To the Graduate Council:

I am submitting herewith a dissertation written by Robert A. O'Connor entitled "An Evaluation of the Readability of Text and Reinforcement of New Vocabulary Words in Four Mathematics Series." I have examined the final copy of this dissertation for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Doctor of Education, with a major in Curriculum and Instruction.

Phyllis E. Huff, Major Professor

We have read this dissertation
and recommend its acceptance:

Accepted for the Council:

Vice Provost
and Dean of the Graduate School

AN EVALUATION OF THE READABILITY OF TEXT AND REINFORCEMENT OF NEW VOCABULARY WORDS IN FOUR MATHEMATICS SERIES

A Dissertation

Presented for the

Doctor of Education

Degree

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Robert A. O'Connor

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Robert A. O'Connor

ABSTRACT

The purpose of this study was to evaluate seventh and eighth grade textbooks from four mathematics series through the use of readability scores and the reinforcement of new vocabulary words. This was done to determine if a method could be developed which would help educators better evaluate mathematics series in order to select appropriate textbooks which match up well with the reading level of the students. The readability scores were calculated by using the Dale-Chall Readability Formula and the Kane Formula II for use with mathematics materials. The new vocabulary words introduced in the series were listed on an adapted form of the *Worksheet for Analysis of Instructional Materials Beyond Readability Scales* (Schindler, 1980). The reinforcements of the new vocabulary words were checked on the adapted Schindler worksheet.

From the Dale-Chall corrected grade levels (CGL) used in this evaluation, five of the eight textbooks were seen as being written at a readability level which was more difficult than the proposed grade level. The Kane formula did not determine that any of the texts were significantly different in level of difficulty. The four mathematics series did not adequately reinforce the new vocabulary words listed in the introductory lessons. These findings point out the need for

publishers as well as teachers to pay attention to the language of mathematics due to the impact which textbooks have upon the mathematics curriculum.

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INTRODUCTION

School systems tend to rely on mathematics textbook series to provide teachers and students with appropriate and adequate materials which will enhance mathematics instruction. This reliance is made with good intentions, but is often not made based on adequate foundations of research which include readability of text and the reinforcement of new vocabulary words in mathematics textbook series. Readability of text has been determined through the use of readability formulas, such as the Dale-Chall formula, which are concerned with the efficient use of a word list and sentence length. Research has shown that the number of times a new vocabulary word is reinforced is vital to the conceptualization of a particular idea or concept (Gates, 1930).

When selecting a mathematics textbook series to provide for mathematics instruction, the need to use care and insight is related to the teacher's reliance on such materials. Willoughby (1984) notes the dependence on mathematics textbook series by school systems when he states that the textbook is the most important influence in determining what mathematics are taught in schools. Reys and Knowles (1968) surveyed the status of elementary school mathematics textbook series and found that 66% of the schools used one textbook series and 26% used two textbook series. This apparent dependence upon textbooks underscores the importance of giving consideration to the difficulty of the vocabulary. This dependence on the textbook is also stressed by Grouws and Robinson (1973).

A major problem faced by the classroom teacher is whether the textbook is written at an appropriate reading level for students, based on the reading grade level provided by the publisher. The publisher, like the school systems selecting mathematics series, has good intentions when assigning a specific grade level to a text. But it is in this area that good intentions are not enough and that adequate research is needed in order to insure that a text is appropriate for a specific grade level. Spache (1978) makes this observation:

> Publishers customarily designate their readers and other textbooks as suited for specific grade levels. These grade level designations are undoubtedly made in good faith according to the opinions of the author and the published staff. But like other pooled judgements they are frequently erroneous (p. 31).

When writing textbooks for specified grade levels, the problem of publishing an appropriate series becomes massive as well as very unclear based upon the size and diversity of the school population. The task seems impractical at the publishing company when considering the areas that must be addressed in this process. Harrison (1980) states that in asking

> "what makes a book difficult for a certain child?" we are reminding ourselves that the reader's response to a book is determined by two groups of factors: one group related to his own knowledge and abilities, and another group related to the text itself (p. 12).

The variables affecting readability involved in the text include: legibility of print, illustration and color, vocabulary, conceptual difficulty, syntax, and organization (Harrison, 1980). These variables may be addressed by the publisher to some degree with some assistance from outside sources, i.e. consultants.

The variables affecting readability involved with the reader include: overall reading ability, familiarity with written language, familiarity with oral language, vocabulary, and motivation (Harrison, 1980). These variables are the factors that cause the greatest concern due to their impact on the success of a program in a particular school.

One of the variables that can override the others is motivation. Unfortunately, in regard to textbooks, research shows that mathematics texts have been rated by students as the most boring reading matter (Lunzer & Gardner, 1979). In order to address the students' needs, the classroom teacher must become involved with the process of evaluating mathematics textbooks. This would involve some cooperation with textbook adoption committees which normally select published series for school systems. This project involved the use of a comprehensive evaluation process which included two readability formulas and a worksheet to check new vocabulary word reinforcements.

Background

When a student is in a mathematics program his mathematics ability is measured on (1) mathematical insight and knowledge and (2) acquaintance with language (Thorndike, 1912). While it appears that teachers spend a great deal of time developing a student's mathematical knowledge of basic processes, there also seems to be a lack of instructional time spent acquainting the student with the language involved in mathematics. Many teachers would say that their students can do computational problems but do not read well enough to do the word problems commonly found in mathematics textbooks. The difference is in the mathematical language found in these thought problems. This is interesting since it seems that the language aspect of mathematics is often shied away from or even ignored in the classroom. Many students may not even bother to read the worded context or instructions if they can get by without doing so. This reluctance to read mathematical print seems to be encouraged by mathematics text writers. Campbell (1979) cites an example of mathematical language taken from the first level text in the Fletcher Maths Series (Fletcher, 1971). One random sample taken from the text contained the following terms: set, subset, triangle, square, circle, and partition. All of these are found in a mathematics workbook when the same child may still have difficulty with the complexities of "the cat sat on the mat" (p. 688).

Statement of the Problem

Mathematics textbook series have been cited as the most important influence in determining what mathematics is taught in schools (Willoughby, 1984). In selected mathematics materials Heddons and Smith (1964) found the difficulty level of mathematics materials to be higher than the reading abilities of the students. They point out that "if educators are to be successful in teaching mathematics, either the reading level of the mathematics materials must be lowered or the reading level of the child must be improved, or both" (p. 468). It would seem logical, then, that there would exist accessible methods for educators to implement in order to evaluate mathematics textbook series materials. Unfortunately, this is not the case. Only one readability formula which is specifically intended for mathematics materials was found through research conducted for this study (Kane, 1974). Likewise, only one published set of guidelines that may be used in the process of evaluating mathematics materials has been located through this current research (National Council of Teachers of Mathematics, 1982). In addition, only one worksheet for checking reinforcement of new vocabulary words has been found for use in this study (Schindler, 1980). The difficulty of the mathematics text must not doom students to dealing with a program that will frustrate them. Therefore, it is up to the textbook adoption committees that select series for school systems to determine, through a comprehensive evaluation, which texts would best serve to motivate and challenge their students. The problem examined in this study is: can a method be developed which would help educators better evaluate mathematics series in order to determine appropriate textbooks which match up well with the reading level of the students?

Purpose

The purpose of this study was to evaluate seventh and eighth grade mathematics materials by four publishing companies using the following three measures in order to address the problem stated in this study: the Dale-Chall formula, the Kane Formula II for mathematics materials, and the *Worksheet for Analysis of Instructional Materials Beyond Readability Scales* (Schindler, 1980). These measures were implemented in order to determine the following:

1. Is there a difference between the publishers' stated grade levels of four mathematics series and the actual readability levels according to the Dale-Chall formula and the difficulty levels determined by the Kane formula?

2. Are the new vocabulary words which are introduced in a lesson reinforced at least five times within the context of that lesson (Kingsley, 1965)?

3. Can the three measures implemented in this study be used effectively in determining the reading difficulty of the mathematics texts?

Null Hypotheses

1. There is no significant difference between the publisher's estimate of readability and the actual computed readability scores based on two readability formulas.

2. There is no significant difference between the publisher's number of reinforcements of the new vocabulary words and the recommended five times or more than five times within the lesson of introduction.

3. There is no significant difference between the difficulty levels of the results of the three measures used in this study when indicating the reading difficulty of the mathematics texts.

The comprehensive evaluation technique involved: (1) computing the actual readability of the textbooks and (2) measuring the number of reinforcements of the new words. These aspects of the comprehensive evaluation are concerned with the students' comprehension of text which has a direct effect on the actual grade level of the books in each mathematics series. The corrected grade level scores derived from the Dale-Chall formula indicate a comprehension level which falls between 50% and 75%. The Kane formula is based on the cloze procedure which can provide a good index of comprehensibility. The Schindler worksheet is based on the positive effects of adequate reinforcement for new vocabulary words in the conceptualization of concepts. The appropriateness of the texts for the intended grade levels was seen in the results of the readability formulas as well as in the instructional implications concerning comprehension associated with the reinforcement of new vocabulary words.

Previous Research

Previous research concerning the readability of mathematics materials is not conclusive. There has been little agreement concerning the appropriateness of the methods or instruments to be adopted in this area of study. Early research in this area concerned the use of readability formulas which were intended for use with more general reading materials. The Dale-Chall was the most popular formula used in this effort. Heddons and Smith (1964) are probably the most cited authors in this form of research. These authors based their conclusions concerning the reading difficulty of mathematics materials on such readability formulas as the Spache Readability Formula and the Dale-Chall Readability Formula. Based on the use of these formulas, the authors generally concluded that commercially produced mathematics textbooks were written above the grade level for which they were intended.

More recent research has been critical of the use of these formulas based on their apparent deficiency regarding the omission of the specialized language of mathematics which is not included in their word lists (Grouws & Robinson, 1973; Hater & Kane, 1975; Smith & Kepner, 1981). The criticisms seem well-founded when Dale and Chall (1948) state that readability formulas are applicable only to material similar to the criteria on which they are based:

> Too often this is forgotten and an attempt is made to apply a formula based on children's reading to materials that are beyond its range of such matter and difficulty. This has led to criticism of the formulas when actually the fault lay in their application to a type of material for which they were not designed. . . . No studies are based exclusively on materials devoted to specialized areas such as science or mathematics.

In addition to the use of readability formulas, the cloze procedure has been offered as a possible method for use in determining the reading difficulty levels of mathematics materials (Grouws & Robinson, 1973; Hater & Kane, 1975; Smith & Kepner, 1981). Information gathered from using cloze on passages from a given textbook can help to answer a number of questions. First, the data collected indicates the general appropriateness from a readability standpoint of the book for a specific group of students. Facts concerning comprehension are gathered and not just information concerning the student's ability to say the words. Second, information concerning the variability of the reading material from one part of the textbook to another is generated if numerous passages are studied.

Importance of the Study

The previous research noted in this study has briefly pointed out the development of attempts to assess the levels of reading difficulty associated with mathematics materials. The use of the cloze procedure was discussed in the prior section. It is out of this procedure that the Kane Formula II for mathematics materials implemented in this study was developed. In order to generate the Kane formula, the cloze procedure was adapted for use with mathematical passages. This study attempts to compare the results determined through the use of the Kane Formula II for mathematics materials with those results found by using the Dale-Chall Readability Formula. The comparison of these formulas will provide a reader of this study with information concerning the importance of the use or disuse of the Kane formula. The authors of the Kane formula point out that this formula was developed to make available an objective instrument for assessing the reading difficulty level of mathematics instructional materials. The Kane formula is recognized by the National Council of Teachers of Mathematics (NCTM) as a valuable tool in this area of research (NCTM, 1982).

Definitions of Terms

1. Comprehensive Evaluation is defined as an evaluation technique for programs encompassing the use of readability formulas and the *Worksheet for Analysis of Instructional Materials Beyond Readability Scales* (Schindler, 1980).

2. Mathematics Program is defined as a published sequence of textbooks, teachers' manuals, and student workbooks. Each book is assigned a grade level by the publisher. These programs are designed to teach specific skills that develop mathematical insight and knowledge such as numeration, basic facts, fractions, decimals, etc.

3. Factors are the characteristics of published materials that have an effect on actual readability of that material. The readability factors are: vocabulary words, frequency of the word reinforcement, typography, interest-value, style of writing, number of syllables, and sentence length. The variables which are checked in the Kane Formula II are: words not on the Dale List of 3,000 words that are also not on the 80% Mathematics List, number of changes from a word token to a math token and vice-versa, number of different

mathematics terms not on the 80% Math List plus the number of different math symbols not on the 90% Symbols List, and the number of question marks.

4. New Words are the new vocabulary words introduced before each new lesson in a mathematics series.

5. Readability is defined as the actual grade level calculation derived from a readability formula. The Dale-Chall formula was developed as a tool to calculate the actual grade levels of published text materials. The Kane Formula II was specifically designed to calculate the readability of mathematics materials. It is the term used for how readable the material is in printed form.

A. Actual Readability is the calculated grade level by a readability formula.

B. Estimated Readability is the grade level designation publishers place on the published textbooks.

C. Comprehensive Readability is the grade level of books computed by readability formulas and the number of times the new words are reinforced in the published material.

6. Reading can be defined as the act of extracting meaning from the printed page. Some skills involved in reading are: word attack, vocabulary recognition, and comprehension.

7. Reinforcement is the frequency of new vocabulary words in a mathematics text lesson after introduction.

8. Word Lists accompany readability formulas to check percentage of hard words in the formula calculations. They were chosen by the authors of readability scales to validate the calculated results.

9. *Worksheet for Analysis of Instructional Materials Beyond Readability Scales* (Schindler, 1980) is a form used to list new vocabulary words and to check the number of times these words are reinforced in the lesson of introduction and subsequent lessons. It is also used to record and subjectively evaluate the skills printed in the teachers' manual.

10. Language of Mathematics refers to the written language found in mathematics instructional materials; in journals, books and papers about mathematics; on chalkboards and overhead projector screens in classrooms; in bank statements and supermarket advertisements, and in the writings of a host of fields related to mathematics.

