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ABSTRACT

In an attempt to determine the level of questioning according to Bloom's taxonomy, generated by test items that accompany selected fifth-grade science textbooks, an analysis of the tests provided by three of the most commonly used elementary science textbooks was completed. Additionally this analysis examined the extent to which each series emphasized the higher levels of questioning and what significant differences, if any, existed between the old and new publications in the number of knowledge-level and above-knowledge-level test items included in end-of-chapter tests. One hundred items from end-of-chapter tests were analyzed from each edition (old and new) of the textbook series (200 per series), which represented a total sample consisting of 600 items. Interrater agreement on training materials reached the 96% level. The 600 items were randomly selected and categorized by the researchers and one experienced classroom teacher, according to the six major categories included in Bloom's taxonomy: knowledge, comprehension, application, analysis, synthesis, and evaluation. Based on the assumption that the three science textbooks selected for study are representative of all science books, one conclusion is that higher order thinking skills are not elicited by end-of-chapter tests that accompany science textbooks. The lack of emphasis on application, analysis, synthesis, and evaluation levels of questioning indicates a gap between the stated goals of elementary science textbooks and actual published material. (KR)

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**Levels of Questioning in Current Elementary Textbooks:
What the Future Holds**

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Levels of Questioning in Current Elementary Textbooks:

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Critical thinking maintains a prominent position among desired learning outcomes in elementary science. Since the textbook method is the primary instructional strategy for teaching science, students' thinking most often parallels the cognitive level(s) of the textbooks being used.

Questioning has been labeled by Hilda Taba as the "most influential teaching act," and research verifies the role of higher-cognitive questioning in eliciting critical thinking (Andre, 1979; Doak, 1970; Hunkins, 1968; Redfield and Rousseau, 1981; Taba, Levine, and Elzey, 1964).

Because teachers use textbooks as the primary source of instruction (Smith, 1980, cited by Mechling & Oliver, 1983), it is necessary to analyze elementary science textbooks and their accompanying resource materials (e.g., published tests) to determine their capacity to develop higher-level thinking skills. Textbook publishers provide a wide variety of accompanying materials such as study guides, chapter and unit tests, posters, parent letters and other materials. Many textbook publishers include scope and sequence charts which emphasize the fact that the text and accompanying materials emphasize divergent, open-ended questions which facilitate critical thinking skills.

Most of the research studies related to questioning have been limited to questions contained in textbooks, and teachers' manuals. The research literature does not contain studies concerning the cognitive levels of test items that accompany elementary science textbooks. This research study compares the levels of questions from science tests accompanying textbooks published in the 1980s to those that will be used in schools in the 1990s.

ANALYZING TEXTBOOK TESTS

In an attempt to determine the level of questioning according to Bloom's (1956) taxonomy, generated by test items that accompany selected fifth-grade science textbooks, an analysis of the tests provided by three of the most commonly used elementary science textbooks was completed. Additionally this analysis examined the extent to which each series emphasized the higher levels of questioning and what significant differences, if any, existed between the old and new publications in the number of knowledge-level and above-knowledge-level test items. Moreover, it was hypothesized that there would be no significant difference between the old and new textbook editions in the distribution of knowledge-level and above-knowledge-level test items included in end-of-chapter tests.

PROCEDURES

Textbook adoption information was obtained from the state departments of education of Alabama, California, Tennessee, and Texas to obtain a rank ordering of the fifth-grade series used most frequently for all states combined. Three of the most widely used

textbooks, both old and new editions, published in the 1980s were analyzed: Accent on Science (1983) and Merrill Science (1989), both published by Charles E. Merrill Company: Holt Science (1984) and Holt Science (1989), both published by Holt, Rinehart, and Winston Company: and Scott, Foresman Science (1983) and Scott, Foresman Science (1989), both published by Scott, Foresman and Company.

One hundred items from end-of-chapter tests were analyzed from each edition (old and new) of the textbook series (200 per series), which represented a total sample consisting of 600 items. Interrater agreement on training materials reached the 96% level. The 600 items were randomly selected and categorized by the researchers and one experienced classroom teacher, according to the six major categories included in Bloom's (1956) taxonomy: knowledge, comprehension, application, analysis, synthesis, and evaluation. Results of the classifications were analyzed and presented in frequency distribution tables and a series of circle graphs. The chi-square statistic was selected to test the proposed hypotheses.

