Thinking in the Social Studies

A task fundamental to the social studies is assisting pupils in determining whether there is any warrant for holding certain beliefs (Metcalf, 1962). One of the goals of social studies is to have pupils examine and understand society. According to Hullfish (1961), thinking is developing a plan and a capability to believe. Believing signifies a willingness to act. In acting, one examines information and questions alternatives.

If the task of the social studies is to consider the social nature and problems of man, critical thinking cannot be excluded. But critical thinking must be defined. Dressel and Mayhew (1954) define such thinking as a process of analyzing a problem, examining its logical and factual bases, and arriving at warranted conclusions. Russell (1960) termed critical thinking as the process of evaluation or categorization consistent with some previously selected and accepted standards. Accordingly, this investigator chose to combine elements of both definitions and defined critical thinking as a cognitive act consisting primarily of analysis and evaluation of data.

General Plan of Study

The study first involved constructing two sets of text-type materials and corresponding answer sheets, one stressing questions requiring analysis and evaluation (Condition A) and the other containing questions stressing knowledge (Condition B). Pupils in both treatment conditions were instructed to read designated sections of their textbook and to respond to the questions on their worksheets. For four weeks, pupils used these materials during a 35-minute portion of the daily social studies period. "Africa and Oceania" was the focus material for this study and was based on chapters in the adopted social studies textbook used by the cooperating school system. This focus was selected because the subjects, from analysis of their practical school experience, had little prior knowledge of the areas. Thus most subjects, if not all,

would be starting their experimental involvement from the same information base. This assumption was borne out in analyzing the results of a pre-achievement test which was employed as a covariant in another aspect of this investigation. The general format and directions of the two sets of special materials were identical, the only varying factor being the questions and their emphases. During the experimental period, teachers refrained from actively engaging in teaching but assisted in coordinating the pupils' use of the materials.

This lack of active teacher participation was an attempt to reduce teachers' influence on the experimental situation.

The use of the questions in a type of "workbook" or loosely programmed format seemed an adequate way to present children with stimuli to trigger critical thinking. Programmed materials designed to get individuals to think have adequate support as to their effectiveness. Many of the questions in these materials, especially with Condition A, were not just aimed at student recall. Rather the questions attempted to involve the students in a detailed analysis and evaluation of the data.

The questions in these materials were designed somewhat as handles by which the students could engage in thinking and gain new understanding.

Procedure

Subjects

Two hundred and sixty pupils served as subjects and were enrolled in eleven sixth-grade classes in three elementary schools serving the same geographic area of a large suburban public school system in a northeastern Ohio community. Pupils were randomly assigned by class to one of two experimental treatment conditions, A or B. A total of 127 pupils were assigned to Condition A, while 133 pupils were assigned to Condition B.

Pupils' IQ scores (*California Test of Mental Maturity*, S Form) and reading scores (*Stanford Achievement Test*, Form W) were subjected to analysis of variance to determine if significant differences between

groups existed. None were found when considering these data across reading levels by treatment and sex.

Experimental Materials

Test of Critical Thinking. The *Social Studies Inference Test* (I.T.) (Taba, 1964) was used as the criterion test of critical thinking. This test was designed to assess pupils' ability to interpret what is presented in a situation and to formulate judgments regarding the validity of inferences from these data. The test does not yield a single "critical thinking" score, but, rather, scores on four aspects of critical thinking: inference, caution, over-generalization, and discrimination. This investigator considers the first and last aspects to be the primary ones in critical thinking.

The test confronts the pupil with various stories describing situations in which certain behaviors or events are interrelated. Following the story, the pupil must decide whether a statement is "probably true," "probably false," or "cannot tell." Odd-even reliability coefficients (at $p < .01$) for this test were reported to be: inference, .87; discrimination, .88; caution, .85; and over-generalization, .71.

The I.T. was administered as both a pretest and a post-test. The pretest was administered two weeks prior to the investigation's initiation and the post-test was administered immediately at the investigation's termination.

