DOCUMENT RESUME

ED 423 142 | SE 061 787

AUTHOR	Wang, HsingChi A.
TITLE	Science Textbook Studies Reanalysis: Teachers "Friendly" Content Analysis Methods?
PUB DATE	1998-04-00
NOTE	22p.; Paper presented at the Annual Meeting of the National Association for Research in Science Teaching (71st, San Diego, CA, April 19-22, 1998).
PUB TYPE	Reports - Research (143) -- Speeches/Meeting Papers (150)
EDRS PRICE	MF01/PC01 Plus Postage.
DESCRIPTORS	Content Analysis; Decision Making; Elementary Secondary Education; Evaluation Methods; *Science Curriculum; Science Education; Science Teachers; *Teacher Attitudes; *Textbook Evaluation; *Textbook Selection; *Textbooks

ABSTRACT

This study focuses on designing a content analysis method that is real to daily instructional practice. The research questions explore the trends in conducting textbook content analysis method in science educational research, and how these trends address daily instructional needs. This paper also includes a review of literature on the role of instructional materials--especially textbooks--in science education research, a review of literature on past content analysis methods for science textbooks, a review of research of instructional needs and recommendations, and a proposal for a content analysis method for teacher education. Findings suggest that in order to design a teacher-friendly content analysis method, researchers must start to survey teacher needs. (Contains 48 references.) (DDR)

SCIENCE TEXTBOOK STUDIES REANALYSIS: TEACHERS "FRIENDLY" CONTENT ANALYSIS METHODS?

HsingChi A. Wang, Ph.D.

School of Education
University of Southern California

A paper presented at the Annual Meeting of NARST in San Diego, 1998.

Introduction

In 1976, the National Science Foundation called for an investigation of the status of science education. Subsequently, Weiss (1978) reported that the school science could be described with one word, *textbook*. Textbooks determined the content of instruction as well as teaching procedures in thousands of classrooms. Such a statement may not be accord with the usual theory in education, but it was reported by schools' supervisors and states' inspectors of instructional materials (Harms & Yager, 1981) year after year. Recently, the Third International Mathematics and Science Study (TIMSS) (Schmidt, McKnight, & Raizen, 1996) indicates that teachers throughout the world base about 50 percent of their weekly teaching time on textbooks. Textbooks persistently have had great influence on what is taught and how it is delivered in science.

Few individuals deny the important roles of science teachers in transforming current science education. However, while science teacher seems to use textbooks most of the time, it is curious that so little effort has been devoted to analyzing curriculum materials (Good, 1993); despite this urgent need. Among six Science Teaching Standards stated in the National Science Education Standards (National Research Council, 1996), one sub-standard of *Teaching Standard D* describes explicitly that

> Effective science teaching depends on the availability and organization of materials, equipment, media, and technology . . . Teachers must be given the resources and authority to select the most appropriate materials and to make decisions about when, where, and how to make them accessible. (NRC, 1996, p. 44-45)

However, without an effective and efficient approach to evaluating instructional materials, teacher preparation will always fail to provide the professional training in selecting, analyzing, and utilizing proper curriculum materials. Thus, deciding which materials, media and even textbooks to assist teaching becomes another uncomfortable chore required of teachers.

Research devoted to the analysis of texts has been conducted periodically throughout the history of education. The common methodology applied by researchers to examine science textbooks has been a form of content analysis. However, the content analysis method had no standard set of rules or guidelines. In general, textbooks studies claiming to apply content analysis were profoundly influenced by Berelson's (1952) ideology. To be objective and systematic, these studies usually excluded qualitative considerations of what "content" and instead simply counted qualities of the representative "content." A central idea in content analysis is classifying words of a text into a smaller number of content categories (Weber, 1985). By contrast, users of textbooks do not use textbooks in that quantitative fashion. To effective learning, the quality of the content is crucial, not the quantity of words in a content category.