FINDINGS AND CONCLUSIONS

As indicated in Table I, a total of 173 (58%) of the 300 test items in the old editions represented the knowledge category. These series contained 109 (36%) comprehension items and only 6% application items. Test items reflective of the analysis and synthesis categories were nonexistent in the distribution; only one evaluation item existed.

Among the new editions (see Table II), the knowledge category received even greater representation collectively. Of the 300 items analyzed, 209 (70%) items were judged as knowledge, 85 (28%) as comprehension, and only 6 items as application.

This analysis also examined the extent to which the test items in both the old and new editions emphasized the higher levels of questioning. For this purpose, levels two through six of Bloom's (1956) taxonomy were combined and percentages were calculated. By collapsing the upper five levels into one major category (i.e., higher level questions), both new and old textbook editions were examined according to their emphasis on understanding or applying science information (higher-level) as compared to memorization (lower-level). The resulting dichotomies of the old publications as shown in Figures 1-3, indicated that two series, Merrill and Holt, possess generally balanced disbursements of lower and higher level questions on the published tests, thereby exposing students to cognitive stages other than mere recall. Closer examination of the higher level questions reveals that Merrill contains more application items than Holt, however both series demonstrated a preponderance of comprehension items. While providing cognitive exercise other than memorization, Merrill and Holt focus primarily on the lowest level of understanding. As indicated by Figure 3, the older edition published by Scott, Foresman contained the lowest percentage of higher level questions. The higher level category in this series possessed 17 comprehension items and one application item. One obvious conclusion is that chapter-end science tests in

this edition predominantly emphasize mere recall of isolated bits of scientific information.

The analysis of new textbook publications reveal an interesting trend with regard to the emphasis of higher level questions. As shown in Figures 4-6, recent publications of both Merrill and Holt place less emphasis on the higher level questions that did older editions; the similarities among these new publications are striking: Merrill and Holt possessed only 26% and 30% higher level questions respectively. On the other hand, Scott, Foresman demonstrated more higher-level test items in the new editions.

In order to determine if changes had occurred over time, the study compared old and new editions for each of these series to determine if significant differences existed in the distributions of knowledge and above knowledge-level test items. The chi-square (X^2) statistical technique was employed through a series of 2 x 2 contingency tables (Textbook Editions: Old and New x Knowledge-Level vs. Above-Knowledge Level Questions).

Results of these analyses revealed that Merrill contained significantly more knowledge-level items in the new editions ($X^2 = 23.98$; $p < .001$). A similar emphasis on the knowledge category was demonstrated by the new Holt science series as indicated by the significant ($p < .001$) chi-square (X^2) value of 9.15. The Scott, Foresman series however, demonstrated no significant difference ($X^2 = 3.37$) in the level of questioning between the old and new

editions, indicating that questioning levels in this text remained unchanged.

DISCUSSION

Based on the assumption that the three science textbooks selected for study are representative of all science books, one obvious conclusion is that higher order thinking skills are not elicited by end-of-chapter tests that accompany science textbooks. The lack of emphasis on application, analysis, synthesis, and evaluation levels of questioning indicates a gap between the stated goals of elementary science textbooks and actual published material. It is recommended that science textbook publishers include test items that engage students with substantial practice with comprehension, application, analysis, synthesis, and evaluation questions. Teachers must also devise supplementary questions, both written and oral, that facilitate the development of higher cognitive processes.

Similar research in the area of science is needed to determine the cognitive levels of questioning utilized in teacher's editions for classroom use and pupil's textbooks for chapter-end review. Other recent experimental studies are needed to determine the effects of higher-level questions on student achievement, attitude, and interest in elementary science.