Experimental Pupil Materials and Procedures. The sets of experimental materials and answer sheets for both conditions were identical in format and directions, and varied only in different question emphasis. Seventeen sets for each condition were developed to correspond to discrete portions of the adopted text (*The Changing Old World*, Cooper, Sorensen, and Todd, 1961). The questions, within each of the 17 sets, were presented in random order in relation to the organization of the textual narrative. Pupils were instructed to write answers to each question on spaces provided.

Materials for Condition A had 47.53 percent of the total questions in the analysis and evaluation categories. Condition B contained a knowledge question emphasis of 87.38 percent.

Pupils in both Conditions worked with these materials from 30 to 35 minutes each day. After reading designated sections in the text, they answered the questions on the appropriate worksheets. Pupils evaluated their

Source of Variation	Original		Adjusted			
	d.f.	S.S.	d.f.	S.S.	M.S.	F
Treatment	1	.55	1	.41	.41	.17
Reading level	3	41.25	3	9.44	3.14	1.35
Sex	1	5.14	1	.96	.96	.41
Treatment $\times$ reading level	3	20.08	3	15.62	5.21	2.24
Treatment $\times$ sex	1	1.10	1	4.11	4.11	1.76
Reading level $\times$ sex	3	11.55	3	14.15	4.71	2.02
Treatment $\times$ reading level $\times$ sex	3	16.28	3	10.51	3.50	1.50
Within groups	244	696.12	243	565.04	2.33	—

All F ratios are non-significant ($p = .05$).

S.S. represents sums of squares.

M.S. represents mean squares.

d.f. represents degrees of freedom.

Table 1. Summary of Analysis of Covariance of Post-Test Scores on Inference Sub-Test of Social Studies Inference Test

Source of Variation	Original		Adjusted			
	d.f.	S.S.	d.f.	S.S.	M.S.	F
Treatment	1	9.30	1	5.40	5.40	4.35*
Reading level	3	4.60	3	6.93	2.31	1.86
Sex	1	5.45	1	8.20	8.20	6.61*
Treatment $\times$ reading level	3	23.97	3	16.40	5.46	4.40**
Treatment $\times$ sex	1	.56	1	.03	.03	.02
Reading level $\times$ sex	3	10.02	3	7.04	2.34	1.89
Treatment $\times$ reading level $\times$ sex	3	14.92	3	8.06	2.68	2.16
Within groups	244	495.12	243	303.18	1.24	—

* Significant at the .05 level.
** Significant at the .01 level.

Table 2. Summary of Analysis of Covariance of Post-Test Scores in Caution Sub-Test of Social Studies Inference Test

responses on the worksheet by referring to a particular answer sheet.

Analysis of Data

The experimental design basic to this study was an analysis of covariance design. Within each treatment condition, data were analyzed according to sex and reading achievement, resulting in a $2 \times 2 \times 4$ (treatment $\times$ sex $\times$ reading level) classificatory scheme. The *Stanford Achievement Test*, Form W, was the instrument used to assign pupils to reading levels. The reading levels were organized by quartiles and had the following ranges based on raw scores: Quartile 1, 0-31; Quartile 2, 32-38; Quartile 3, 39-47; and Quartile 4, 48-64.

Results

Since the criterion test of critical thinking, the *Social Studies Inference Test*, did not yield a total score, its four subscores (inference, caution, over-generalization, and discrimination) were analyzed separately.

Results of the analysis of covariance of the post-test inference scores, adjusting for pretest inference scores, are presented in Table 1. No significant differences were observed for any main effects or interactions.

Consequently, with respect to inference, the dominant use (approximately 50 percent) of analysis and evaluation questions did not produce significant differences between the two treatment groups.