To develop a more scientific and systematic approach for analyzing the quality of science textbooks, Krippendorff's (1980) approach to content analysis may be one solution. Krippendorff defined content analysis as a research technique for making replicable and valid inferences from data to their context. The means to a valid and replicable analysis depends on a clear set of frameworks, recognized as the "conceptual foundations" to guide the investigation. Accordingly, the past science textbooks studies conducted between 1989 to 1996 were generally based on two approaches to establish conceptual frameworks. The first approach is that a framework with theoretical support prior to content analysis will be generated, such as the "scientific literacy" framework generated by Chiappetta, Fillman, and Sethna (1991), and later applied by Lumpe & Beck (1996). The second approach is that the conceptual framework is explored, constructed, and refined during process of content analysis, such as the approach applied by Jeffery & Roach (1994) in their study of evolution protoconcepts. A question emerges from these two approaches, which approach is closer to teachers' approach when textbook-related decisions needed to be made?

In addition to conceptual framework matter, another issue emerges from the content analysis studies of science textbooks is the amount of texts for analysis. One trend is randomly selection of certain portions of the textbook, and another is whole textbook examination for a specific content. Garcia (1985) found randomly selection of 5% pages of each textbook being sufficient to represent textbook content. Hershey (1996) warns that the technique of randomly selecting science textbook pages for themes analysis may "easily skew the results because some chapters emphasize [one theme] much more than the other [themes]" (p.328). Yet, whenever teachers have to select a textbook, how much of the textbook was actually examined?

Purpose of the Study

This study is devoted to design a content analysis method that is real to daily instructional practice. Two guiding research questions will be answered before the method being proposed. 1) What are the trends for conducting textbook content analysis method in the science educational research? 2) To what extend do these trends address daily instructional needs? Specifically, this study wishes to recognize that what are the needs for science teacher educators to prepare qualified science teachers in terms of readiness in their capability of examining instructional materials like textbooks.

The structure of this paper is arranged as: review of literature on the role of instructional materials, especially textbooks in science education research; review of literature on past content analysis method for science textbooks; review of research of instructional needs and recommendations; conclusion and a proposal of a content analysis method for teacher education.

Roles of Textbooks in Science Education

Unlike the standards documents that seek to guide curriculum, instructional materials are concrete to practitioners, who use them in their daily routine. Instructional materials are what teachers and students use in their classrooms. Science textbooks have been known for decades as a dominant instructional tool in science education. It is the textbook in thousands of classrooms that determine the content of instruction as well as the teaching procedures.

This view may not be in accord with the usual theory of education, but it is supported by the facts as reported by supervisors and state inspectors of schools for the past few decades. Recently, this phenomenon was again evidenced by the Third International Mathematics and Science Study (TIMSS) (IEA, 1996), in which it is shown that teachers throughout the world use textbooks to guide their science instruction, with science teachers basing about 50 percent of their weekly teaching time on textbooks. Thus, science textbooks have great influence over how content is delivered and even what should be taught.

The TIMSS report also shows that the long-time admonition of "Less is More!" has rarely been followed. Even though the core science topics are similar across the 50 states, nevertheless, with state administrators selecting topics based on their visions of education, only a few topics are common to all the States. Thus, the highly competitive textbook market has caused publishers to include as many topics as they can, and this has resulted in the thickest textbooks found in the world -- however shallow they may be in content elaboration. The nature of the instructional strategies for teaching and learning a specific topic must be elaborated to provide teachers with appropriate idea about how to explore specific concepts with their students to reinforce learning. Addressing the problems associated with instructional materials is an important function of education reform.

Recognizing the role of science textbooks in instruction does not intend to encourage teaching by textbooks but to bring teacher educators' attention to such a need for teacher preparation. Such need was recognized by deBerg (1989), who described the difficulty science teachers have in gaining access to primary source materials relating to science. Thus, science teachers may turn to science textbooks, which are known for their shortage of authenticity. In addition to content issue, deBerg (1989) chose to examine the history of science in textbooks. He noted the lack of development of an *instructional sense* in the history of science content in textbooks. According to deBerg, the use of exercises, projects, assignments, debates, and discussions by students, which relate to the textbook's history of science content, are absent from all textbooks examined. It is possible that since the history of science is virtually nonexistent in the instructional sense, students are getting very little exposure to understand the purpose of the historical elements inclusion.

