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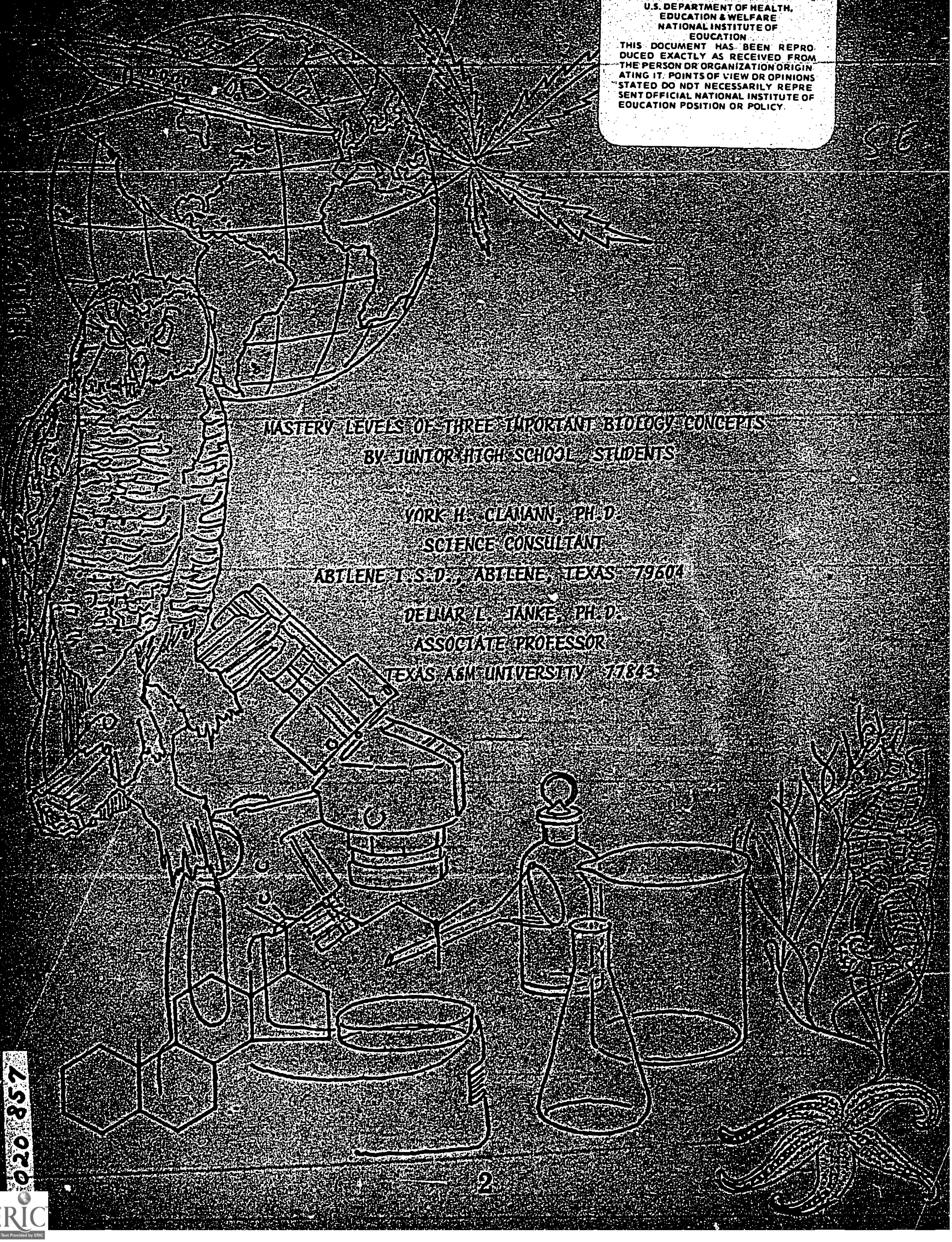
ABSTRACT

In this study, the first three of a panel-judged list of important biology concepts were utilized to determine their mastery level in 75 eighth-graders. The instrument, designed to measure the level of mastery, was based on Frayer's model measuring total, classificatory, and formal concept attainment according to Klausmeier. It was found that the three measured concepts were rank-ordered, with classificatory attainment higher in each concept than formal attainment. (Author/BT)



MASTERY LEVELS OF THREE IMPORTANT BIOLOGY CONCEPTS BY JUNIOR HIGH SCHOOL STUDENTS

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Most curricula in biology-related sciences taught in grades K-12 have been developed with a traditional orientation. This, however, leaves no room for Piaget's theory of hierarchical learning levels. In this study, the first three of a panel-judged list of important biology concepts were utilized to determine their mastery level in 75 eighth grade students. The instrument designed to measure the level of concept mastery was based on Frayer's model measuring total, classificatory, and formal attainment according to Klausmeier. It was found that the three concepts were rank-ordered in total attainment, with classificatory attainment higher than formal attainment in Concepts A and B.