11. Word Tokens are most often written words. Examples: number, the, is, follow, answer, triangle. The number of word tokens in an abbreviation is determined by the number of different word tokens which the abbreviation replaces which have some representation in the abbreviated form. Hyphenated

word tokens are counted as one or more word tokens according to whether the parts can be used alone with meaning.

12. Math Tokens are signs, such as 2, +, and %, which appear in the language of mathematics which are not word tokens, punctuation, or drawings. They are the smallest units which can be used independently to convey the intended meaning of that part of the written material. A graphic sign in which all parts are connected is at most one math token. A graphic sign in which all parts are not connected is more than one math token if two or more parts independently convey the intended meaning of part of the material or if the parts are separated by other tokens.

13. Cloze Procedure can be defined as a systematic deletion of words from a prose passage and the evaluation of the success a reader has in supplying the deleted words.

Limitations

1. Word reinforcements were checked only in the first chapter in which they were found. A search was conducted for three topic related lessons following the initial lesson in order to determine the total number of reinforcements of new vocabulary words associated with a particular concept. Extended searches beyond the immediate chapter were futile because of the isolated nature of the concepts

covered in each chapter. In some texts three topic related lessons could not be found in the immediate chapter.

2. The mathematics materials were partially evaluated with an instrument (Dale-Chall Readability Formula) designed for use with reading materials (Basal Series).

3. The language of mathematics is not widely used in everyday language and is assumed to be more difficult due to this factor. Mathematical terminology is often excluded from many word lists. This limitation pertains to the use of the Dale-Chall Readability Formula in this study.

Delimitations

This study concentrated on commercial mathematics materials written for seventh and eighth grade students by four publishing companies. This researcher purposefully restricted these aspects of this study to accommodate the Kane Formula II for use with mathematics materials.

Method and Procedures

This study required the collection of data from seventh and eighth grade mathematics materials produced by four published companies. The publishing companies included in this study were: Harcourt Brace Jovanovich text series

Mathematics Today (Abbott & Wells, 1987), Houghton-Mifflin text series *Houghton-Mifflin Mathematics* (Dolciani et al., 1987), D. C. Heath text series *Heath Mathematics* (Rucker et al., 1987), and the Holt, Rinehart & Winston text series *Mathematics Unlimited* (Fennell, 1987). The measuring instruments used to collect the data were: the Dale-Chall Readability Formula, the Kane Formula II, and the *Worksheet for Analysis of Instructional Materials Beyond Readability Scales* (Schindler, 1980). The selection of sample passages followed the guidelines included in each measurement instrument.

An index number for each book was computed using a ratio that places the publishers' estimated grade level over the readability level computed by the researcher using the Dale-Chall Readability Formula. The result was then subtracted from 1. A 20% confidence interval was used as the allowable tolerance for the index numbers closest to 0, +.1, and -.1. In this process a positive index number shows that the actual readability level is higher than the publishers' estimated readability level. Likewise, a negative index number shows that the actual readability level is lower than the publishers' estimated readability level.

The Kane Formula II for use with mathematics materials computes a predicted readability score. A table is provided which lists the amount to add to and subtract from a predicted cloze score to mark the range of the true cloze scores. A confidence level (.90 or .75) is then selected. A level of .90 means that

90% of all possible true cloze scores lie within the given range. A level of .75 means that 75% of all possible true cloze scores lie within the given range. The .90 and .75 confidence levels were calculated in this study in order to determine as accurately as possible the difficulty levels of the mathematics textbooks. The Kane Formula II is recommended for use by the National Council of Teachers of Mathematics in its publication, *How to Evaluate Mathematics Textbooks* (NCTM, 1982).

Each new word presented in a specified lesson or unit was listed on the *Worksheet for Analysis of Instructional Materials Beyond Readability Scales* (Schindler, 1980). The number of reinforcements for each new word were checked and categorized into three columns: less than five, five, and more than five. Percentages were calculated by placing the number of reinforcements over the total number of new words presented in each book.

The results gathered from these three instruments were checked for the types of relationships between and among them in terms of determining the reading difficulty of the individual textbooks. In other words, if the measures showed agreement concerning the difficulty of a text, then a particular text had the highest readability score on the Dale-Chall formula, the lowest readability score on the Kane Formula II, and also showed a low number of adequate new word reinforcements according to the worksheet. Patterns of consistencies of inconsistencies were discussed in this study.

Summary

Mathematics series are used extensively in schools today. Because of the popularity of these series, careful considerations must be made when selecting an appropriate series for students. The purpose of the study, previous research, importance of the study, definitions of terms, null hypotheses, limitations, delimitations, and method and procedures were presented in this chapter.

CHAPTER 2

RELATED LITERATURE

Introduction

The purpose of this chapter is to examine the literature relating to: the aspects of readability, readability in relation to teaching mathematics, reinforcement of new vocabulary words, and the comprehensive evaluation of readability.

The Aspects of Readability

When looking at mathematics programs in schools, there is a good chance that some type of basal text or textbook will be found. The popularity of these textbooks as the core of the mathematics curriculum stresses the need for proper evaluation to insure a degree of appropriateness to serve the students' needs. Effective teachers use a variety of materials, but still rely a great deal on the textbook. The writers of these textbooks are attempting to serve the needs of a very large, diverse population. With these attempts comes the responsibility for writers to consider student readability of the textbook as a major factor in their work.

In order to contend with this problem, the writer should have a clear description of the audience. The students' reading, educational and intellectual levels, previous experience with the topic, interests, and level of motivation should be known. For greatest effectiveness in writing, the writer should also be addressing an audience that is fairly homogeneous.

It is unlikely that a writer of a mathematics textbook series would be able to collect information about the total audience. Since the writer needs to understand the audience as much as possible, a more practical approach is taken. A sample population of the potential audience is selected and tested. The results of this study are then used to base the levels of the materials which will be the most appropriate for the audience. This method will give the writer an idea about the sample population, but it will not give a clear picture of the audience as a whole.

There are bound to be students in the audience who will have a great deal of difficulty with the textbook due to the fact that their abilities and needs were not represented in the sample population. Klare (1963) seems to address this aspect of readability when he defines the term "to indicate ease of understanding or comprehension due to the style of writing" (p. 1). Since the style of writing is suited to the sample population, it will have great difficulty serving a large, diverse audience, such as the total school population. Style of writing is partially determined by the frequency of new word reinforcements which is a factor of comprehensive readability that is discussed in this study.

Readability formulas have had a profound influence on the textbook publishing industry in the past 10 years (Fry, 1988). A review of the aspects of readability seems crucial, then, in light of the several criticisms leveled against their use. The basis of these criticisms centers around the heavy amount of emphasis which may be placed upon the results gained from the formulas. Two major criticisms of readability formulas include: their sole use for determining appropriate grade levels assigned to textbooks and attempts to write textbooks to a particular formula. Ojemann (1934) indicates that, in addition to vocabulary difficulty, other factors such as composition, sentence structure, concreteness or abstractness of relationships, obscurity, and incoherence in expression should be examined when determining text difficulty. An excerpt from Huggins and Adams (1980, p. 91) makes a similar claim, stating that readability formulas are concerned only with surface structures.

> Although readability measures can be found that correlate fairly well with text difficulty . . . their main weakness is that the difficulty of a passage involves its comprehension, and surface structure descriptions capture only some of the syntactic variables necessary to comprehension. As an extreme example of the inadequacy of these [readability formulas], most of them would yield the same readability index on a passage if the word order

> within each phrase, and the order of the phrases within each sentence, were scrambled.

Readability research initially came from two sources—studies of vocabulary control and studies of readability measurement. Vocabulary studies examined "new words" in reading textbooks, the number of times they were repeated, and their difficulty levels. Readability measurement studies grew out of an interest concerning the comprehension difficulty of content area textbooks. During the early years, researchers developed instruments which would reliably and validly distinguish easier from more difficult texts or grade levels in order of difficulty. The first readability study (Lively & Pressey, 1923) was begun when junior high science teachers reported an unusual number of technical terms in their texts which necessitated acquiring a scientific vocabulary instead of learning scientific facts and generalizations. From this point on, the level of reading difficulty of textbooks would be examined through the use of various procedures and instruments. The desired outcome of this work would be to produce textbooks which would be suitable for use by all children.

A review of the formative years in the development of readability formulas and measures provides a summary of this concept up to the present. The most concise summary/review found by this author was presented by Klare

(1988). The 12 points listed illustrate the developing concept of readability and are outlined briefly.

1. <u>The almost exclusive emphasis on style variables in readability formulas</u>. Even though they did not develop the first readability formula, Gray and Leary's formulas illustrates this first point (Gray & Leary, 1935). Their five style factors which produce an average comprehension score include: number of different hard words not on Dale List of 769, number of personal pronouns, average number of words per sentence, percentage of different words, and number of prepositional phrases. This procedure of combining only style variables in a regression equation became the typical pattern for formula development.

2. <u>The reduction of style variables to semantic and syntactic factors</u>. The second formula produced by Washburne and Morphett is an example of this point since it uses the following three variables: number of different words, number of different uncommon words (outside Thorndike's 1,500), and number of simple sentences in 75 sample sentences (Washburne & Morphett, 1938). Lorge's formula illustrates the same point by using these variables: average sentence length in words, number of prepositional phrases per 100 words, number of different hard words per 100 words not on the Dale 769 word list (Lorge, 1939). Both of these formulas are regression equations designed to compute grade placement.

3. The search for a satisfactory criterion for formula development. The formulas of Washburne and Morphett and of Lorge also illustrate this point. Washburne and Morphett achieved a multiple R of .86 with their criterion which used the reading test scores of children who reported reading and liking a large sample of books. Lorge found a multiple R of .77 with McCall and Crabbs' *Standard Test Lessons in Reading* used as the criterion. Lorge published a revised formula due to an error he discovered in his calculations from the earlier formula (Lorge, 1948). The new formula had a reduced multiple R of .67 with the same criterion. The McCall-Crabbs Lessons turned out to be convenient for others to use in future searches for a satisfactory criterion.

4. The presentation on readability formula scores in terms of grade levels. The Washburne-Morphett and Lorge formulas provided scores directly in terms of grade placement. The use of grade level scores led to the increasing popularity of readability formulas. Formulas which did not include these scores, at first, eventually added them. The use of grade level scores also led to many disagreements among formula makers. These disagreements were usually due to the variables used, the developmental criteria used, and the range of ability of the subjects. The comprehension level used by the various formula makers also differed and ranged from the 50-75-100% level.

5. <u>The efficient use of a word list for the semantic factor and sentence length for the syntactic factor</u>. Dale and Chall's formula (1948) illustrates this point well. The McCall-Crabbs passages were used as criteria for developing this formula which includes the following variables: percentage of words outside the Dale list of 3,000 and average sentence length in words. These variables are used to compute the reading grade score of pupils who can answer correctly one-half (50% comprehension level) the questions on a McCall-Crabbs passage. A correction table is included with the formula in order to account for the matter of curvilinearity. This allows the formula scores to correspond more closely to difficulty.

6. <u>The efficient use of syllable length for the semantic factor and sentence length for the syntactic factor</u>. Flesch's Reading Ease formula illustrates this point (Flesch, 1948). This formula used the McCall-Crabbs Lessons and the 75% comprehension level to compute Reading Ease. This formula, as does the Dale-Chall, includes a table which provides for the curvilinearity in the grade level scale.

7. <u>The trend to increased emphasis on ease of use</u>. Danielson and Bryan (1963) as well as Schuyler (1982) are represented in this trend. Both developed computerized readability formulas to aid users in large scale applications as well as a wide range of applications. The Readability Graph developed by Fry (1963

& 1977) may be computed with a hand calculator by entering syllable length and number of sentences per 100 word sample. Fry's Graph is the most widely used of all readability measures.

8. <u>The development of formulas for languages other than English</u>. Work in this area came later than in the area of English, but much has been published since 1951. Formulas have been developed in at least 14 other languages since that time.

9. <u>The introduction of the cloze procedure as a convenient criterion for formula development</u>. The cloze procedure can provide a good index of comprehensibility which makes it a good potential criterion for the development of readability formulas. The cloze procedure is a popular criterion for formula development because it is objective in scoring, easy to use and analyze, uses the text itself as the test, and yields higher correlations than the McCall-Crabbs Lessons in comparison of the same formulas (Miller, 1972). The popularity of the cloze procedure was further enhanced when Bormuth developed extensive sets of passages scored in terms of cloze percentages correct (Bormuth, 1969). Other formulas such as the Kame Formula II for mathematics materials have been developed and cross-validated through the use of these passages.

10. <u>The growing criticism of readability formulas in terms of their developmental criteria and their grade level scores</u>. The omission of grade level

scores is recommended in this section by the International Reading Association (IRA). This current project moves in this direction by implementing the Kane Formula II which computes a predicted readability score when comparing the difficulty level of two texts.

11. The growing criticism of readability formulas in terms of "writing to formula." Formula developers have warned against writing to formula because formulas cannot be used in the production of readable writing, since index variables are not sufficient for this purpose.

12. The need for improvement of current readability measures. This point is illustrated by the following suggestions (Klare, 1984).

• Remember that different formulas may give different grade level scores on the same piece of writing. Though they may resemble thermometers in giving index values, they differ in that (like most educational and psychological tests) they do not have a common zero point.

• Look over existing formulas and pick a good one for the purpose at hand, but consider all formulas to be screening devices and all scores to be probability statements (Monteith, 1976).

• Choose a formula with two variables for rough screening purposes; having only one variable decreases predictiveness, but having more than two usually increases effort more than predictiveness. For critical applications or for research, apply more than one formula or try one of the newer, more complex formulas.

• Increase the value of an analysis by taking a large random (or numerically spread) sampling. For critical applications or for research, analyze the entire piece of writing (a computer program can be of help). For most books, three samples (often recommended) can give an indication of the average level of difficulty, but cannot say anything useful about variations in difficulty.

• Bear in mind that formula scores derive from counts of style difficulty; therefore, they become poorer predictors of difficulty at high grade levels (especially college) where content weighs more heavily.

• Consider again the purpose of the intended reading material; training readers calls for more challenging material than merely informing or entertaining them.

• Take into account other recognized contributors to comprehension; otherwise, formula scores may overestimate or underestimate difficulty. For example, using special interests or incentives to get above average motivation can help to keep challenging material from being frustrating.