The results of covariance analysis of the post-test caution scores adjusted from pretest scores for caution are summarized in Table 2. As is evident from Table 2, two main effects and one interaction were statistically significant. Pupils in Condition A (analysis and evaluation questions) scored higher (see Table 3) on caution than did pupils in Condition B (knowledge questions); too, girls scored higher on caution than did boys. The significant treatment $\times$ reading level interaction helps explain the significant treatment effects. Pupils in Condition A at the Quartile 3 reading level scored significantly higher than pupils in Condition A, Quartile 2 and Quartile 4, and in Condition B, Quartile 2,

Treatment Group	Sex of Pupils	Reading Level			
		Q1	Q2	Q3	Q4
A	boys	15.89	16.08	16.79	13.46
	girls	18.00	15.11	20.42	17.61
B	boys	16.36	15.19	12.61	16.60
	girls	18.00	15.34	15.46	14.46

Table 3. Adjusted Means for Post-Test Caution Scores

Quartile 3, and Quartile 4; but not higher than pupils in Conditions A and B reading level Quartile 1. Pupils in Condition B, Quartile 1, scored significantly higher than pupils in Condition B, Quartile 2, Quartile 3, and Quartile 4. The adjusted means (see Table 4) were nonsignificant between the two conditions at reading levels Quartiles 1, 2, and 4.

Treatment Group	Reading Levels			
	Q1	Q2	Q3	Q4
A	16.60	15.65	18.29	15.76
B	17.23	15.27	14.44	15.16

Table 4. Adjusted Means of Post-Test Caution Scores of Pupils in Two Treatments and Four Reading Levels

The results of the analysis of covariance of the post-test over-generalization scores are summarized in Table 5. No statistically significant differences were observed for any of the main effects, and only one interaction reached significance. Overall, then, questions emphasizing higher level cognitive processes did not result in pupils' higher or lower over-generalization than that exhibited by pupils using questions emphasizing knowledge.

The treatment $\times$ reading level interaction, however, reveals that pupils reacted differentially in the two conditions at different

reading levels. Specifically, pupils using the higher level questions (Condition A) at the lowest reading level, Quartile 1, over-generalized more than pupils using the knowledge questions (Condition B) at the Quartile 1 reading level as well as higher than pupils in Condition A, Quartile 3 and Quartile 4, and in Condition B, Quartile 4. Pupils in Condition A, Quartile 2, over-generalized more than those in Condition A, Quartile 3 and Quartile 4, and Condition B, Quartile 1 and Quartile 4. Higher over-generalization was observed for pupils in Condition B, Quartile 2, than for those in Condition B, Quartile 1 and Quartile 4, and in Condition A, Quartile 3 and Quartile 4.

Also, higher over-generalization scores were made by those in Condition B, Quartile 3, than by pupils in Condition B, Quartile 1 and Quartile 4, and in Condition A, Quartile 3 and Quartile 4. Pupils in Condition A, Quartile 1 and Quartile 2, and in Condition B, Quartile 2 and Quartile 3, over-generalized at nonsignificantly different levels. Similarly, pupils in Condition B, Quartile 1 and Quartile 4, and in Condition A, Quartile 3 and Quartile 4, did not differ significantly in their over-generalization and, as indicated above, had lower over-generalization scores than pupils in Condition A, Quartile 1 and Quartile 2, and in Condition B, Quartile 2 and Quartile 3. Consequently, these results indicate that the

Source of Variation	Original		Adjusted			
	d.f.	S.S.	d.f.	S.S.	M.S.	F
Treatment	1	.01	1	.19	.19	.54
Reading level	3	7.43	3	1.71	.57	1.62
Sex	1	.17	1	.82	.82	2.34
Treatment $\times$ reading level	3	4.41	3	3.95	1.31	3.74*
Treatment $\times$ sex	1	.20	1	.15	.15	.42
Reading level $\times$ sex	3	1.70	3	1.46	.48	1.37
Treatment $\times$ reading level $\times$ sex	3	3.12	3	1.76	.59	1.68
Within groups	244	124.02	243	86.64	.35	—

* Significant at the .05 level.