MASTERY LEVELS OF THREE IMPORTANT BIOLOGY

CONCEPTS BY JUNIOR HIGH SCHOOL STUDENTS

<u>INTRODUCTION</u>: The sequencing of information in courses of biology or biology-related sciences in grades K-12 has been based primarily on tradition, as can be seen by noting the work of the Committee of Ten in 1893. In the science group, the Zoology Committee recommended a curriculum which traiditionally is the general pattern followed by most schools today. This curriculum was based on the intuition of select people who felt that this was probably the best method of orientation (*Hurd, 1961*). Empirical data in regard to student ability or desire had not been gathered at that time, and thus the method of curriculum selection was quite subjective.

Another trend in curriculum experimentation involved attempts to break down specific disciplines into their component parts, and to match the learning of these to the developing intellectual abilities of children (*Ripple, 1964*). Piaget (*1964*) has proposed a hierarchy through which the intellectual maturation of children develops. This taxomony gives investigators a basis on which to estimate the probable intellectual ability of a subject, given his chronological age.

<u>PURPOSE</u>: Learning of concepts increases the theoretical volume of material a person can learn, since the number of memorized, individual "bits" decreases (*Shamos, 1966*). The incorporation of facts into a unifying concept initiates the development of proper associations in such a fashion that whenever the defining attributes of a concept occur, even in the context of a new stimulus pattern, the conceptual response will be evoked (*Bourne and Restle, 1959*).

Klausmeier (*1974*) states that concepts may be attained at four discrete levels: the *concrete* and *identity* levels are lower-order attainments such as verbal labels and recognition; the *classificatory* and *formal* levels are considered levels of concept mastery. Attainment at the classificatory level indicates that the student is able to recognize the name of the concept, given an example, and can distinguish between examples and non-examples of that concept. The formal level of attainment is reached, when the student has attained the classificatory level and can also distinguish relevant and irrelevant attributes; as well as associate the concept name with the relevant attributes.

Thompson (1972) published a list of currently credible biology concepts which his research indicated should be included in the K-12 curriculum. His final list (of a three-part serial study) was drawn from the "feedback" of research biologists, university biology instructors, and science educators; 475 of whom responded to his request: "List what you consider to be the five to seven most important concepts from your specialty and from biology in general of which every child should have knowledge prior to graduating from high school." The replies of each series were compiled and edited so that duplication of concepts was eliminated and relevancy of the concepts was established. The final list consisted of 114 currently credible biology concepts considered to be important in K-12 curricula.

The purpose of the study presented here is to validate a model of concept attainment and determine the mastery level, according to Klausmeier (1974), attained by a random population of eighth grade students, in regard to three credible biology concepts considered important for K-12 curricula. The concepts chosen for this study were among those rated most important by Thompson's (1972) study.

METHOD: The following three concepts were chosen for the study:

Concept A: With minor exceptions, living things obtain their energy directly or indirectly from the sun through photosynthesis.

Concept B: The management of natural resources to meet the needs of successive generations demands long-term planning.

Concept C: Living things tend to increase in numbers to the level their particular habitat will permit. Man's ability to modify his environment does not make him an exception. His success in bypassing some environmental barriers is now challenged by new ones.

Twenty multiple choice questions were then developed for each concept according to the hierarchy as established by Klausmeier (*1974*). The framework for measuring concept mastery was developed by Frayer (*Frayer, Quilling, Harris and Harris, 1972*). Table 1 shows the task types as defined in Frayer's framework, as well as their relation to Klausmeier 's mastery levels.

Table 1: Hierarchy of Task Attributes for Concept Mastery

Klausmeier's Concept Attainment Level		Frayer's Task Type
formal	1.	Given the name of an attribute value, the student can select the example of the attribute value.
	2.	Given an example of an attribute value, the student can select the name of the attribute value.
classificatory	3.	Given the name of a concept, the student can select the example of the concept.
	4.	Given the name of a concept, the student can select the non-example of the concept.
	5.	Given an example of a concept, the student can select the name of the concept.
formal	6.	Given the name of a concept, the student can select the names of the relevant attribute values of the concept.
	7.	Given the name of a concept, the student can select the names of the irrelevant attributes of the concept.
formal	8.	Given the definition of a concept, the student can select the name for the concept.
	9.	Given the name of a concept, the student can select the correct definition of the concept.
(utility)	10.	Given the name of a concept, the student can select the name of a concept supra-ordinate to it.
	11.	Given the name of a concept, the student can select the name of a concept sub-ordinate to it.
(utility)	12.	Given the names of two concepts, the student can select the principle which relates them.