• Do not rely on formulas alone in selecting reading materials when this can be avoided. Include judges for characteristics that formulas cannot predict and to be sure that formulas have not been misused in preparing materials. Do not use just any judges—select experts or get more reliable opinions.

• Prepare to shift material after tentative placement. Where to draw the line between reading material that frustrates readers and reading material that challenges them cannot be specified easily with or without formulas.

• Keep formulas out of the writing process itself. If you use formulas for feedback, try the writing-rewriting cycle described by Macdonald-Ross (1979): Write → Apply formula → Revise → Apply formula . . . .

Readability in Relation to Teaching Mathematics

Mathematics textbook series are at the core of many mathematics programs. Reys and Knowles surveyed the status of elementary textbooks and found that 66% of the schools used one textbook while 26% used two textbooks (Reys & Knowles, 1968). School systems put a lot of faith in the fact that the materials in these textbooks are appropriate for their students. It seems unusual then that mathematics textbooks do not match up well with basal reading books in terms of the vocabulary used by the author. This was pointed out by Stauffer who found substantial inconsistencies between the vocabulary in basal reading books and mathematics texts at the third grade level, where approximately 43% of the words in three third-grade mathematics books were not included in seven current third-grade reading texts (Stauffer, 1966). Reed studied quantitative vocabulary and found no significant agreement between the mathematics vocabulary and the vocabulary in the reading series used by her pupils (Reed, 1965). Earp also noted that the vocabulary of arithmetic books has not paralleled or presented a vast overlapping with that of reading texts (Earp, 1971). This mismatch in vocabulary between texts emphasizes the importance of direct vocabulary study in the mathematics classroom. Smith and Kepner note that teachers should insure that the components of reading in the mathematics classroom are used and reinforced (Smith & Kepner, 1981). In order to address this area of concern, the following nine steps are recommended by Pachtman and Riley (1978):

1. Select problems to be taught which represent the mathematical concepts you wish students to learn.

2. Identify and list the vocabulary contained in the word problems that students need to know in order to read, understand, and solve the problem.

3. Add to the list mathematical concepts implicit in the problems but which are not directly represented by vocabulary terms.

4. Arrange the words in a "diagram" or "structured overview" which depicts the relationship among these terms.

5. Place the words on cards or slips of paper so that you have several packets of words, each packet containing the words in the structured overview.

6. Place students in small groups and distribute a packet to each group. Have students arrange and rearrange the slips of paper in attempting to construct their own structured overview.

7. Monitor and assist the groups.

8. Terminate the activity and provide feedback by comparing the groups' structured overviews.

9. Include reinforcement.

In a study done by Earp and Tanner (1980) to gain more information about students' reading and mathematics, a word count was made of a basal mathematics text used in a school. The words were grouped into three categories: basal words, common words, and mathematical words. It was found that the students' abilities to decode the words in the samples was high (above 90%). When the students' comprehension was checked, it was found to be high (98.1%) for common words but was much lower for mathematical words (49.9%). The obvious conclusion of this study was that mathematical words are not frequently used in spoken language as are common words. The exclusion of mathematical terms from oral language restricts a student's opportunities to gain comprehension of these terms. The study also showed that comprehension of the mathematical words was raised when the words were presented in a stronger context. Since the students were able to use contextual clues to gain comprehension, it can be seen that the original mathematical phraseology was not particularly helpful in developing comprehension.

Mathematics materials are not the same as reading materials. The mathematical language found in mathematics texts is not as familiar to students as is the language in their reading materials. The density of the quantitative vocabulary in mathematics textbooks is a factor which must be taken into consideration when directing vocabulary study in the classroom. Smith (1964) notes that a special characteristic of mathematics text is compactness and that every word and symbol is important and must not be avoided or skipped. This density of the vocabulary also requires a sensitivity on the part of the teacher in adjusting the rate of instruction for students in order to avoid unnecessary frustration. Mathematics also differs from reading in that comprehension is very rarely checked when a student is working in a particular skill area. If students can solve a problem using the required mathematical functions, then they will be allowed to move on in the text. The students will probably not be required to discuss the answers or to explain the process by which the answers were obtained. This lack of oral language makes it possible for students to succeed in mathematics without understanding what they are doing or even why they are doing it.

This lack of comprehension may cause the student to have difficulty with mathematics symbols and their various meanings. The student may also have difficulties with word problems and problem solving activities. According to Hater, Kane, and Bryne (1974), there are approximately 153 symbols in mathematics (excluding English letters) that appear in mathematics texts written for grades 4 through 12. Monroe (1918) estimates that there may be as many as 28 different ways to verbally express a single mathematics problem. These two factors work together to further compound the child's difficulties in trying to understand the task at hand. Word problems and problem solving activities are likely to be the most difficult challenge for the student. This is because the student must deal with the various symbols as well as apply language skills in order to interpret the context in which the problem is presented.

When discussing readability in relation to mathematics materials, there are some considerations which need to be made:

1. Good readers are not necessarily good problem solvers, and poor readers are not necessarily poor problem solvers (Harvin & Gilchrist, 1970).

2. There is no linear relationship—good problems solvers are characterized by a variety of reading levels, although poor problem solvers are generally characterized by low reading levels (Cottrell, 1967).

These considerations are significant in that they point out the need to distinguish between the difficulties in presenting a difficult concept and the problems associated with linguistic style.

Reinforcement of New Vocabulary Words

Reinforcements of new vocabulary words are used to help students learn the words and to be able to recognize them rapidly. Kingsley (1965) stated that there should be five repeated citations of a word within the lesson of introduction. This recommendation was based on basal reading books but should also apply to mathematics texts. These repetitions should be provided by the publisher as well as the classroom teacher in a variety of ways. Harris (1970) states that "To be effective, this repetition should not be monotonous drill, but should be presented in such a way as to maintain the child's interest at a high level and encourage accuracy of perception" (p. 319).

In contrast, research has also shown that reinforcements of new words in mathematics series have been neglected. Horodezky and Weinstein (1981) state that:

> Whereas in basal readers, vocabulary is generally carefully controlled and words are deliberately repeated many times, the data contained in this study revealed that at least 75 percent of the different words were repeated fewer than ten times in each of the texts. Teachers should therefore be alerted to the fact that this lack of repetition might present a potential problem for the unskilled and beginning reader (p. 128).

This problem can be further compounded when it is realized that mathematical terms may have totally different meanings when used in everyday spoken language. Examples of words that appear in mathematics and everyday language would include: factor, closed, half, ring, and base. Word frequency can be seen as a critical factor to be considered when determining the difficulty of a text. Klare (1963) notes that increased word frequency allows the reader to have a larger number of words within his memory span. He goes on to say that increased memory span is related to comprehension as well as learning and retention, and that frequently used words have more familiar dictionary meanings.

Gates (1930) made an investigation of vocabulary loads for various intelligence levels and found that some students have difficulty learning new words which are not adequately reinforced. Gates' findings on the number of reasonable repetitions for new vocabulary words at different intelligence levels are reported below. The number of repetitions listed at each level are seen as being necessary in order for the students to retain the new vocabulary words and to recognize them rapidly.

120-	I.Q.	- 20 repetitions
110-119	I.Q.	- 30 repetitions
90-109	I.Q.	- 35 repetitions
80-89	I.Q.	- 40 repetitions
70-79	I.Q.	- 45 repetitions
60-69	I.Q.	- 55 repetitions (p. 35)

The importance of reinforcements of new vocabulary words for students at all ability levels can be seen from this data.

Comprehensive Evaluation of Readability

The use of a comprehensive evaluation by a teacher can be very beneficial. This study defines comprehensive evaluation as an evaluation technique for programs encompassing the use of readability formulas and the *Worksheet for Analysis of Instructional Materials Beyond Readability Scales* (Schindler, 1980). It can take much of the guesswork out of trying to decide if materials are appropriate. It also may reduce the frustrations of the teacher and student toward the materials. The aspects of the comprehensive evaluation that were used in this study included: (1) use of a readability formula to determine grade levels; (2) use of a readability formula to determine the reading difficulty of a text in relation to another text; and (3) use of a worksheet for further analysis. These methods were used to determine how appropriate the mathematics materials are for their specified grade levels. This is not a final comprehensive evaluation technique for use by all teachers. The purpose of this study was to examine these three measures in order to allow the reader to decide which, if any, of these measures would be beneficial with the use of other criteria in selecting an appropriate series.

Summary

Mathematics textbooks have become widely used in elementary education today. The mathematics terms used in these textbooks are not common in our spoken language. Successful students in mathematics may not necessarily comprehend the material due to this lack of spoken language in mathematics. In order to better serve the students who will be using a mathematics textbook, a comprehensive evaluation process is needed. This process includes: (1) a readability formula to calculate grade levels; (2) a readability formula to determine reading difficulty of a text in relation to another textbook; and (3) a worksheet to record new words with a frequency of reinforcements in the textbook materials. Teachers may use these measures to aid in the selection of an appropriate mathematics textbook. The limitations concerning the use of the Dale-Chall formula should be kept in mind, but the appropriateness of its use should be determined by the reader in order to meet individual needs. It should be noted that research into this area has diminished in recent years. Nevertheless, publishers have continued to develop and publish mathematics textbooks with designated grade levels on them.

CHAPTER 3

DESIGN FOR EVALUATION OF MATHEMATICS SERIES

Introduction

The purpose of this chapter is to present the following: the procedures for data collection, the instruments used to collect data, and the statistical procedures used in the analyses of data.

Data Collection Procedures

For this study the researcher chose four mathematics series which are used by various school systems. The series chosen were: (1) *Mathematics Today* (Abbott & Wells, 1987) Harcourt Brace Jovanovich; (2) *Houghton-Mifflin Mathematics* (Dolciani et al., 1987) Houghton-Mifflin Company; (3) *Heath Mathematics* (Rucker et al., 1987) D. C. Heath & Company; and (4) *Mathematics Unlimited* (Fennell, 1987) Holt, Rinehart & Winston. In this study the data were collected solely by the researcher. These texts were available through the Curriculum Lab at The University of Tennessee, Knoxville, and were selected and approved by the state curriculum committee for use in Tennessee schools. These particular series were chosen for this study because they are used frequently in area schools. Data were collected over a 9-month period.

Instrumentation

The following instruments were used to collect data for this study: (1) the Dale-Chall Readability Formula (see Appendix A); (2) the Kane Formula II for mathematics materials (see Appendix B); and (3) the *Worksheet for Analysis of Instructional Materials Beyond Readability Scales* (Schindler, 1980) (see Appendix C).

After surveying a list of readability scales, the Dale-Chall Readability Formula was chosen for this study. It is one of the most accurate formulas used for estimating the difficulty of a text (Dale & Chall, 1948). Studies have shown that the Dale-Chall is the most valid readability formula when used with materials intended for grades 4 and above (Harrison, 1980). Since the texts used in this study were from grades 7 and 8, the Dale-Chall was seen as the most appropriate formula to use for determining grade level scores for the texts being analyzed. The Dale-Chall formula probably has the best reputation among reading authorities for being accurate and reliable, and there is also evidence that the Dale-Chall formula is somewhat more highly predictive than any of the other formulas available today (Harrison, 1980). This formula has complex but clearly stated instructions for selecting sample passages, computing average sentence length, and determining the percentage of unfamiliar words (those not included in the "Dale List of 3,000 Words") (Harrison, 1980). The average sentence length and percentage of unfamiliar words are multiplied by specifically derived constant factors. They are then added together with another constant factor to arrive at a formula raw score. A correction table is then used to convert the raw score to a corrected grade level score.

The other readability scale chosen for this study was the Kane Formula II for mathematics materials. This scale does not assign grade level scores, but instead predicts the level of difficulty when comparing texts. It is designed for use with textbooks in grades 6-10. Mathematical tokens as well as words are counted and computed using the following independent variables:

A = Number of words not on the Dale List of 3,000 words that are also not on the list of Mathematics Words Familiar to 80% of 7th-8th grade students.

B = Number of changes from a word token to a math token and vice-versa.

C = Number of different math terms not on the 80% Math List plus the number of different math symbols not on the 90% Symbols List.

D = Number of question marks.

The variables are then manipulated within the following equation: Predicted Readability = -0.15A + 0.10B - 0.42C - 0.17D + 35.32. This result, sampled from a passage of 400 tokens (words and symbols) is designed to correlate with the number of correct responses on a 75-item cloze procedure. The higher the formula score, the easier the reading level of the passage. The multiple correlation coefficient of the predictor variables with the mean cloze score is 0.55, when means that the formula can claim to predict (0.55) squared percent or approximately 30% of the change in the readability level of mathematics books written for grades 6-10. This prediction does not appear high, but the methods used in generating the formula argue that the predictive power of the formula is free from substantial bias. This formula was developed through the use of the cloze procedure which is based upon the learning theory of gestalt psychology. Taylor (1953) first introduced this technique which requires the learner to conceptualize a complete event through the interrelationships of its component elements. This was applied to readability by systematically deleting every n-th word from a prose passage and replacing every deletion with a blank of standard length and then requiring the reader to supply the deleted words.

Hater (1969) conducted studies which concluded that cloze tests adapted for use with mathematical passages are measures of reading difficulty in the language of mathematics. A collection of cloze tests of varying lengths were administered to diverse groups of students and established the reliability of cloze scores in the language of mathematics and provided initial evidence that cloze scores and comprehension test scores are essentially equivalent measures.

A Worksheet for Further Analysis

In addition to the Dale-Chall Readability Formula and Kane Formula II, another tool can be beneficial in the comprehensive evaluation process. In order to record the number of new words introduced in a lesson as well as the number of times the new words are reinforced, the *Worksheet for Analysis of Instructional Materials Beyond Readability Scales* (Schindler, 1980) was used in this study. This worksheet was adapted for use with this study. Its use prior to this study was limited to curriculum materials outside of mathematics. The adaptations included: the number of sections analyzed and the manner in which reinforcements were checked. The original Schindler worksheet takes three samplings (beginning, middle, and end) from a text and records the new vocabulary words used in each sample. Reinforcements of the new vocabulary words listed in a sample are then checked by examining the next three stories following that sample. The adapted form of the worksheet took the complete list of new vocabulary words from each chapter in the text. A new vocabulary word was checked in its initial lesson and then reinforcements of that word were searched for in subsequent lessons in the immediate chapter. Searches for reinforcements beyond the immediate chapter were futile due to the isolated nature of the content found in each chapter. These adaptations allowed for a more comprehensive examination of the new vocabulary words which were included in this study.