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TABLE 1
 FREQUENCY AND PERCENTAGE OF END-OF-CHAPTER TEST ITEMS FOR THREE PUBLISHED
 FIFTH-GRADE SCIENCE TEXTBOOK SERIES ACCORDING TO BLOOM'S TAXONOMY
 OF EDUCATIONAL OBJECTIVES
 (OLD EDITIONS 1983-1984)

Category	Holt		Scott, Foresman		Merrill	
	<u>n</u>	%	<u>n</u>	%	<u>n</u>	%
Knowledge	49	49	82	82	42	42
Comprehension	49	49	17	17	43	43
Application	2	2	1	1	14	14
Analysis	0	--	0	--	0	--
Synthesis	0	--	0	--	0	--
Evaluation	0	--	0	--	1	1
Total	100	100	100	100	100	100

Note. Percentages are rounded to the nearest whole numbers.

TABLE 2

FREQUENCY AND PERCENTAGE OF END-OF-CHAPTER TEST ITEMS FOR THREE PUBLISHED
 FIFTH-GRADE SCIENCE TEXTBOOK SERIES ACCORDING TO BLOOM'S TAXONOMY
 OF EDUCATIONAL OBJECTIVES
 (NEW EDITIONS 1989)

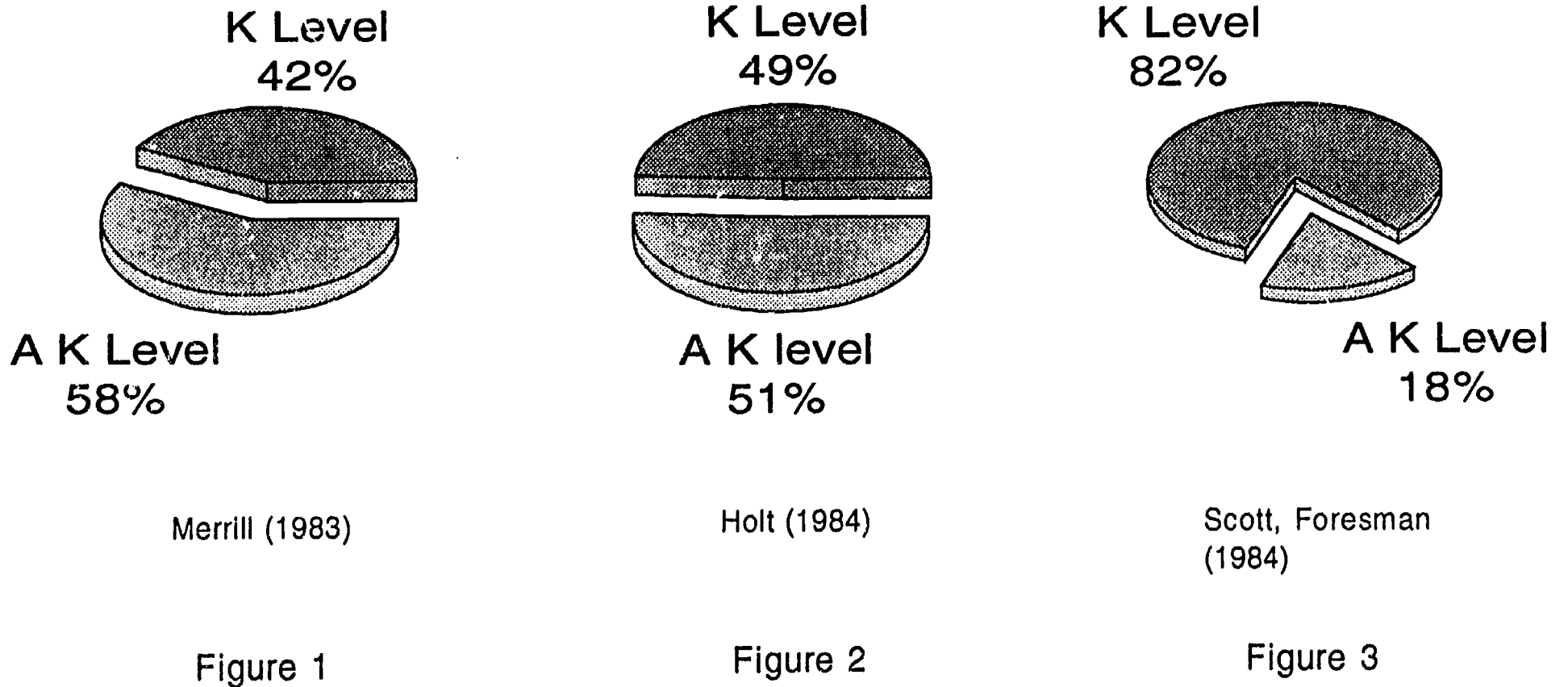
Category	Holt		Scott, Foresman		Merrill	
	<u>n</u>	%	<u>n</u>	%	<u>n</u>	%
Knowledge	70	70	71	82	72	72
Comprehension	28	28	29	17	14	14
Application	2	--	0	--	4	4
Analysis	0	--	0	--	0	--
Synthesis	0	--	0	--	0	--
Evaluation	0	--	0	--	1	1
Total	100	100	100	100	100	100