Each task type may be measured by several questions in the instrument, but a single question may measure the attainment of only one task type.

After the optimal number of questions for each task type was developed, the questions were prepared and submitted to a panel to determine whether each question properly measured only within the given task type. Then another panel determined the biological accuracy and the structural appropriateness of each stem, answer, and three distractors. After each of the panel judgments, the instruments were pilot-tested in classroom situations similar to the situation determined for the actual study.

Eighth grade students ($n=75$) who had previously completed one year of life science study in a large metropolitan school district were chosen to participate in this research effort. Six (one-hour) classes taught by the same teacher, were utilized. Statistical analysis of the results demonstrated that none of the classes were significantly different ($p=.01$) in regard to level of concept mastery. Each class was read the three concepts; students who did not understand the defintion of any word which was read, were given that definition. The teacher refrained from giving any further clarification. The students were allowed twenty minutes to answer the multiple choice questions for each concept. At the end of the testing period, questions and answers were collected by the investigator. The order in which the concepts were tested was random.

RESULTS: The raw scores for each of the concepts at the formal and classificatory attainment level were subjected to statistical analysis. Figure 1 shows the percent of students (*x-axis*) who correctly answered the questions within a given mastery level (*y-axis*). Figures 2-7 are the histogram representation of the percent of students (*y-axis*) who achieved a given score (*x-axis*) at each level of concept mastery.

It was found that those students sampled had more factual knowledge of Concept A than of Concept B than of Concept C, as indicated by their classificatory attainment levels (*fig. 2,4, and 6*). Concepts A and B showed similarities in attainment by students at the formal level, while Concept C responses gave a clear indication that students did not have the prerequisities to attain formal mastery (*Fig. 3, 5, and 7*).