Data Analyses

The data were analyzed by charting each series according to readability scores and frequency of new word reinforcements.

From the Dale-Chall Readability Formula, an index number for each book was computed using a ratio that placed the publishers' estimated grade level over the readability level computed by the researcher. The result was then subtracted from 1. A 20% confidence interval was used as the allowable tolerance for the index numbers closest to 0, +.1, -.1. This confidence interval was chosen in order to be consistent with related research concerning readability (Watson, 1981). In this process, a positive index number shows that the actual readability level is higher than the publisher's estimated readability level. Likewise, a negative index number shows that the actual readability level is lower than the publisher's estimated readability level. In addition, the average formula raw scores were converted to corrected grade levels according to the Correction Table which was provided with the Dale-Chall formula. The corrected grade level indicates the grade at which a book can be read with understanding. The average formula raw scores as well as the corrected grade levels are discussed in relation to the publishers' estimated reading levels in Chapter 4.

The Kane Formula II computes a predicted readability score. A table is provided which lists the amounts to add to and to subtract from a predicted cloze score to mark the range of the true cloze scores. A confidence level (.90 or .75) was then selected. A level of .90 means that 90% of all true scores lie within the given range. A level of .75 means that 75% of all possible true cloze scores lie within the given range. The precision of the predicted cloze scores derived from the Kane formula was then checked. This was done to determine whether the predicted reading scores in two different books indicate different reading levels or are in fact due to errors in measurement. The precision of the scores was checked by examining the ranges of the true cloze scores which were established when the confidence levels were selected. The true cloze scores do not need to be different if the ranges overlap, but if the ranges do not overlap, then the level selected determines how confident the researcher can be in stating that the true cloze scores are different. The .90 and .75 confidence levels were calculated in this study in order to determine as accurately as possible the difficulty levels of the mathematics textbooks.

The final results calculated from both readability instruments were then compared. These comparisons involved the grade level scores determined by the Dale-Chall Readability Formula and the predicted readability scores (difficulty levels) derived from the Kane Formula II. The similarities and differences found in these results are discussed in Chapter 4.

Each new word presented in a specified lesson or unit was listed on the *Worksheet for Analysis of Instructional Materials Beyond Readability Scales.* The number of reinforcements for each new word was then checked and categorized into three columns: less than 5, 5, and more than 5. The reinforcements of these new words were also checked in the next three lessons. Percentages were then calculated by placing the number of reinforcements over the total number of new words presented in each book.

Summary

This chapter discussed the design by which the mathematics series were evaluated. The four series selected were listed. The instruments used to evaluate the series were also listed and described. Finally, the process for the analyses of data was discussed. The results of this study are discussed in Chapter 4.

CHAPTER 4

RESULTS

Introduction

The purpose of this chapter is to discuss the comprehensive evaluation of seventh and eighth grade textbooks from four mathematics series. In this chapter the null hypotheses and the actual results of the study are analyzed in two separate sections. The first section contains the first two null hypotheses and is labeled Individual Analysis of Each Mathematics Series. The second section contains the third null hypothesis which integrates information concerning each program and is labeled Comparative Analysis of the Four Mathematics Series.

The four mathematics series are dealt with in this order: (a) *Mathematics Today* (Abbott & Wells, 1987) Harcourt Brace Jovanovich; (b) *Houghton-Mifflin Mathematics* (Dolciani et al., 1987) Houghton-Mifflin Company; (c) *Heath Mathematics* (Rucker et al., 1987) D. C. Heath & Company; and (d) *Mathematics Unlimited* (Fennell, 1987) Holt, Rinehart & Winston.

All four series were analyzed according to the null hypotheses, by applying the Kane Formula II for mathematics materials, the Dale-Chall Readability Formula and the *Worksheet for Analysis of Instructional Materials Beyond*

Readability Scales. The precision of the predicted cloze scores for all textbooks was checked at the .90 and .75 confidence levels. The ranges of the true cloze scores overlapped at both confidence levels for all textbooks. This result indicated that the true cloze scores did not need to be different when the textbooks were compared. The worksheet was adapted to fit the format of the mathematics texts. New vocabulary word reinforcements were checked in three lessons, when possible, in the immediate chapter following the introductory lesson. This approach was taken due to a lack of topic-related lessons in subsequent chapters. The adaptations made on the worksheet are shown in Appendix C.

Individual Analysis of Each Mathematics Series

The observations of the Harcourt Brace Jovanovich series, according to the null hypotheses, are as follows:

Harcourt Brace Jovanovich

Ho:1. There is no significant difference between the publisher's estimate of readability and the actual computed readability scores based on two readability formulas.

The seventh grade text has an actual readability (7.1) which results in an index number (.01) considered tolerable for this study. The corrected grade level for this text (9th-10th) reveals the instructional difficulties possible with this text.

Average and below average students would probably have great difficulty reading this text with the understanding necessary in order to be successful with it. This text has a predicted readability score (32.5) computed by the Kane Formula II which will be discussed in the comparative analysis section found later in this chapter. The eighth grade text has an actual readability (6.9) which results in an index number (-.16) considered below the tolerable confidence interval for this study. However, the corrected grade level for this text (7th-8th) reveals a text that is probably appropriate for its intended grade level. This text has a predicted readability score (31.5) which will be discussed in the comparative analysis section. It is of interest to note that the two readability formulas are not conclusive as to which text in this series is easier (see Table 1, Figure 1, and Figure 2).

Ho:2. <u>There is no significant difference between the publisher's number of reinforcements of the new vocabulary words and the recommended five times or more than five times within the lesson of introduction.</u>

In this series neither text has at least 50% of the new vocabulary words reinforced a minimum of five times. The seventh grade text has only 42% of its new vocabulary words reinforced at least five times. The eighth grade text has 45% of its new vocabulary words reinforced at least five times. This series also contained omissions concerning the new vocabulary words which are listed in the teacher's manuals for both grade levels. The seventh grade teacher's manual

Table 1. Estimated and actual readability, index, corrected grade level (CGL), percentage new words reinforced for Harcourt Brace Jovanovich text series (1987).

					Percentage Reinforced		
Text	Estimated	Actual	Index	CGL	Less than 5	5	More than 5
Mathematics Today	7	7.1	.01	9-10	58	10	32
	8	6.9	-.16	7-8	55	6	39
Means			-.08		57	8	35

KANE II PREDICTED READABILITY GRAPH

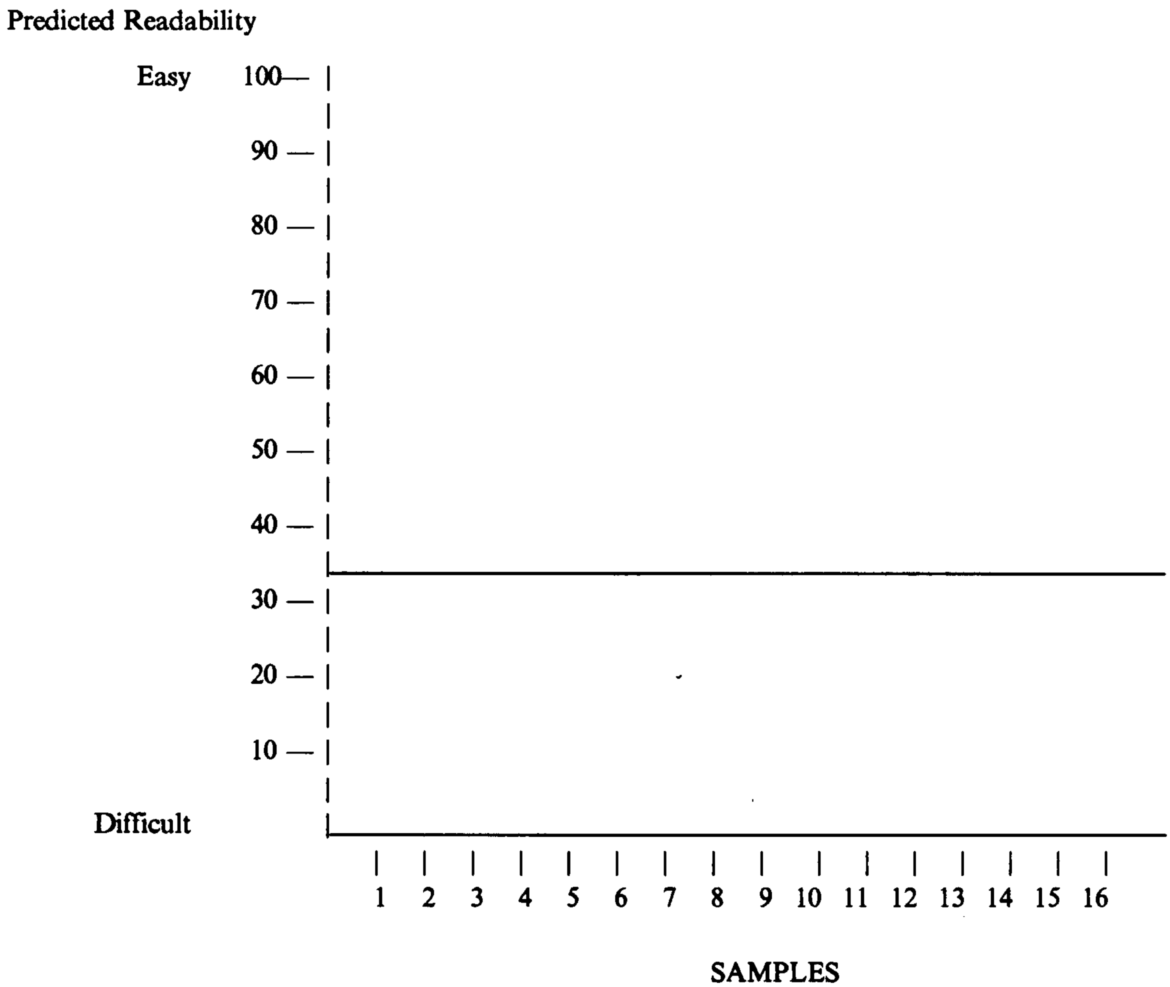
TEXT A — TITLE Mathematics Today

GRADE 7 — PUBLISHER Harcourt Brace Jovanovich

AUTHOR Abbott, J. & Wells, D. W.

COPYRIGHT DATE 1987

SCORER Robert A. O'Connor



$$\text{Mean Score} = \frac{33.4+33.37+36.15+32.41+35.25+38.48+36.97+35.96+33.3+32.5+31.34+34.97+16.69+26.33+33.54+29.96}{16}$$

$$= 32.5$$

Figure 1. Kane II Predicted Readability Graph, *Mathematics Today* (HBJ), Grade 7

KANE II PREDICTED READABILITY GRAPH

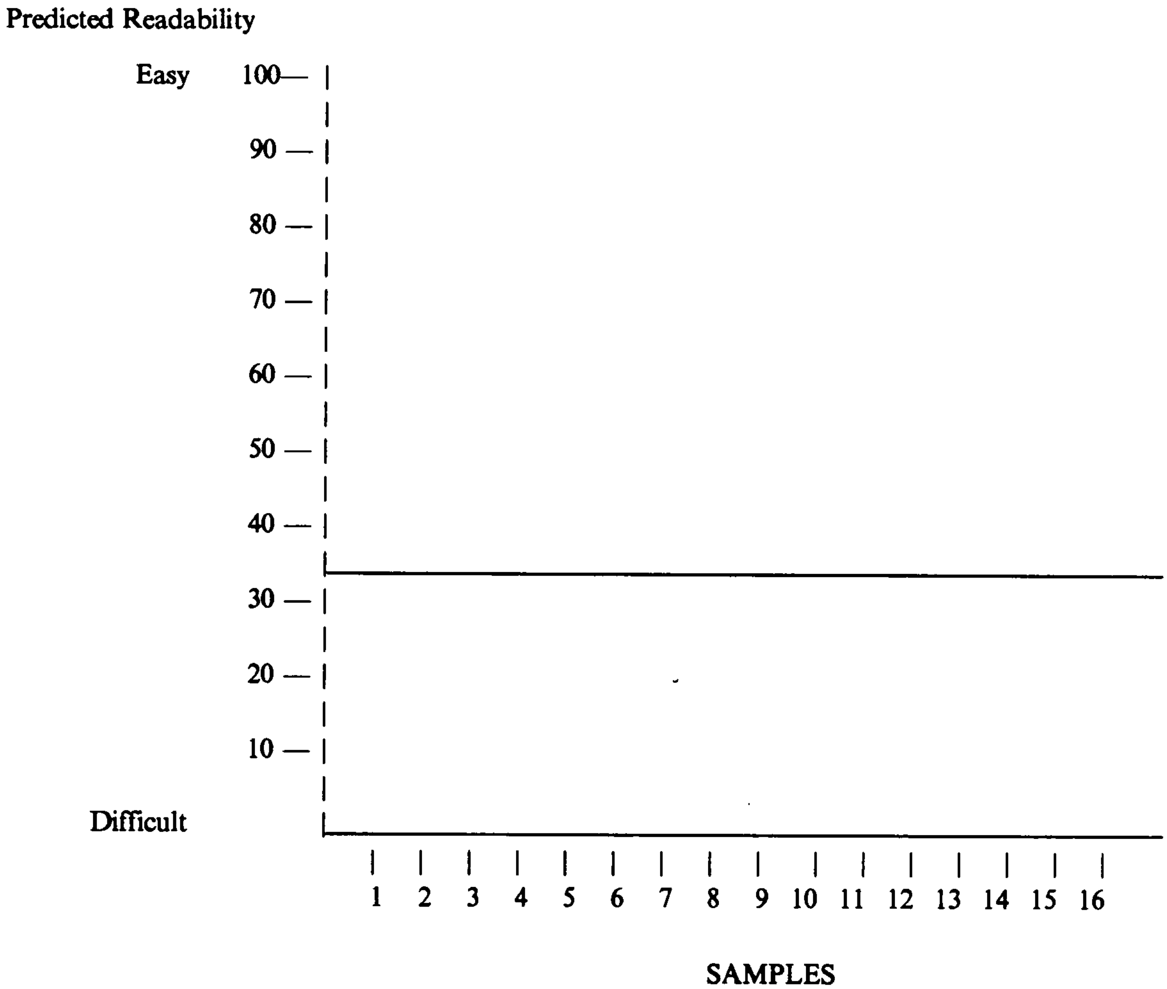
TEXT __B__ TITLE __Mathematics Today__

GRADE __8__ PUBLISHER __Harcourt Brace Jovanovich__

AUTHOR __Abbott, J. & Wells, D. W.__

COPYRIGHT DATE __1987__

SCORER __Robert A. O'Connor__



$$\text{Mean Score} = \frac{35.52+32+30.28+33.06+34.32+33.03+31.64+33.43+34.64+26.61+22.23+31.73+30.61+34.03+29.31+31.55}{16}$$

$$= \underline{31.5}$$

Figure 2. Kane II Predicted Readability Graph, *Mathematics Today* (HBJ), Grade 8

included "n/a" as a new vocabulary word, but it is never mentioned in the student textbook. The eighth grade teacher's manual included "equivalent decimals" as a new vocabulary word. This new vocabulary word is mentioned in the student textbook, but it is never defined or explained. Both texts studied in this series fall far below the recommended five or more times reinforcements (see Table 1).