Note. Percentages are rounded to the nearest whole numbers.

Figures 1-3

Percentage of Knowledge-Level and Above Knowledge-Level End-of-Chapter Test Items for Three Selected Fifth Grade Science Textbook Series

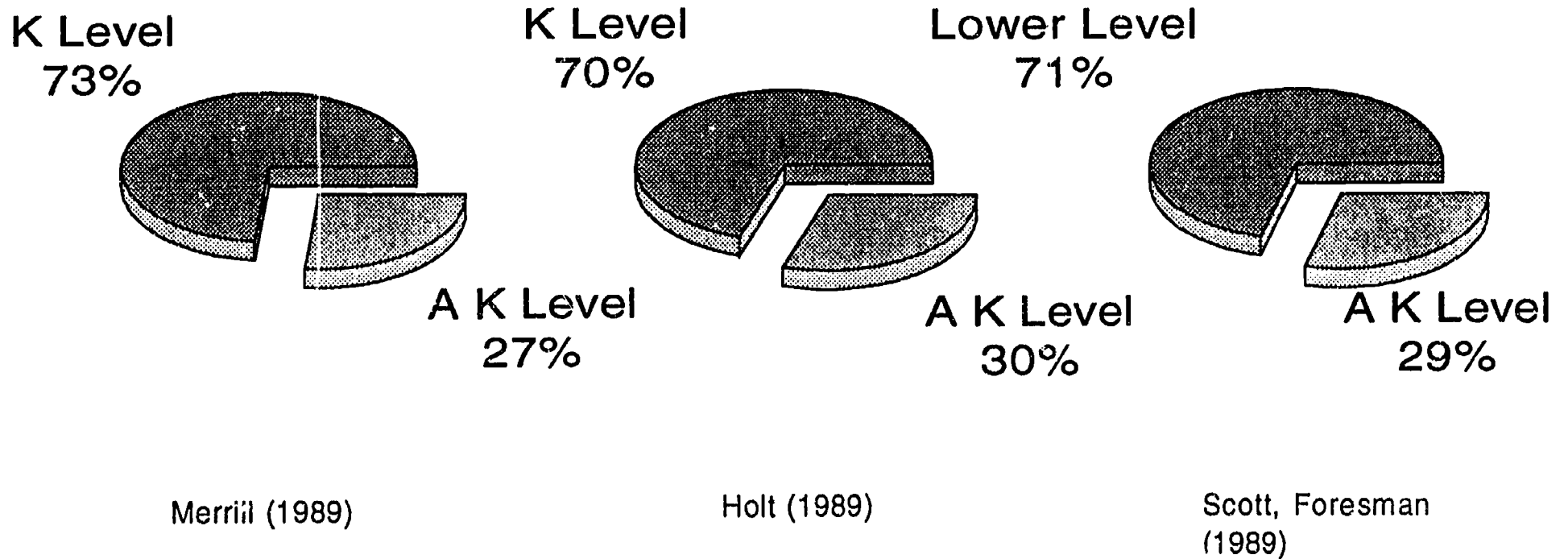
(Old Editions 1983-84)



K Level = Knowledge Level
A K Level = Above Knowledge Level

Figures 4-6

Percentage of Knowledge-Level and Above Knowledge-Level End-of-Chapter Test Items for Three Selected Fifth Grade Science Textbook Series (New Editions 1989)



Merril (1989)

Holt (1989)

Scott, Foresman (1989)

Figure 4

Figure 5

Figure 6

K Level = Knowledge Level
 A K Level = Above Knowledge Level