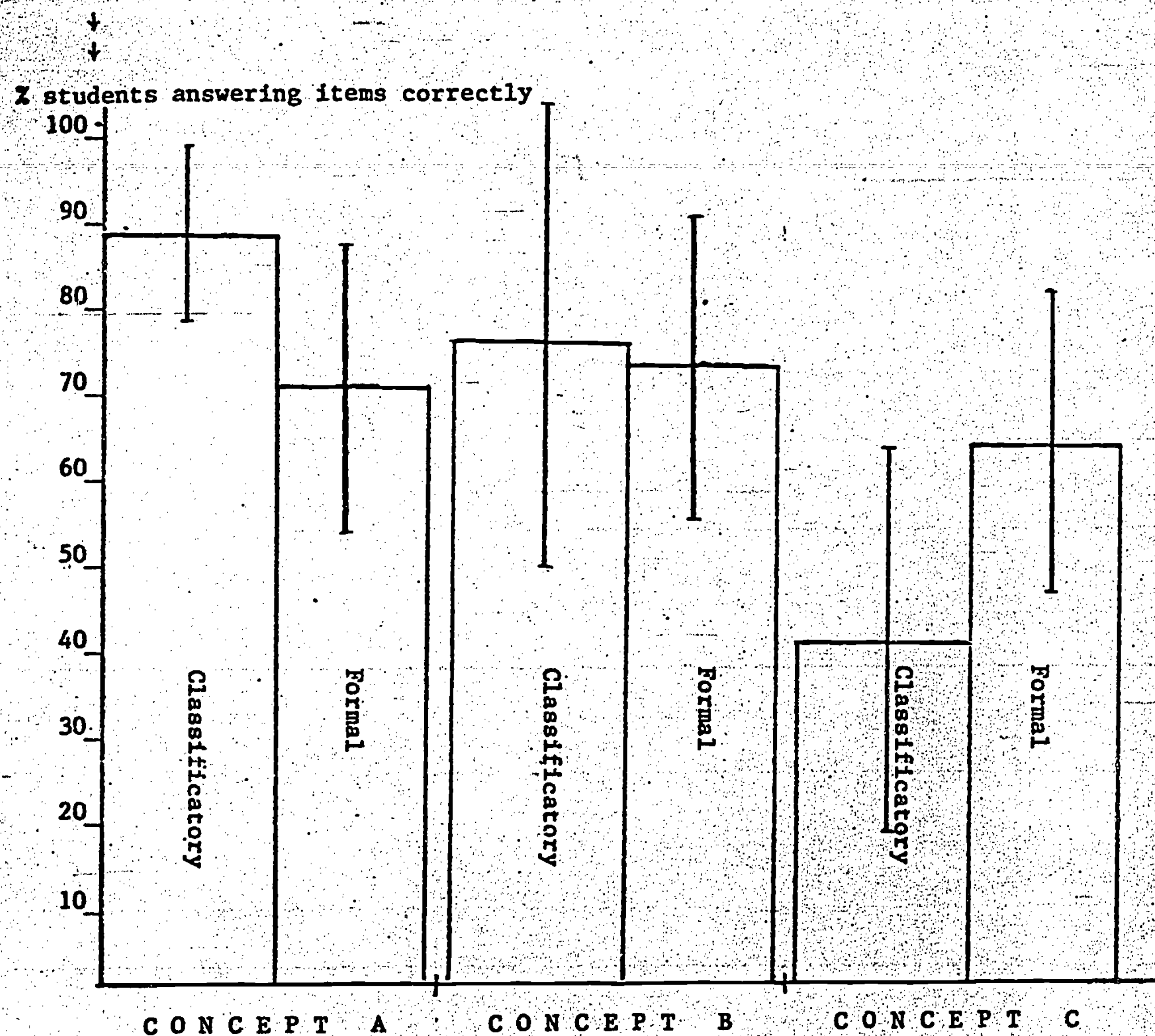

Figure 1: Percent of students correctly answering questions in the given level of the concept indicated. Center lines indicate range of scores.