The observations of the Houghton-Mifflin series, according to the null hypotheses, are as follows:

Ho:1. <u>There is no significant difference between the publisher's estimate of readability and the actual computed readability scores based on two readability formulas</u>.

The seventh grade text has an actual readability (6.9) which results in an index number (-.01) considered tolerable for this study. The corrected grade level for this text (7th-8th) reveals a text that is probably appropriate for its intended grade level. These scores suggest that above-average, average, and below-average students would probably experience success reading this text in the mathematics classroom. This text has a predicted readability score (31.5) computed by the Kane Formula II which will be discussed in the comparative analysis section found later in this chapter. The eighth grade text has an actual readability (7.1) which results in an index number (-.13) which is considered below the tolerable confidence interval for this study. However, the actual instructional level of this text can be seen in its corrected grade level score (9th-10th). Average and below-average students would probably have great difficulty reading this text with the understanding necessary in order to be successful with it. This text has a predicted readability score (30.8) which will be discussed in the comparative analysis section. It is of interest to note that the results from two readability formulas do give an indication that the seventh grade text is the easier of the two texts in this series (see Table 2, Figure 3, and Figure 4).

Ho:2. <u>There is no significant difference between the publisher's number of reinforcements of the new vocabulary words and the recommended five times or more than five times within the lesson of introduction.</u>

The texts in this series all fall far below the recommended five times or more than five times reinforcements for the new vocabulary words (see Table 2). The seventh grade text has only 34% of its new vocabulary words reinforced at least five times. The eighth grade text has only 39% of its new vocabulary words reinforced at least five times. This series also contains omissions concerning the new vocabulary words which are listed in the teachers' manuals for both grade levels. The seventh grade teacher's manual includes "percentage" as a new vocabulary word. However, this word is never mentioned in the student textbook. The seventh grade teacher's manual also includes "circumference" as a new vocabulary word. This word is mentioned in the student textbook, but it is never

Table 2. Estimated and actual readability, index, corrected grade level (CGL), percentage new words reinforced for Houghton-Mifflin text series (1987).

					Percentage Reinforced		
Text	Estimated	Actual	Index	CGL	Less than 5	5	More than 5
Houghton-Mifflin Mathematics	7	6.9	-.01	7-8	66	4	30
	8	7.1	-.13	9-10	61	10	29
Means			-.14		63	7	30

KANE II PREDICTED READABILITY GRAPH

TEXT C

GRADE 7

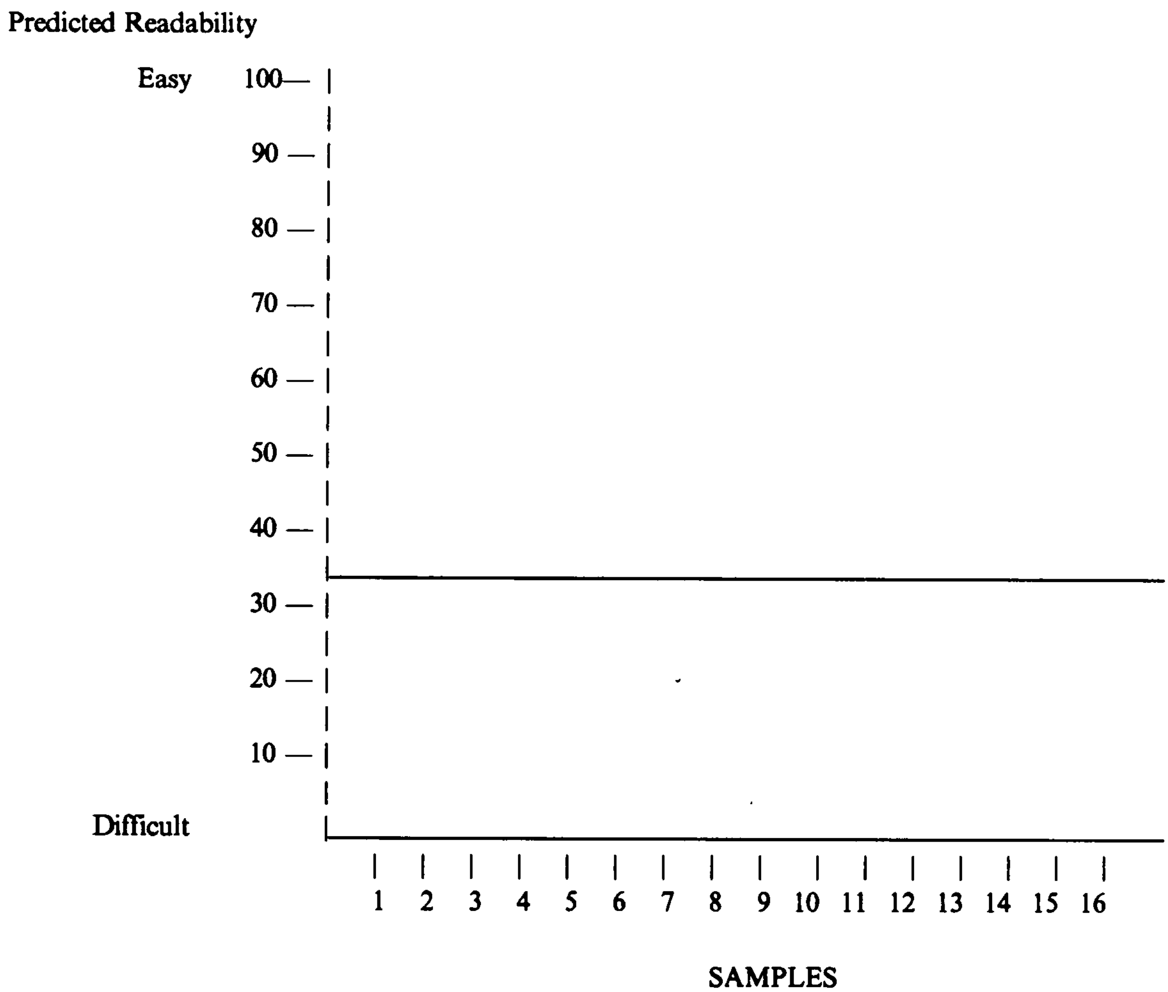
TITLE Houghton-Mifflin Mathematics

PUBLISHER Houghton-Mifflin

AUTHOR Dolciani, Brown, Cole

COPYRIGHT DATE 1987

SCORER Robert A. O'Connor



$$\text{Mean Score} = \frac{35.31+27.55+36.39+30.57+22.37+34.68+36.57+35.53+33.03+38.56+24.03+28.85+27.84+25.76+35.06}{16}$$

$$= 31.5$$

Figure 3. Kane II Predicted Readability Graph, *Houghton-Mifflin Mathematics* (HM), Grade 7.

KANE II PREDICTED READABILITY GRAPH

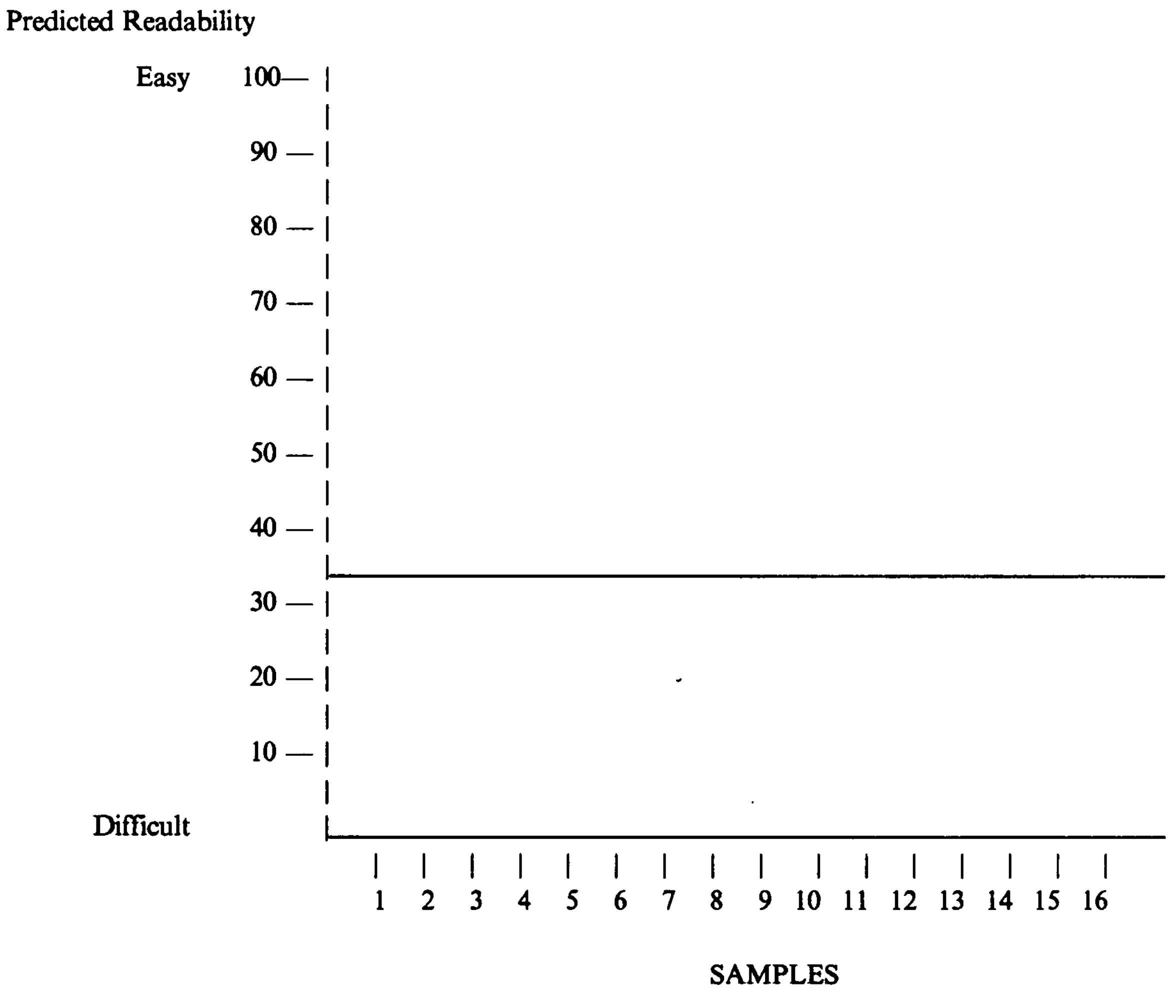
TEXT D TITLE Houghton-Mifflin Mathematics

GRADE 8 PUBLISHER Houghton-Mifflin

AUTHOR Dolciani, Brown, Cole

COPYRIGHT DATE 1987

SCORER Robert A. O'Connor



Mean Score $= \frac{30.38+33.92+33.33+33.9+31.93+31.37+36.59+25.2+29.25+35.24+23.88+29.14+32.37+27.06+28.09}{16}$

$= \underline{30.8}$

Figure 4. Kane II Predicted Readability Graph, *Houghton-Mifflin Mathematics* (HM), Grade 8.

defined or explained. The eighth grade teacher's manual includes "debit" as a new vocabulary word. However, this word is never mentioned in the student textbook. The eighth grade teacher's manual also includes "ordered pair," "corresponding," "slant height," "simplify," and "is greater than or equal to" as new vocabulary words. These words are mentioned in the student textbook but are never defined or explained.

The observations of the D. C. Heath series, according to the null hypotheses, are as follows:

D. C. Heath

Ho:1. There is no significant difference between the publisher's estimate of readability and the actual computed readability scores based on two readability formulas.

The seventh grade text has an actual readability (7.4) which results in an index number (.05) considered tolerable for this study. However, the corrected grade level score (9th-10th) derived from the Dale-Chall formula reveals the actual instructional level of this text. These scores indicate that average and below-average students will probably have difficulty being successful with this text in the mathematics classroom. This text has a predicted readability score (32.5) computed by the Kane Formula II which will be discussed in the comparative analysis section found later in this chapter. The eighth grade text has an actual readability (7.3) which results in an index number (-.10) considered tolerable for this study. The corrected grade level score (9th-10th) indicates the actual instructional level of this text. These scores indicate that average and below-average students may have difficulty being successful with this text in the mathematics classroom. This text has a predicted readability score (32.6) which will be discussed in the comparative analysis section. It is of interest to note that the results from the two readability formulas do give a slight indication that the eighth grade text is the easier of the two texts in this series (see Table 3, Figure 5, and Figure 6).

Ho:2. <u>There is no significant difference between the publisher's number of reinforcements of the new vocabulary words and the recommended five times or more than five times within the lesson of introduction.</u>

None of the texts in this series comes close to the recommended number of reinforcements (see Table 3). The seventh grade text has only 37% of its new vocabulary words reinforced at least five times. The eighth grade text has only 40% of its new vocabulary words reinforced at least five times. This series also contains omissions concerning the new vocabulary words listed in the teachers' manuals. The seventh grade teacher's manual includes "diagonal" and "opposite parts" as new vocabulary words. These words are never mentioned in the student textbook. The seventh grade teacher's manual also includes "Celsius (C),"

Table 3. Estimated and actual readability, index, corrected grade level (CGL), percentage new words reinforced for Heath text series (1987).