Ball and Cohen's (1996) idea of providing teachers with: a) comfort and confidence in content, and b) the pedagogy of the content; has not happened in teacher education yet. Such preparation is perceived as one indispensable component of teachers' willingness to change their instructional paradigm for innovative teaching. "Teachers are central to education, but they must not be placed in the position of being solely responsible for reform. Teachers will need to work within a collegial, organizational, and policy context that is supportive of good science teaching" (NRC, 1996, p. 27). Standards-based science education reform will need more than the documentation of science standards reports; there is a pressing need to investigate the readiness of science teachers to approach quality science teaching. As one criteria of quality teaching endorsed in standards document as indicator of wisely utilizing instructional materials, teacher education will need to address such emerging need.

Research of Content Analysis Methodology

> Content analysis is a research technique for making replicable and valid inferences from data to their context. (Krippendorff, 1980, p. 21)

To analyze textbook's content, a set of criteria or frameworks, recognized as the "conceptual foundations" that guide the investigation, is a must. Conceptual frameworks portray "prescriptive, analytical, and methodological purposes," which can avoid cursory and subjective analysis. The objective of this section is to review content analysis techniques commonly applied by researchers by scrutinizing the 31 studies of science textbook content analysis conducted during the years of 1989 to 1996.

Baker (1991), Finley, Lawrenz, and Heller (1992), and Lederman, Gess-Newsome, and Zeidler (1993) conducted summaries of science education research in 1989 and 1990, 1991, and 1992, respectively. Science textbook analysis from the three summary studies were integrated with recent science textbook studies during 1993 to 1996. A summary table (Table 1) of the research objectives (data needs), data sources, and methodology (instrumentation) suggests a wide number of content analysis approaches.

Table 1.

Summary Chart of Textbooks Content Analysis Research (1989-1996)

Author/Year	Data Needs	Data Source	Instrumentation
Anderson & Botticelli (1990)	Investigation in: • Quantitative techniques to measure texts' information organization • subjective evaluation of 12 common segments	• 4 introductory biology textbooks • 2 analysts	• numbering relevant sentences • established rules for identifying key words • 2 coding schemes (explicit & implicit) • progression density coefficient (contextual cue words & new words)
Barrow (1990)	• Identify Magnet concepts presentation styles • Identify Potential Magnet Misconceptions	10 elementary school science textbooks	• Recording the pages for specific concept • Composite rating instrument (p = prose; I=illustration; L=laboratory)
Bazler & Simonis (1991)	Gender equity presentation comparison between 1970's and present editions of texts	2 versions of each 7 high school chemistry textbooks:	Replicating a previous study in 1970 • frequency counts with 1970 study for coding scheme comparison • inter-rater reliability
Borger (1990)	Environmental content	science & geography textbooks & published curriculum guidelines for 7-12 graders in Ontario	• Environmental perspectives framework
Chiang-Soong & Yager (1993)	Science, Technology, & Society topics	• All pages of the 11 most frequently used science textbooks (Weiss, 1978) • 2 raters	• STS framework from project synthesis • inter-period rating technique (3 weeks) • intra-observer (consistency .98); inter-rater reliability .80
Chiappetta, Fillman, & Sethna (1991b)	4 Major themes of scientific literacy • knowledge of science • investigative nature of science • science as a way of thinking • interaction of science, technology, and society	• Randomly selected from life, earth, physical science, chemistry, and biology textbooks • 2 experienced raters & 1 raters trained by manual	• adopted & extended Garcia's (1985) categories • descriptors cards • rater's training manual • pilot study to justify the framework • inter-rater reliability & Kappa value for inter-rater agreement