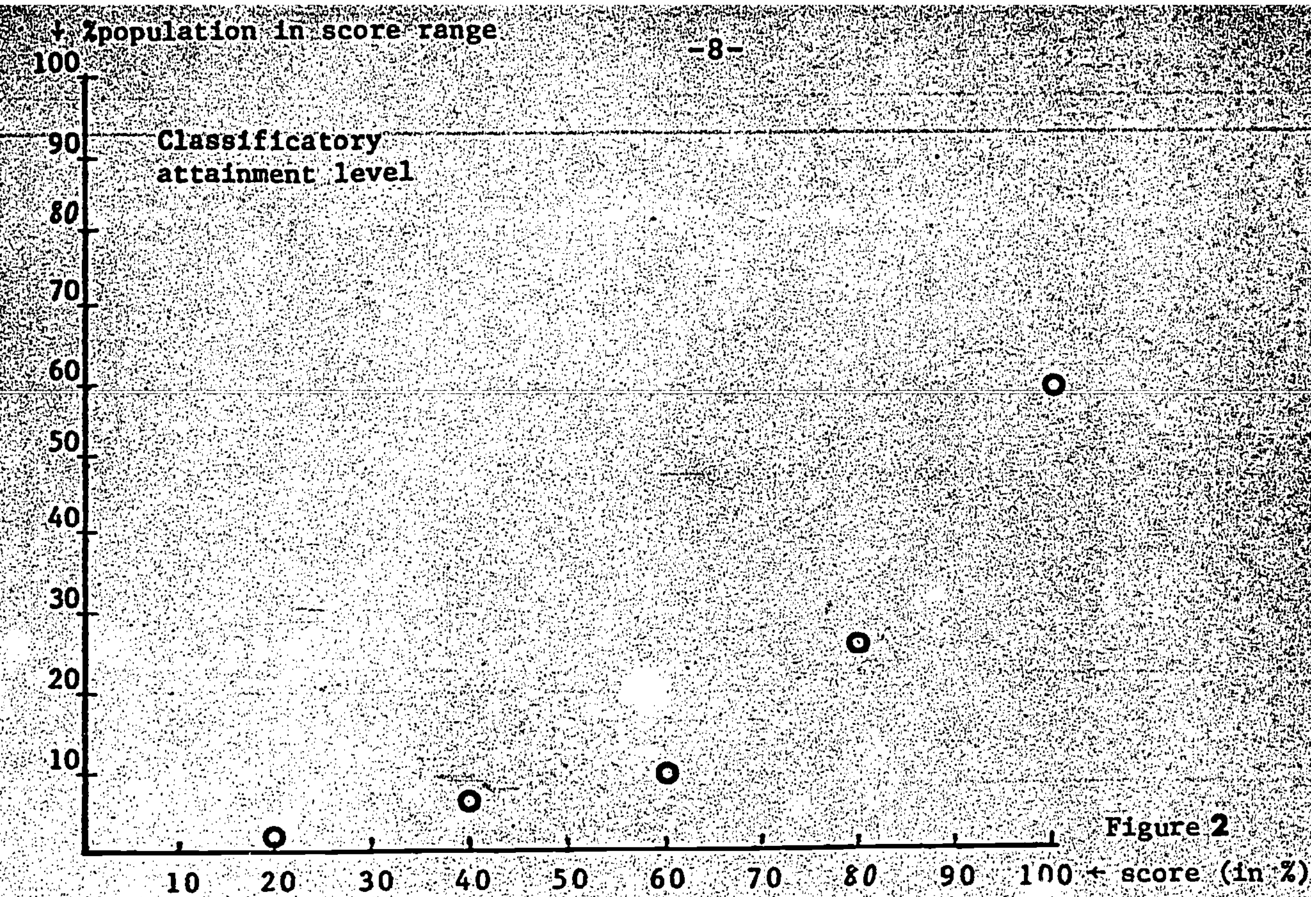

Figure 2

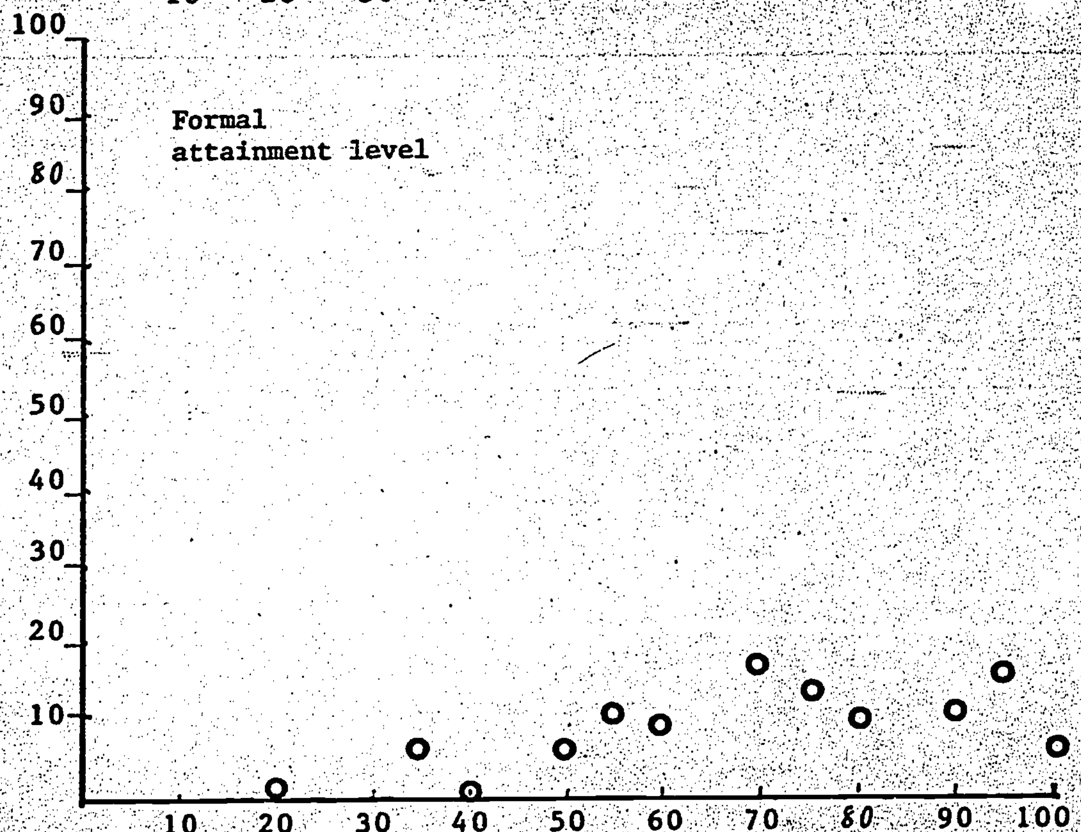

Figure 3

Figures 2 and 3: Degree of population concept attainment by levels. Concept A.