					Percentage Reinforced		
Text	Estimated	Actual	Index	CGL	Less than 5	5	More than 5
Heath Mathematics	7	7.4	.05	9-10	63	5	32
	8	7.3	-.10	9-10	60	6	34
Means			-.03		61	6	33

KANE II PREDICTED READABILITY GRAPH

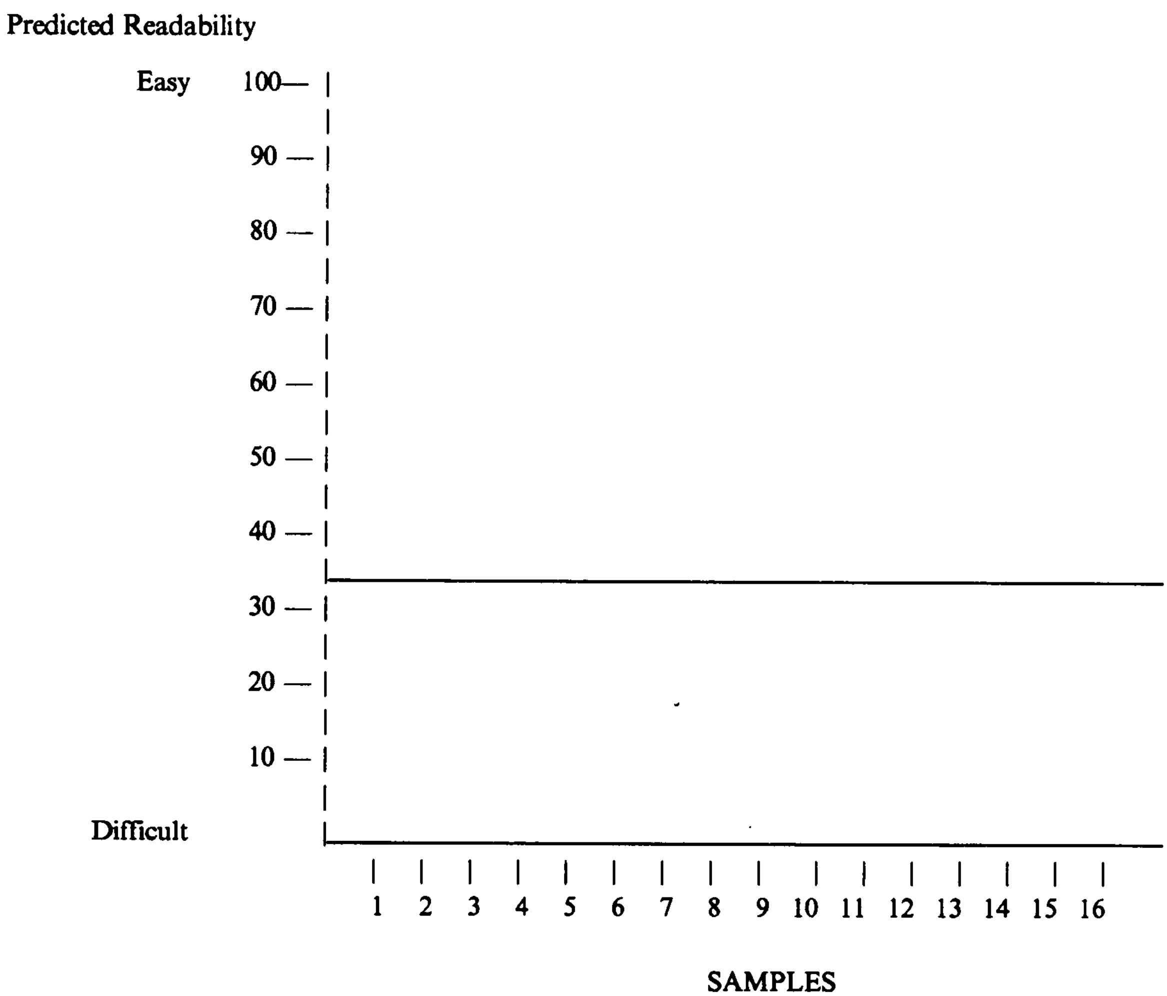
TEXT E — TITLE Heath Mathematics

GRADE 7 — PUBLISHER D. C. Heath & Company

AUTHOR Rucker, Dilley, Lowry

COPYRIGHT DATE 1987

SCORER Robert A. O'Connor



Mean Score = $\frac{36.24+33.96+33.4+31.25+33.42+32.93+34.36+32.61+35.72+33.84+30.89+25.61+28.7}{16}$

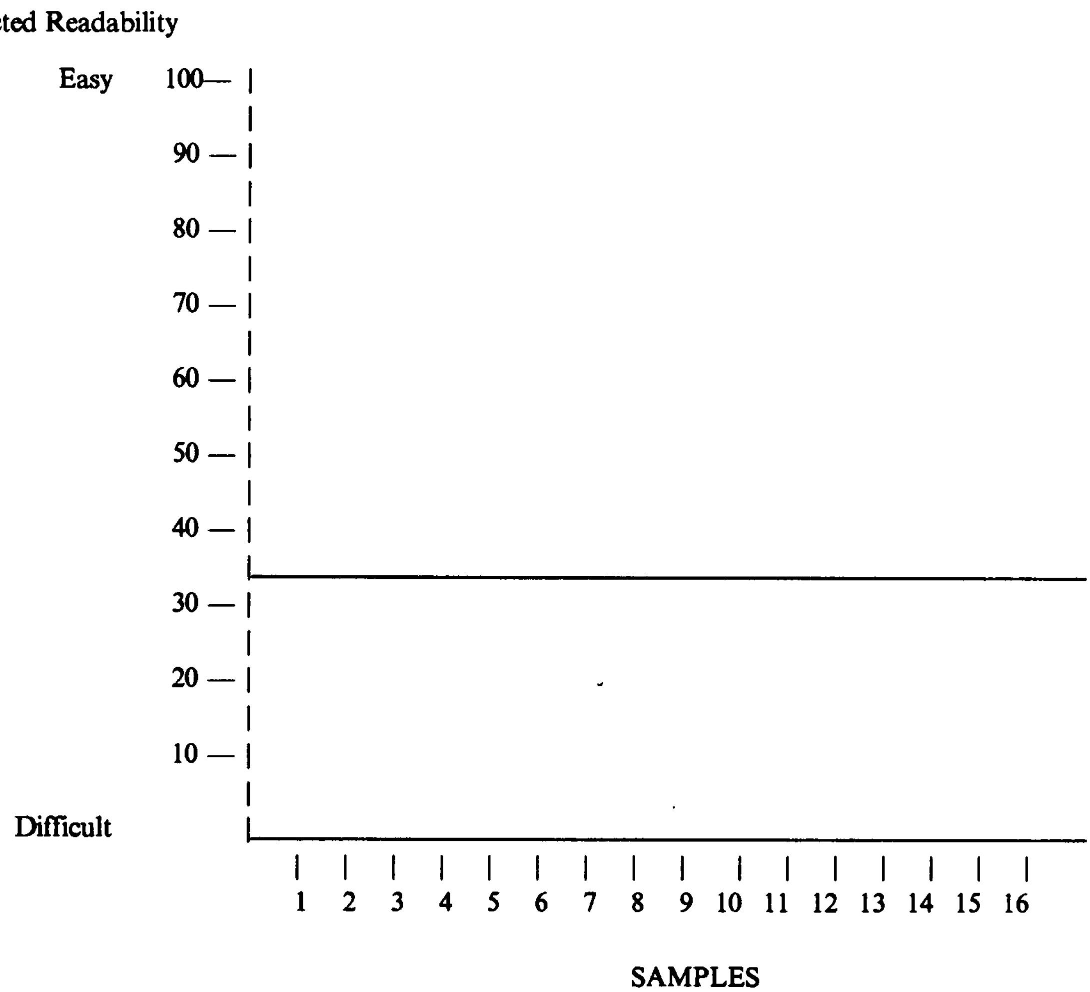
= 32.5

Figure 5. Kane II Predicted Readability Graph, Heath Mathematics (H), Grade 7.

KANE II PREDICTED READABILITY GRAPH

TEXT F
GRADE 8

TITLE Heath Mathematics
PUBLISHER D. C. Heath & Company
AUTHOR Rucker, Dilley, Lowry
COPYRIGHT DATE 1987
SCORER Robert A. O'Connor



Mean Score = $\frac{34.08+36.61+34.82+24.33+32.97+37.09+32.79+33.1+35+31.4+33.58+31.04+26.41}{13}$

= 32.6

Figure 6. Kane II Predicted Readability Graph, Heath Mathematics (H), Grade 8.

"balance," "commission," "credit," "down payment," "retail price," "broken-line graph," "circle graph," "data," "frequency distribution," and "pictograph" as new vocabulary words. These new vocabulary words are mentioned in the student textbook but are never defined or explained. The eighth grade teacher's manual includes "percent of discount" and "protractor" as new vocabulary words. These words are never mentioned in the student textbook. The eighth grade teacher's manual also includes "Celsius (C)," "chord," "balance," "commission," "discount," "down payment," "fee," "installment plan," "monthly payment," "salary," "sale price," "stock," "wages," "like terms," "circle graph," "data," "pictograph," "tally," and "tangent (tan)." These new vocabulary words are mentioned in the student textbook but are never defined or explained.

The observations of the Holt, Rinehart & Winston series, according to the null hypotheses, are as follows:

Holt, Rinehart & Winston

Ho:1. There is no significant difference between the publisher's estimate of readability and the actual computed readability scores based on two readability formulas.

The seventh grade text has an actual readability (7.2) which results in an index number (.03) considered tolerable for this study. However, the corrected grade level score (9th-10th) derived from the Dale-Chall formula reveals the actual instructional level of this text. These scores indicate that average and below-average students will probably have difficulty being successful with this text in the mathematics classroom. This text has a predicted readability score (32.2) computed by the Kane Formula II which will be discussed in the comparative analysis section found later in this chapter. The eighth grade text has an actual readability (6.9) which results in an index number (-.16) considered below the tolerable confidence interval for this study. The corrected grade level score (7th-8th) indicates that this text would be appropriate for this instructional level for a majority of the students. This text has a predicted readability score (33.4) which will be discussed in the comparative analysis section. It is of interest to note that the results of the two readability formulas do give an indication that the eighth grade text is the easier of the two texts in this series (see Table 4, Figure 7, and Figure 8.

Ho:2. <u>There is no significant difference between the publisher's number of reinforcements of the new vocabulary words and the recommended five times or more than five times within the lesson of introduction.</u>

The texts in this series all fall far below the recommended five or more repetitions of new vocabulary words (see Table 4). The seventh grade text has only 29% of its new vocabulary words reinforced at least five times. The eighth

Table 4. Estimated and actual readability, index, corrected grade level (CGL), percentage new words reinforced for Holt, Rinehart & Winston text series (1987).

					Percentage Reinforced		
Text	Estimated	Actual	Index	CGL	Less than 5	5	More than 5
Mathematics Unlimited	7	7.2	.03	9-10	71	5	24
	8	6.9	-.16	7-8	67	11	22
Means			-.07		69	8	23

KANE II PREDICTED READABILITY GRAPH

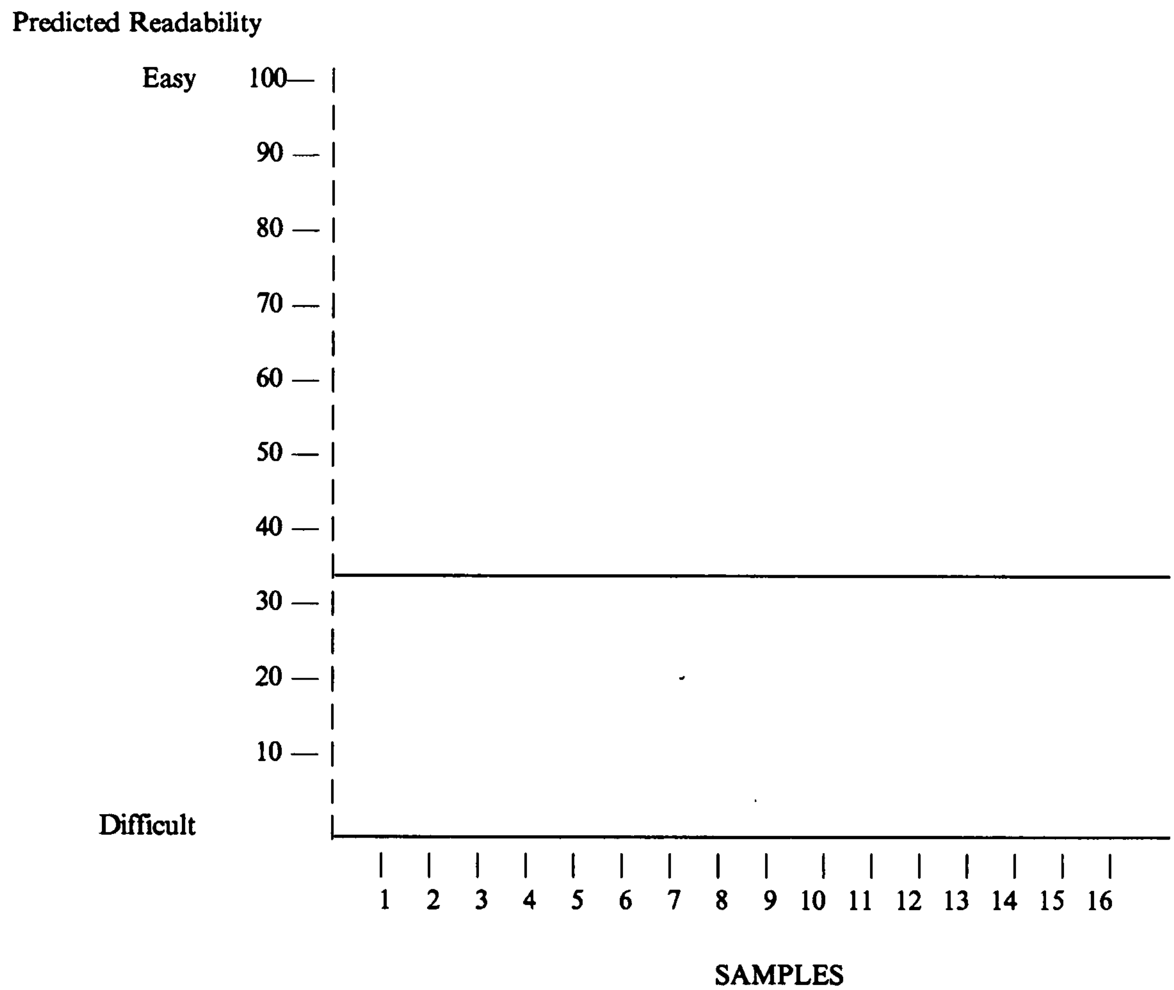
TEXT G   TITLE Mathematics Unlimited

GRADE 7   PUBLISHER Holt, Rinehart & Winston

AUTHOR Fennell, F.