Author/Year	Data Needs	Data Source	Instrumentation
Chiappetta, Sethna, & Fillman (1991c)	4 scientific literacy themes & expository learning aids	• 5% of the 5 most commonly adopted chemistry textbooks & 2 additional nationally recognized chemistry texts • 2 raters	• same procedures as previous study
Chiappetta, Sethna, & Fillman (1993)	4 major scientific literacy themes & Number of vocabularies included	5% of 5 middle school life science textbooks & the whole chapters specific devoted to "What science is?" from each textbook	Same techniques of their 1991 studies
deBerg (1989)	Emergence of quantification in pressure-volume problems; the sequencing from: • Learning Theory (sequencing, emergence, problem solving) • Nature & method of science	• 28 physics and chemistry textbooks • single rater	• Theoretical based conceptual framework
deBerg & Treagust (1993)	Gas law sequence, Modes of presentation on gas properties • qualitative modes • quantitative modes	• 14 secondary chemistry textbooks used in Australia • 104 teachers interviews	• content coding framework • teacher questionnaire
Eltinge & Roberts (1993)	Science as a process of inquiry • identify key words • identify relationship between key words	• 9 editions of high school biology textbooks *Modern Biology* (1955-1988)	• Linguistic content analysis (PLCA - computer analytic software) • logistic regression
Evans (1989)	• Discovery/ Inquiry/Process orientation • Hands-on activities inclusion • Reading & vocabulary demands	• 4th grade science teachers' manuals published by Silver Burdett & Merrill • 17 grade 4 teachers & 360 of their students were the raters	• modified CASST (Criteria for the Analysis and Selection of Science Text)
Fillman (1989)	4 major scientific literacy themes	• 5% of 11 Biology textbooks adopted by Texas State • 2 raters	• establish the appropriateness of Chiappetta, et al's analyzing manual

Author/Year	Data Needs	Data Source	Instrumentation
Glenn (1990)	Rosenthal's (1985) sub-topic of evolution: • origin of life • evidence for evolution • theories of evolution • human evolution • evaluation & creationism	• three publishers' high school earth science textbooks since the 1960-1989	• identify themes appearance • identify books' preference and introduction chapter's presentation styles of evolution • determine the extent of the presentation • detailed review the extensive coverage books but scanning the less coverage books
Hamm & Adams (1989)	Global Problems & Issues: • population growth • world hunger • air quality • atmospheric issues • water resources • war technology	• 10 grade 6 & 7 textbooks representing 90% used in California State • 5 raters	• Issuing survey to recognized 'experts' in science, science education, and engineering. • Analytic framework developed based on the survey's findings • rating instrument
Hehr (1989)	Scientific Literacy Preparation: • concepts (defined, partially defined, explained, example) • attitudes (present or absent) • processes skills (present or absent)	• chapters randomly selected from 25 Texas State adopted textbooks in life, earth, physical, and biological science • 5 secondary science teachers trained as raters	• Evaluation framework • Ground rules
Holt, Rinehart, & Winston	Science as Inquiry	• Selected chapters (genetics, leaf structure, & introduction) of 1956, 1965, 1977, & 1985 editions of *Modern Biology*	• Linguistic content analysis for categories • Regression analysis of the categories
Jeffery & Roach (1994)	Evaluation Protoconcepts (topics for preparing students study evolution in later year) • Geological time • Natural transition of earth environment • Variability & alteration of genetic makeup biotic potential	• 5 elementary & middle school earth science and life science textbook series (total 7 textbooks) by a textbook selection criteria	Conceptual content analysis (approaching the data "blind") • identify possible data • standardized the language • 17 concepts identified through qualitative exploring • established grounded theory