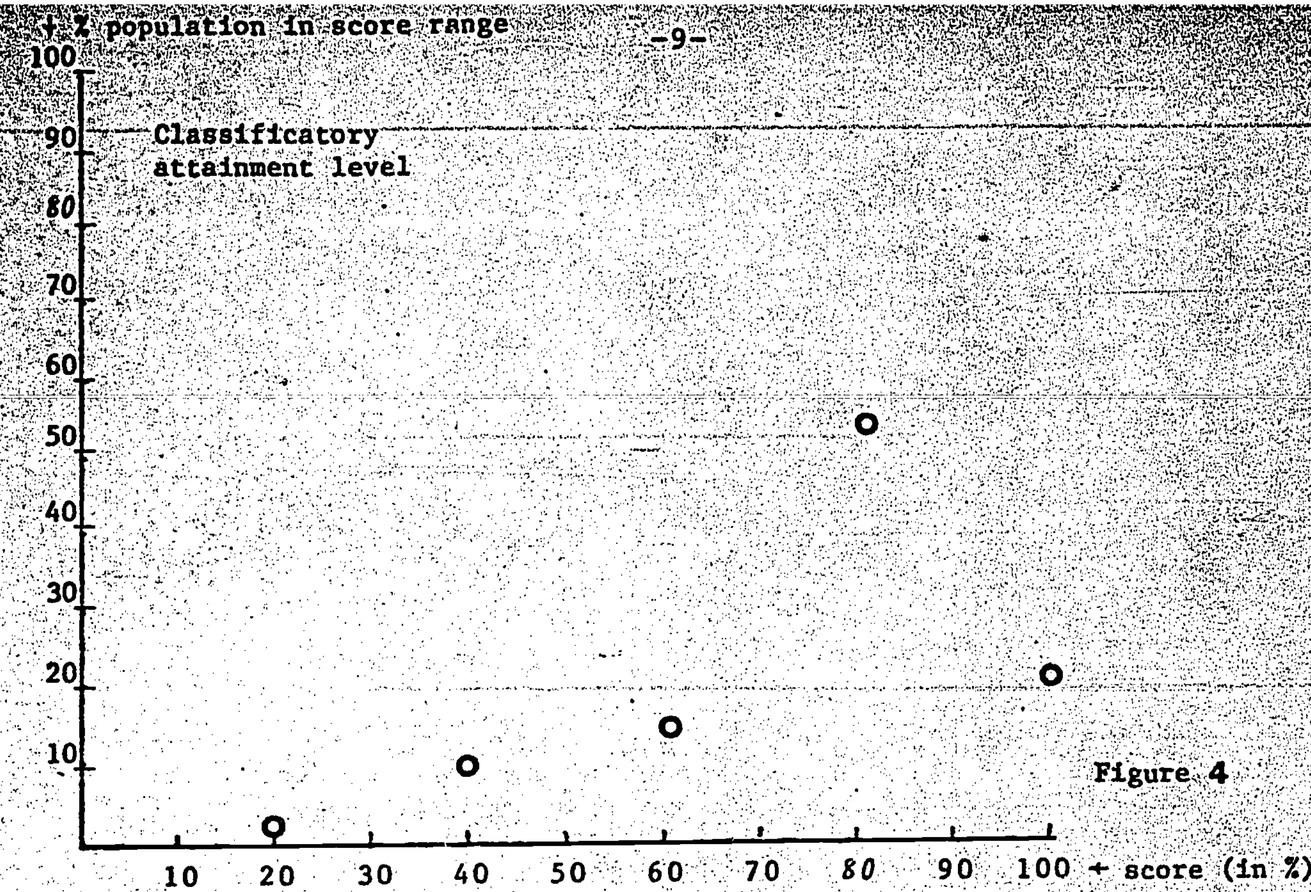

Figure 4

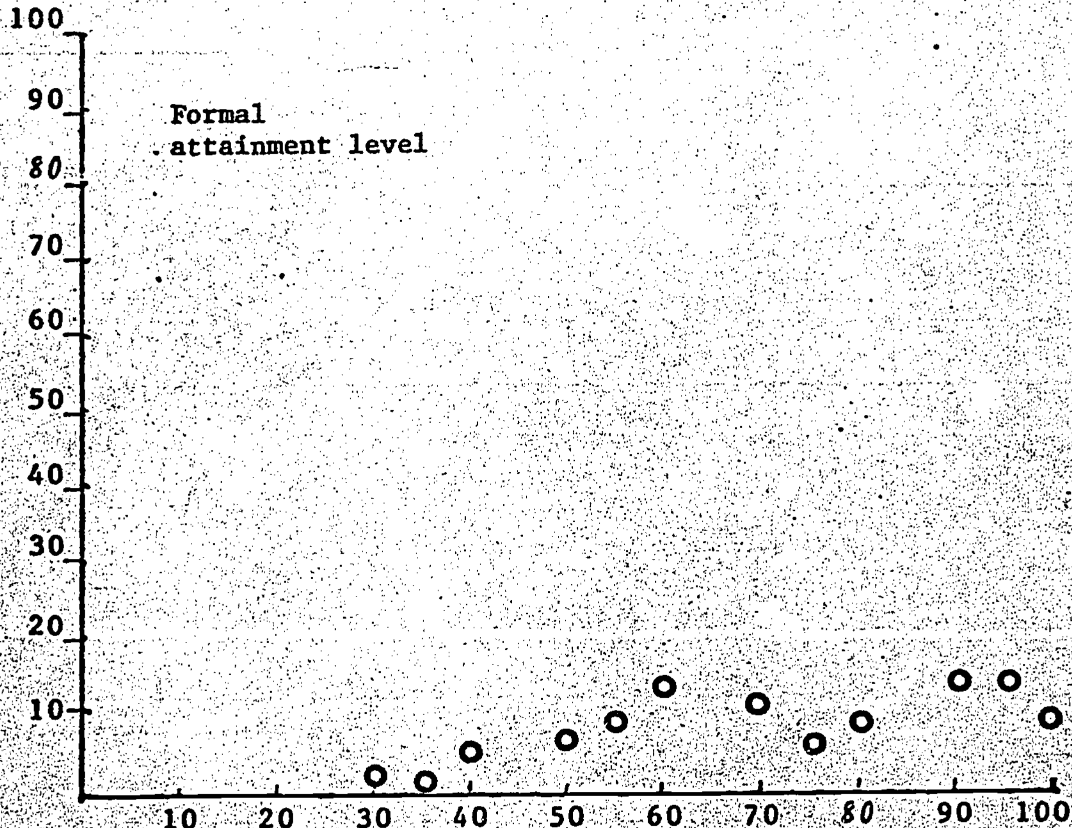

Figure 5

Figures 4 and 5: Degree of population concept attainment by levels. Concept B.