COPYRIGHT DATE 1987

SCORER Robert A. O'Connor



Mean Score = $\frac{40.67+35.53+36.89+37.61+30.58+26.36+34.92+35.04+25.63+31.87+33.99+28.95+26.51+31.04+29.01+31.26}{16}$

= 32.2

Figure 7. Kane II Predicted Readability Graph, *Mathematics Unlimited* (HRW), Grade 7.

KANE II PREDICTED READABILITY GRAPH

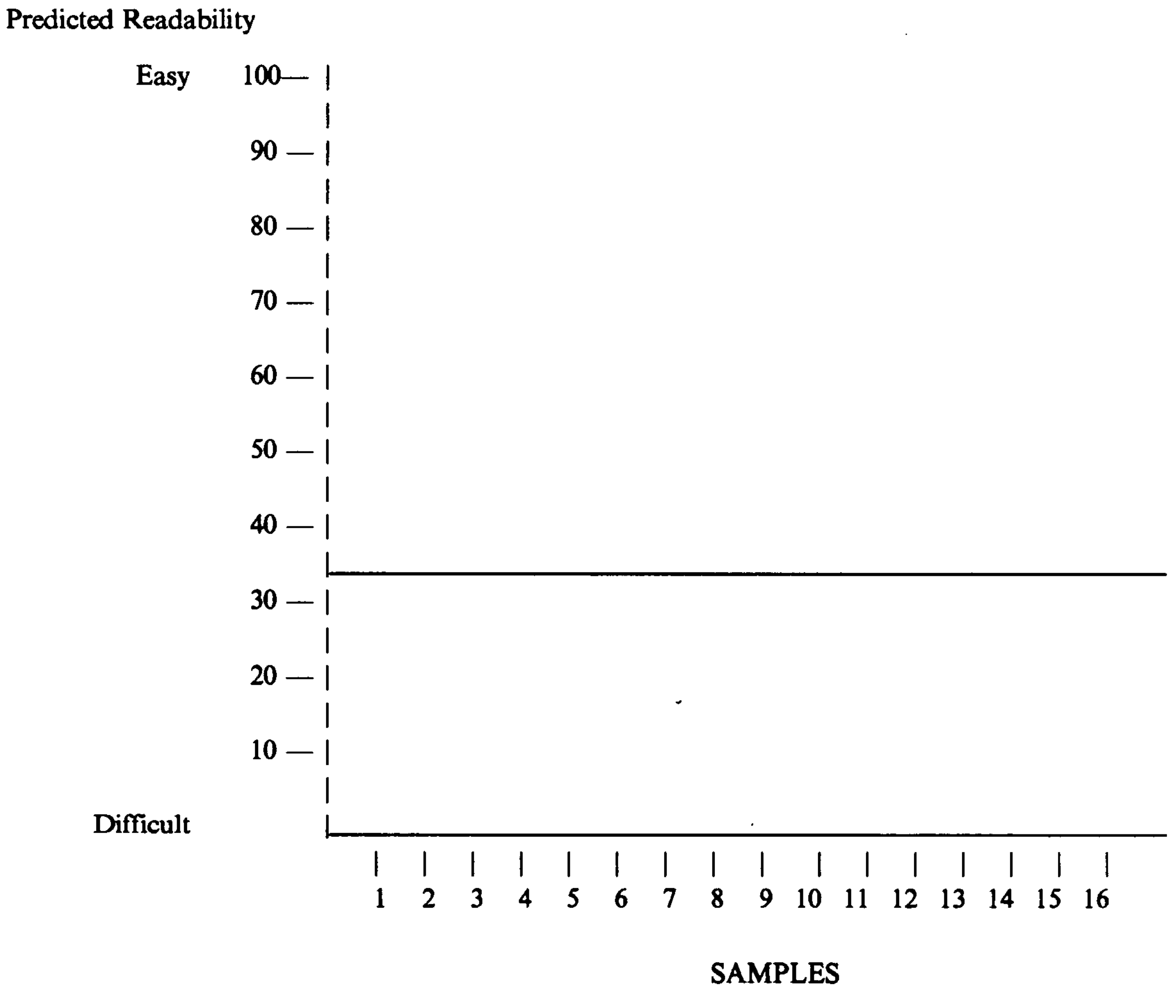
TEXT H — TITLE Mathematics Unlimited

GRADE 8 — PUBLISHER Holt, Rinehart & Winston

AUTHOR Fennell, F.

COPYRIGHT DATE 1987

SCORER Robert A. O'Connor



Mean Score= $\dfrac{41.17+32.62+35.31+36.93+36.72+34.43+46.34+32.63+28.73+28.4+32.96+29.73+32.95+25.65+30.38+30.11}{16}$

= 33.4

Figure 8. Kane II Predicted Readability Graph, *Mathematics Unlimited* (HRW), Grade 8.

grade text has only 33% of its new vocabulary words reinforced at least five times. This series also contains omissions concerning the new vocabulary words listed in the teachers' manuals. The seventh grade teacher's manual includes "Identity Property of Multiplication," "root," "terminating decimal," "repeating decimal," "complex fraction," "inches," "frequency distribution table," and "mass" as new vocabulary words. However, these terms are never mentioned in the student textbook. The seventh grade teacher's manual also includes "trillions" and "millionths" as new vocabulary words. These terms are mentioned in the student textbook but are never defined or explained. The eighth grade teacher's manual includes "millionths," "Celsius," and "bimodal" as new vocabulary words. However, these terms are never mentioned in the student textbook. The eighth grade teacher's manual also includes "order of operations," and "common factor" as new vocabulary words. These terms are mentioned in the student textbook but are never defined or explained.

Comparative Analysis of the Four Mathematics Series

The four mathematics series were analyzed across text in order to evaluate the mean values for the series. Table 5 shows the mean index numbers and the mean percentages of reinforcements. The mean index numbers, the corrected grade level scores derived by the Dale-Chall formula, the predicted readability

Table 5. Mean index numbers, percentage new words reinforced.

Series	Mean Index	Mean Percentage Reinforced		
		Less than 5	5	More than 5
Mathematics Today Harcourt Brace Jovanovich (1987)	-.08	57	8	35
Houghton-Mifflin Mathematics Houghton-Mifflin (1987)	-.14	63	7	30
Heath Mathematics D. C. Heath & Company (1987)	-.03	61	6	33
Mathematics Unlimited Holt, Rinehart & Winston (1987)	-.07	69	8	23

scores computed by the Kane Formula II, and the mean percentages of new vocabulary word reinforcements were used to compare the four series to one another.

The Harcourt Brace Jovanovich series mean score (-.08) is within the confidence interval (+.1 through -.1) considered tolerable for this study. However, this score is suppressed by the index number (-.16) gained from the eighth grade text which helps to disguise the difficulty of the seventh grade text (.01). The corrected grade level score for the seventh grade text (9th-10th) also points out the difficult nature of this text. The corrected grade level score for the eighth grade text (7th-8th) points out the appropriateness of this text for the intended grade level. The predicted readability scores computed by the Kane Formula II for the seventh grade text (32.5) and the eighth grade text (31.5) do not indicate a true difference in the difficulty levels for these texts in this series.

The Houghton-Mifflin series mean score (-.14) is below the confidence interval considered tolerable for this study and is the lowest mean score derived in this study. This result occurred since the index numbers for both texts were negative. The other series contained at least one text which had a positive index number. The corrected grade level score for the seventh grade text (7th-8th) points out the appropriateness of this text for the intended grade level. The corrected grade level score for the eighth grade text (9th-10th) points out the possible difficult nature of this text for the intended grade level. This is the only series in which the seventh grade text is seen as being less difficult than the eighth grade text. The predicted readability scores computed by the Kane Formula II for the seventh grade text (31.5) and the eighth grade text (30.8) do not indicate a true difference in the difficulty levels for these texts in this series.

The D. C. Heath & Company series mean score (-.03) is within the confidence interval considered tolerable for this study and is the highest mean score derived in this study. This is the only series for which the corrected grade level scores for both texts are the same (9th-10th). The other series contained one text with a corrected grade level score in the 7th-8th grade range. The predicted readability scores computed by the Kane Formula II for the seventh grade text (32.5) and the eighth grade text (32.6) do not indicate a true difference in the difficulty levels for these texts in this series.

The Holt, Rinehart & Winston series mean score (-.07) is within the confidence interval considered tolerable for this study. This series is very similar to the Harcourt Brace Jovanovich series in its results. In fact, the only difference in scores between the two series occurred with the seventh grade texts where the Harcourt Brace Jovanovich text index score (.01) is slightly lower than the Holt, Rinehart & Winston text index score (.03). The averaging of the index numbers can be seen in Table 6. The predicted readability scores computed by the Kane

Table 6. Estimated and actual readability, index, corrected grade level (CGL), percentage new words reinforced for all series.

					Percentage Reinforced		
Text	Estimated	Actual	Index	CGL	Less than 5	5	More than 5
Mathematics Today	7	7.1	.01	9-10	58	10	32
(HBJ, 1987)	8	6.9	-.16	7-8	55	6	39
Means			-.08		57	8	35
Houghton-Mifflin Mathematics	7	6.9	-.01	7-8	66	4	30
(HM, 1987)	8	7.1	-.13	9-10	61	10	29
Means			-.14		63	7	30
Heath Mathematics	7	7.4	.05	9-10	63	5	32
(DCH, 1987)	8	7.3	-.10	9-10	60	6	34
Means			-.03		61	6	33
Mathematics Unlimited	7	7.2	.03	9-10	71	5	24
(HRW, 1987)	8	6.9	-.16	7-8	67	11	22
Means			-.07		69	8	23

Formula II for the seventh grade text (32.2) and the eighth grade text (33.4) do not indicate a true difference in the difficulty levels for these texts in this series.

All four series fall far below the recommended five times or more than five times reinforcements of new vocabulary words within the lesson of introduction. The Harcourt Brace Jovanovich series ranks first with 43% of the new vocabulary words adequately reinforced. The D. C. Heath & Company series ranks second with 39%. The Houghton-Mifflin series ranks third at 37%. The Holt, Rinehart & Winston series is the least adequate among the series in this area at 31%.

These percentages indicate a lack of attention to the reinforcements of new vocabulary words by the authors and publishers. This lack of attention in addition to the average sentence length and number of unfamiliar words in the texts contribute to the overall difficulty of certain texts within each series.

CHAPTER 5

SUMMARY, FINDINGS, CONCLUSIONS, DISCUSSION, AND SUGGESTIONS FOR FURTHER RESEARCH

Introduction

The purpose of this chapter is to present the following: a summary of the study, findings, null hypotheses, conclusions, discussion, and suggestions for further research.

Summary of Study

The purpose of this study was to evaluate seventh and eighth grade textbooks from four mathematics series through the use of readability scores and the reinforcement of new vocabulary words. This was done to determine if a method could be developed which would help educators better evaluate mathematics series in order to select appropriate textbooks which match up well with the reading level of the students. The following questions were presented: 1. Is there a difference between the publishers' stated grade levels and the actual readability levels according to the two readability formulas? 2. Are the new vocabulary words reinforced five times or more than five times within the lesson of introduction: and 3. Can the three measures be used effectively in determining the reading difficulty level of the mathematics texts? The readability scores were calculated by using the Dale-Chall Readability Formula and the Kane Formula II for use with mathematics materials. The results of the Dale-Chall formula included actual readability scores and corrected grade level scores which helped to pinpoint the actual instructional grade levels for each text. The Kane formula produced predicted readability scores which were used in comparing the difficulty of the texts in relation to each other. The new vocabulary words introduced in the series were listed on an adapted form of the *Worksheet for Analysis of Instructional Materials Beyond Readability Scales* (Schindler, 1980). The reinforcements of the new vocabulary words were checked on the adapted Schindler worksheet. Reinforcements were checked outside the introductory lesson in order to count the actual number of reinforcements of each new vocabulary word.

Findings

The question examined in this study: "can a method be developed which would help educators better evaluate mathematics series in order to determine appropriate textbooks which match up well with the reading level of the students?" was answered successfully, although not conclusively. Much work still needs to be done to develop a more comprehensive method for evaluating mathematics materials.

The comparative analysis discussed results which highlighted the various similarities and differences between the four series. Each series included at least one text that was too difficult, according to the corrected grade level scores, for the intended grade level. The mean index numbers indicated that three of the four series were within the tolerable confidence interval (+.1 through -.1). The Houghton-Mifflin series had a mean index number (-.14) which was below this interval. The mean index numbers, if viewed alone, would indicate that all four series are appropriate, or at least tolerable, for the intended grade levels. The use of the corrected grade levels, however, allowed the researcher to better analyze the individual texts in each series by noting the appropriate instructional grade levels for each text. These instructional grade levels indicate the grades at which a book can be read with understanding. For example, a book with a corrected grade level of 7-8 is one which should be within the reading ability of average students in grades 7 and 8.