Table 5. Summary of Analysis of Covariance of Post-Test Scores on Over-Generalization Sub-Test of Social Studies Inference Test

Source of Variation	Original		Adjusted			
	d.f.	S.S.	d.f.	S.S.	M.S.	F
Treatment	1	.46	1	.06	.06	.33
Reading level	3	10.73	3	4.18	1.39	7.72*
Sex	1	.06	1	.00	.00	.00
Treatment $\times$ reading level	3	.38	3	.74	.25	1.38
Treatment $\times$ sex	1	.27	1	.41	.41	2.27
Reading level $\times$ sex	3	.04	3	.30	.10	.55
Treatment $\times$ reading level $\times$ sex	3	.23	3	.50	.16	.88
Within groups	244	53.16	243	44.04	.18	—

* Significant at the .01 level.

Table 6. Summary of Analysis of Covariance of Post-Test Scores on Discrimination Sub-Test

poorest readers (Quartile 1) who used the knowledge questions (Condition B), the better than average readers (Quartile 3) who used the higher level questions (Condition A), and the best readers (Quartile 4) in both conditions over-generalized less than pupils in the other treatment-reading level groups.

Results of the analysis of covariance of the post-test discrimination scores adjusted for pretest discrimination scores are presented in Table 6. As may be observed, there were no statistically significant differences in discrimination between pupils in the two treatment conditions and between boys and girls and no significant interactions. Pupils' reading levels, however, were related to their discrimination scores. Discrimination scores of all pupils in reading levels Quartile 1 and Quartile 2 were not statistically different. Pupils in Quartile 4 scored higher on discrimination than those in Quartile 3, Quartile 2, and Quartile 1; pupils in Quartile 3 scored higher than both Quartile 2 and Quartile 1.

Conclusions

The following conclusions are warranted from the data analyses:

1. Pupils using text-type materials with a cognitive-question emphasis upon analysis and evaluation (Condition A) did not differ

significantly with respect to inference from pupils who received similar type materials with a dominant emphasis of knowledge questions (Condition B).

2. Higher-cognitive level questions (Condition A) produced significantly more caution overall among girls than was true of boys or girls using lower level questions (Condition B). The higher level questions stimulated more caution in boys than girls at the middle (Quartile 2 and Quartile 3) reading levels.

3. Pupils in Condition A in the lowest reading level over-generalized more than similar pupils in Condition B as well as more than pupils in the highest reading levels (Quartiles 3 and 4) of Condition A and the highest reading level of Condition B. Pupils in the middle reading levels who were exposed to Condition B over-generalized more than pupils in either the lowest or highest reading levels in this treatment group.

4. There were no significant differences in the discrimination scores of pupils between the two treatment conditions. However, pupils' reading levels were related to their discrimination scores; better readers in both conditions achieved higher discrimination scores than did poorer readers.

5. To the extent that the four *Infer-*

ence Test sub-tests represented "critical thinking," the appropriate null hypothesis must be accepted. That is, with only minor exceptions, pupils using questions with a dominant emphasis on analysis and evaluation did not differ significantly with respect to critical thinking from those pupils using questions predominantly of the knowledge type.

Discussion

That analysis and evaluation questions did not stimulate an increase in critical thinking is not a simple conclusion; plausible reasons to explain this finding are necessarily complex. At the outset, critical thinking must be seen as a vague concept; its common use frequently suggests that it is a slogan rather than a precisely formulated idea. The lack of instruments to measure this type of thinking testifies to the difficulty of bringing adequate definition to the concept.

Consequently, a possible reason for the failure of the high level questions to stimulate critical thinking perhaps should not be attributed to the questions used, but rather to a faulty criterion measure, the *Social Studies Inference Test*. This test provides no overall score, and each sub-test score alone does not comprise critical thinking.

Indeed, the test at the time of the experiment existed in only an experimental version, and its developer (Taba, 1964) made no claim that it would provide an adequate measure of gross critical thinking. Still, even with these obvious inadequacies, this test was considered at the time to be the only reasonably suitable instrument to assess critical thinking of elementary school pupils. Additional and more satisfactory instruments to measure critical thinking need to be developed so that critical thinking can be analyzed, measured, or proven to be, in reality, non-existent. Particularly useful would be the analysis of present tests (at secondary and adult levels) which purport to measure critical thinking in order to determine if specific factors (for example, similar to the "structure of intellect model" [Guilford, 1966]) exist in them.