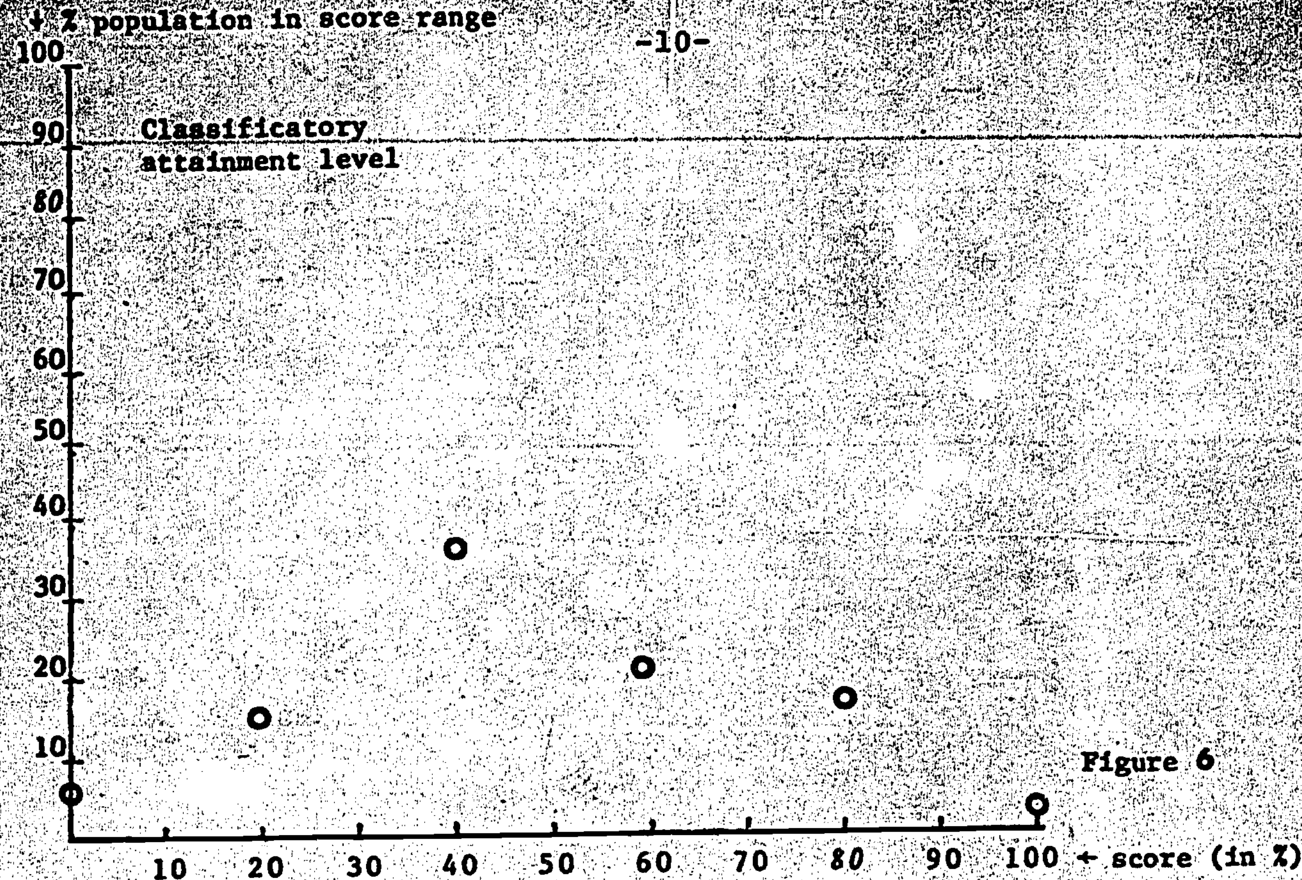

Figure 6

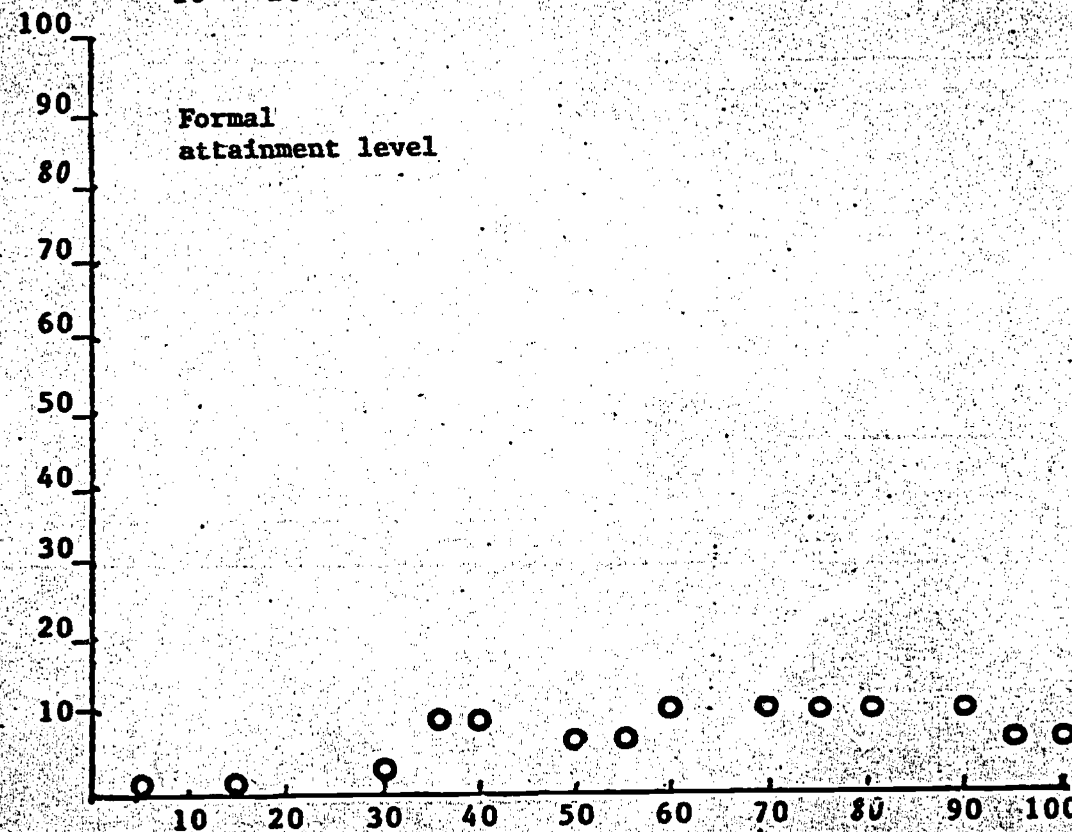

Figure 7

Figures 6 and 7: Degree of population concept attainment by levels. Concept C.

<u>CONCLUSIONS</u>: This study gives an indication that the three concepts measured had (in some form) been previously introduced with some success, to the sample population. Concept A was most familiar to the students; to such an extent that 30% of them were able to function at the formal level of attainment, while 82% were functioning at the classificatory level. The amount and level of functioning dropped step-wise for the other two concepts, indicating that, perhaps, the seventh grade was not the best time to teach these broad concepts, or that the concepts were not taught so that a mastery level could be attained by the students. In work to follow, different grade levels will be tested and taught these concepts to determine the educationally optimal time for their placement in the curriculum.

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