The three series which were within the tolerable confidence interval (Harcourt Brace Jovanovich; Heath; and Holt, Rinehart & Winston) all had corrected grade level scores for the seventh grade texts (9th-10th) which were inappropriate for the seventh grade level. It would be easy to see how these texts could be a source of great frustration for nearly all seventh grade students. The Houghton-Mifflin seventh grade text had a corrected grade level score (7th-8th) which indicated that this text could be read with understanding at the intended grade level. The Harcourt Brace Jovanovich seventh grade text had an index number (.01) which indicated that this text was the second most appropriate one for this grade level. The Holt, Rinehart & Winston seventh grade text had an index number (.03) which indicated that this text was the third most appropriate one for this grade level. The D. C. Heath seventh grade text had the highest index number (.05) which indicated that this text was the least appropriate one among the series for this grade level.

Two of the three series which were between the tolerable confidence interval had corrected grade level scores for the eighth grade texts (7th-8th) which were appropriate for the eighth grade level. These included the Harcourt Brace Jovanovich text and the Holt, Rinehart & Winston text. The Heath text and the Houghton-Mifflin text had a corrected grade level score (9th-10th) which indicated that these texts were too difficult for the intended grade level. It is interesting to note that the corrected grade level scores for the Houghton-Mifflin series indicated that the seventh grade text (7th-8th) was less difficult than the eighth grade text (9th-10th). The corrected grade level scores for the Harcourt Brace Jovanovich series and the Holt, Rinehart & Winston series indicated that the seventh grade texts (9th-10th) were more difficult than the eighth grade texts (7th-8th). The corrected grade level scores for the D. C. Heath series (9th-10th) indicated that both texts were similar in difficulty.

The results gained from the Kane Formula II differed from those provided by the Dale-Chall Formula in that these results were strictly comparative in nature and did not compute specific grade level difficulties for each text. As was mentioned earlier, none of the results gained from the Kane formula were significantly different. Therefore, the score for each text derived by this formula does not truly indicate that any text is more difficult than the others. These results led to the implementation of the Dale-Chall formula which did point out various levels of difficulty according to the corrected grade level scores. The differences between the corrected grade level scores were somewhat similar to those found with the Kane formula in that, even though some texts scored in the 7th-8th grade range and others in the 9th-10th grade range, these scores remained close to the borderline between these two levels.

According to the *Worksheet for Analysis of Instructional Materials Beyond Readability Scales* (Schindler, 1980), none of the texts in the series did an adequate job of reinforcing the new vocabulary words within the lesson of introduction. The series which did the most adequate job of reinforcing the new vocabulary words was *Mathematics Today* (Harcourt Brace Jovanovich). This series had the highest percentage of new vocabulary words reinforced at the recommended five times or more than five times at the seventh and eighth grade levels. The eighth grade text in this series had the highest percentage (45%) for all texts at any grade level. Even though this score was the highest among the series, it still points out the lack of attention to the reinforcement of new vocabulary words by all the publishers in this study.

The lack of reinforcements is at least partially due to the format of the mathematics texts. Several chapters in each of the texts introduce 40-50 new vocabulary words. These new vocabulary words are introduced in a brief lesson (usually two pages) and are usually not presented again just as the topic or skill is not repeated within the text. This, in addition to inadequate reinforcements in the initial lesson, can cause students to have great difficulty retaining and comprehending the new vocabulary words. The inconsistencies of the new vocabulary words found in the teachers' manuals and the student texts was noted in Chapter 4. These inconsistencies involved the new vocabulary words which are listed in the teachers' manuals but are either not explained or do not appear at all in the student texts. These omissions were not very numerous but were consistently found in each of the texts. The series studied also seem to put a stronger emphasis on student practice (math skills) than in reinforcing directions or explanations concerning a particular topic or skill (reading skills). This emphasis supports the statement from Chapter 2 that students may go through the mathematics curriculum without understanding what they are doing or why they are doing it. To this researcher, this approach would be comparable to using a reading program which only required students to recognize new vocabulary sight words and then move on to the next reader in the series without any need to comprehend or analyze the material.

Conclusions

1. There is a difference (particularly at the seventh grade level) between the publishers' stated grade levels of the four mathematics series and the actual readability levels according to the Dale-Chall formula and the difficulty levels determined by the Kane formula.

2. The new vocabulary words which are introduced in a lesson are not consistently reinforced at least five times within the context of that lesson in any of the mathematics texts.

3. The three measures implemented in this study can be used effectively in determining the reading difficulty of the mathematics texts.

Discussion

The information gathered in Chapter 4 indicates that all four series were analyzed adequately through the data available in the comprehensive evaluation. This study includes the use of the corrected grade levels derived from the Dale-Chall formula and the predicted readability scores computed from the Kane Formula II for use with mathematics materials. The corrected grade levels were included in this study in order to present a more accurate description of the actual instructional levels for the texts in this study. It was felt by this researcher that the discussion of the index numbers, which were computed by comparing the actual readability scores from the Dale-Chall formula with the estimated readability scores of the publishers, did not clearly illustrate the possible instructional difficulties found in some of the texts. The Kane Formula II was a valuable instrument in the comprehensive evaluation process used in this study. The Kane formula includes the Dale List of 3,000 Familiar Words as well as various lists which include familiar and unfamiliar mathematical terms and symbols. The combination of these lists serve to determine the overall difficulty of the texts in this study. Also, the order of analyses were done in the most efficient order for this study.

The comprehensive evaluation process of the four mathematics series proved to broaden the analysis beyond simply calculating a readability formula. Some of the more notable results of the comprehensive evaluation process were evident in the results concerning the seventh grade texts. Three of the four seventh grade texts were substantially more difficult than the estimated grade level of the publishers. The corrected grade level scores (9th-10th) derived from the Dale-Chall formula for the three texts as well as the inadequate number of reinforcements for new vocabulary words were valuable in exposing the instructional difficulties possible with these texts. The results showed that these texts may serve to only frustrate many students at this grade level. Students are usually taught at the instructional or frustration level but should be taught at the independent level in order to encourage them in their academic work. Students make more word recognition errors at the instructional level than at the independent level, and comprehension is not as high. Betts (1946) defined the independent level as the one at which a student can read easily, without assistance, with few word recognition errors (1% or less), and with good comprehension (90%). The instructional level is the highest level at which a child can do satisfactory reading with assistance from a teacher. Word recognition errors are few (5%), and comprehension (70%) is satisfactory. The frustration level is the level where word recognition (less than 90%) is poor and comprehension (less than

50%) is inconsistent. At the frustration level, students make too many errors in word recognition and comprehension is not adequate enough in order to be successful with the text. The three seventh grade texts mentioned above were developed at the frustration level, which would cause great difficulty in mathematics for most students at this grade level.

Overall, the eighth grade texts were more appropriate than the seventh grade texts. The Kane formula did not determine that there was a significant difference between the seventh and eighth grade texts in terms of difficulty level. The corrected grade levels derived from the Dale-Chall formula indicated that two of the four eighth grade texts were written at an appropriate instructional level (7th-8th), which might allow students at this grade level to work at an independent level. The two remaining eighth grade texts had a corrected grade level (9th-10th) which indicated that these texts could very possibly be frustrating for students at this grade level.

The attention paid to comprehension in this study was evident in each of the three instruments used. The corrected grade level scores derived from the Dale-Chall formula indicated a comprehension level which falls between 50% and 75%. The Kane Formula was based on the cloze procedure which can provide a good index of comprehensibility. The Schindler worksheet was based on the positive effects of adequate reinforcements in the conceptualization of concepts.

The results gained from the implementation of these instruments indicated positive as well as negative aspects in terms of comprehension with the texts. Three of the texts studied had corrected grade level scores which were seen as being appropriate for the intended grade level. The Schindler worksheet, however, exposed severe inadequacies in reinforcements of new vocabulary words which were very discouraging. The problems discussed in this area may very well account for the greatest source of frustration experienced by students and teachers in mathematics classrooms. Due to the reliance on mathematics texts in many classrooms, this researcher feels that students' attitudes toward mathematics are at least partially shaped through experiences with the mathematics text. If the experiences are negative, then the reluctance to read mathematics is reinforced even more.

The attitude of this researcher towards mathematics changed dramatically because of this study. While researching this project, an awareness developed that many of the teaching practices which were criticized in this study were common in this researcher's classroom. The language of mathematics became an important part of the lessons in the classroom and brought much more meaning to these lessons. The students' attitudes towards mathematics changed when the language was reinforced and discussed regularly. The students became more able to explain how they managed to solve problems and were more confident and eager to solve these problems. The most dramatic change occurred in an elementary resource classroom. A student had taken a pretest for a chapter on multiplication and division. The student had correctly answered only 1 out of 25 problems on the chapter pretest and was convinced that she would be unable to learn how to multiply and divide. The emphasis of the lessons changed to include the language of multiplication and division, and her attitude changed dramatically. She was much more attentive in class and volunteered to discuss the concepts which were covered. The results of her posttest (100%) would have been surprising if only the pretest and posttest had been compared and her development in the classroom had not been observed. This researcher feels that results such as these could become commonplace if other teachers would attempt to teach mathematics as a language as well as a skill.

Suggestions for Further Research

Observations of this study reveal additional possibilities for expanded research. The first option would be to continue to search for instruments designed for use in evaluating mathematics materials and to compare these with the ones used in this study. A second option would be to investigate evaluation procedures currently in use by local, regional, state, and national agencies for evaluating mathematics materials. These procedures should include: readability of text, reinforcement of new vocabulary words, teaching the language of mathematics, chapter organization, text organization, etc. This option could serve to greatly expand this area of research. A third option would involve further research into the area of new vocabulary word reinforcements and its effect in determining the difficulty level of mathematics textbooks.

Additional studies for further research would be beneficial for students as well as teachers. Teachers would benefit from having appropriate textbooks in the classroom by knowing that instructional time is being adequately supported and reinforced through the textbooks. Students would benefit from having appropriate textbooks which provide additional insight into the understanding of mathematical concepts. Publishers should be familiar with expanded research in order to develop more appropriate mathematics series. Educators should also be familiar with expanded research in order to make appropriate decisions concerning the use of mathematics series in their classrooms. In the end, it is the mathematics series which determine the mathematics skills or concepts our students are taught.

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APPENDIX

APPENDIX A

DALE-CHALL READABILITY FORMULA-TABLE II

Article: ______	No. ______	Page No. ______	Page No. ______
Author: ______		From ______	From ______
Publisher: ______		To ______	To ______
1. Number of words in the sample	______	______	______
2. Number of sentences in the sample	______	______	______
3. Number of words not on Dale List	______	______	______
4. Average sentence length (divide 1 by 2)	______	______	______
5. Dale score (divide 3 by 1, multiply by 100)	______	______	______
6. Multiply average sentence length (4) by .0496	______	______	______
7. Multiply Dale score (5) by .1579	______	______	______
8. Constant	3.6365	3.6365	3.6365
9. Formula Raw score (add 6, 7, and 8)	______	______	______

Average raw score of _____ samples . . . . ______ Analyzed by ______ Date ______
Average corrected grade-level . . . . ______ Checked by ______ Date ______

APPENDIX B

KANE FORMULA II WORKSHEET FOR THE LANGUAGE OF MATHEMATICS

Book Title____________________ Publisher____________________

Author____________________ Copyright Date_____ Scorer__________

$\frac{\text{Number of pages in book proper}}{10}$ = _____ Choose a sample every ___ pages

	SAMPLE 1	SAMPLE 2
Beginning page	__________	__________
Title of section	__________	__________
400-token count end with 5 tokens	__________	__________
Variable A	____ x (-0.15) = ______	____ x (-0.15) = ______
Variable B	____ x (0.10) = ______	____ x (0.10) = ______
C1	__________	__________
C2	__________	__________
Variable C	____ x (-0.42) = ______	____ x (-0.42) = ______
Variable D	____ x (-0.17) = ______	____ x (-0.17) = ______
Constant	35.52	35.52
Predicted Readability Score:	__________	__________APPENDIX C

WORKSHEET FOR ANALYSIS OF INSTRUCTIONAL MATERIALS BEYOND READABILITY SCALES

Name of Book ______________________________

Workbook ______________________________

Publisher ______________________________

Proposed Grade Level ______________________________

Other Information ______________________________

Pick a story at the beginning, middle, and end of each level and analyze according to information requested below:

List New Words	Number of times reinforced	Reinforcements in next 3 stories

List New Words	Number of times reinforced	Reinforcements in next 3 stories

Looking at teacher's manual, list skills to be taught in this lesson:

Skills	Are they taught ?

Skills to be taught or reinforced in workbook	Check appropriate observation		
	taught	reinforced	neither

WORKSHEET FOR ANALYSIS OF INSTRUCTIONAL MATERIALS BEYOND READABILITY SCALES (ADAPTED)

Name of Book ______________________________

Workbook ______________________________

Publisher ______________ Proposed Grade Level ______________

Other Information ______________________________

Pick a story at the beginning, middle, and end of each level and analyze according to information requested below:

List New Words	Number of times reinforced	Reinforcements in 3 topic-related lessons in chapter of introduction

List New Words	Number of times reinforced	Reinforcements in 3 topic-related lessons in chapter of introduction

Looking at the teacher's manual, list skills to be taught in this lesson:

Skills	Are they taught ?

Skills to be taught or reinforced in workbook	Check appropriate observation taught	 reinforced	 neither

VITA

Robert A. O'Connor was born in Knoxville, Tennessee, on November 17, 1957. He attended St. Mary's Catholic Elementary School and was graduated from South High School in 1975. The following year he entered The University of Tennessee, Knoxville, and in June 1980 he received a Bachelor of Science degree in Special Education.

Robert was employed by the Anderson County School System in August 1980 and taught in resource and self-contained special education classrooms at the junior high and high school levels for the next seven years. Three of these years were spent teaching in an alternative self-contained program for special education students who had a variety of behavior disorders.

In 1987 Robert began teaching in the Oak Ridge City School System in an elementary resource classroom. He received his Master of Science degree in Special Education at The University of Tennessee, Knoxville, in June 1988. He participated in the STRIVE program at Oak Ridge National Lab during the Summer of 1990 and is involved in TN LEAD grant projects concerned with effective leadership and drug and alcohol prevention. Robert is currently teaching junior high resource in the Oak Ridge System. He will receive a Doctor of Education degree in Curriculum & Instruction at The University of Tennessee, Knoxville, in May 1991.