The investigator had hoped that, by en-

gaging the subjects with high level questions, he would enable children to become aware of and to practice the skills of critical thinking. Children confronted with analysis and evaluation questions should be, it seems, forced to consider various situations and to begin to discriminate, to sort out, to analyze, to recognize underlying assumptions, and to evaluate data critically. The restriction of pupils to answering questions with no opportunity for discussion may have tended to reduce their enthusiasm and to stifle their development of critical thinking. Discussion of the materials and the questions by teachers and pupils possibly would have contributed to greater and perhaps significant differences between the two treatment groups. Critical thinking would seem to demand that pupils be given the opportunity to reflect, to discuss, and to question further. The absence of this opportunity may very well have served as a deterrent to the pupils' development of critical thinking. Too, pupils might have been affected adversely because of lack of teacher interaction. Pupils are accustomed to the teacher's playing a dominant role in the classroom. Yet, in this investigation, the teacher served only to coordinate the pupils' use of the materials.

Another possible reason for the observed nonsignificant difference between the groups might be attributed to the strategy of presenting questions. Pupils might have done better in Condition A had a strategy been incorporated into the experiment whereby they used a predominance of low-level knowledge questions first and then utilized higher-level analysis and evaluation questions. Taba (1967) advocated this strategy and had obtained empirical evidence as to its effectiveness. This possibility seems particularly intriguing and merits additional and specific research.

Pupils in Condition A may have developed no increased critical thinking because of their lack of experience with high level questions in their previous classroom learning activities. Pupils, typically, are confronted with questions requiring the return of information which has been presented by the teacher. It is not common for pupils to experience questions that ask them to react

to and to manipulate information. Pupils lacking this experience may not have had the prior learnings necessary for dealing with the sudden confrontation of questions demanding that they think with the knowledge they possess.

The length of the experimental period may not have been sufficient to stimulate critical thinking in those pupils using the analysis and evaluation questions as contrasted with those pupils using the knowledge questions. Fostering complex cognitive functions probably demands an extended time. However, other studies report the stimulation of critical thinking in a similar time period. These studies (Cousins, 1963; Elsmere, 1963; McGarry, 1961) may not have measured critical thinking but rather a special type of achievement. That is, learning the use of a particular model for thinking (for example, a procedure of "problem solving") probably represents a significant and useful achievement, but not necessarily an increase in the ability to think critically.

The failure of analysis and evaluation questions to stimulate critical thinking may have its strongest explanation in the possibility that critical thinking is an ability, or abilities, which cannot be taught, but only improved to some unknown degree. Perhaps critical thinking is analogous somewhat to intelligence. One does not teach to improve intelligence; one only teaches so that its potential will be utilized. Perhaps critical thinking must also be viewed in a similar

light. A teacher may not be able to teach critical thinking; he can, however, work to make sure that this ability, inherent in each pupil, is utilized to its potential. It seems that this possible explanation is the most far reaching in its implications for education.

If critical thinking is an ability, then pupils will not be taught to think, but will be provided opportunities which will develop their ability. Methods and strategies of teaching would have to change. The objectives and techniques of evaluation of critical thinking, then, by teacher-made or standardized tests, would have to be readjusted appropriately. Likewise, research concerned with critical thinking would have to be reoriented. Empirical research adding to the plausibility of viewing critical thinking as an ability, or cluster of abilities, is that completed on the nature of problem solving (Merrifield, Guilford, Christensen, and Frick, 1962). This research suggests that problem solving does not exist as a unitary ability. Rather, it must be considered as multiple abilities.

The role of the question is still imprecise with regard to critical thinking. The failure of the high level questions to stimulate such thinking forestalls the simple conclusion that if the right questions are framed, pupils will think critically. The findings possibly suggest that the knowledge question has more value than it has been accorded in the stimulation of thinking. At this point, additional research is a requisite condition for the advancement of more conclusive evidence.

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