Author/Year	Data Needs	Data Source	Instrumentation
Lin (1990)	Current Goals of Science Education • nature of science • interrelationship of STS • openness of laboratory activities • types of questioning style	• Taiwan junior high school earth science textbook	• Framework • Intra-rater & inter-rater
Lloyd (1990)	Reading comprehension of photosynthesis content • detailed background information • analogies • examples	• 3 biology textbooks	• Conceptual framework (concepts of the requirements, the process, the products, & the by-products) • numbers & nature
Lumpe & Scharmann (1991)	Contemporary science education goals • scientific inquiry • problem solving skills • manipulative skills • observational skills	• selective Lab activities content in Modern Biology (1989) & BSCS Green (1987) • 2 raters	• Content Coding Scheme: 24 task categories under 4 major groups (planning & design, performance, analysis & interpretation, and application) • Inter-rater reliability .80
Lumpe & Beck (1996)	Scientific Literacy Themes adopted from Chiappetta, et. al (1991) Descriptive Information • no. of chapters • no. of pages • vocabulary included	• 7 Biology textbooks 5% randomly selected pages • 2 raters (ex-biology teachers)	• Same techniques as Chiappetta, et. al. (1991) • Inter-rater reliability
Otero & Campanario (1990)	Characteristics of comprehension	• 6 paragraphs of physical science passages (4 contains contradiction in the second and last sentences) • secondary science students	• rating 4-point scale • short responses on problematic sentences
Selden (1991)	• Whether Eugenics was presented as legitimate science • Eugenic social policies recommended	• 40 high school texts	• texts analysis • photographs analysis

Author/Year	Data Needs	Data Source	Instrumentation
Shepardson & Pizzini (1991)	Expository learning aids • cognitive level of questions (input, processing, output)	• Stratified sampling techniques for 17% of the high school science texts that represent 50% of national market (total 3140 questions were analyzed) • 2 raters	• An analysis scheme for classification of cognitive level of questions
Staver & Bay (1989)	• conceptual structural • reasoning demands	• 11 K-3 texts on topics of air & water	• conceptual mapping of 17 segments
Staver & Lumpe (1993)	The means of • introducing Mole concept • defining Mole concept • explaining Mole concept	• 29 high school & introductory college chemistry textbooks	• Cross reading-discussion • Reaching agreement between raters
Strube (1989)	Literary style of presentation (readability) • Distant authorial voice • precision • context • syntax • use of rhetorical style	• physics textbooks	no specification
Vachon & Haney (1991)	Level of Abstraction (LoA): the ratio of # of concepts w/o concrete examples to the total # of concepts in a text passage	• 9 samples of 200-word passages selected from 5, 7, 10 grades life, earth, & physical science textbooks. • 61 science teachers from elementary and secondary as raters • 11 teachers from 5, 7, 10 grades recognized the abstractness & students' comprehension	• 24 science educators to validate the identifying procedures • Cronbach's alpha & other criteria to construct the LoA score for each passage

General Research Questions That Require Content Analysis

A common kind of research uncertainty revealed in the 31 content analysis studies was; When a science instructional concept (such as scientific literacy, science as inquiry, equity in science, etc.) reaches a certain consensus among science educators, researchers usually begin to wonder what the status or readiness of science textbooks is, with regard to that specific concept -- since science teachers have been found to rely so heavily on textbooks. Almost every study cited in Table 1 investigated the weight a specific idea/concept carried in science textbooks, from a quantitative perspective. A quantitative approach focused on answering question such as "How many pages are or what percentage of a science textbook is devoted to scientific literacy?"

By comparison, a few researchers such as deBerg (1989), Wheeler and Hill (1990), and Jeffery and Roach (1994), conducted their studies from a more qualitative standpoint. A qualitative approach refers to a study of a specific concept's presentation style such as a mathematically oriented presentation of the pressure-volume concept, or the misconceptions produced by diagrams in science textbooks. From the 31 studies in Table 1 another type of research question, which requires content analysis indicated concern with the writing-related issues of science textbooks. For instance, Seldon (1991) investigated the use of propositions or analogies as learning aids, and Strube (1989) studied the literacy styles of science textbooks as they relate to science learning.

Common Data Sources for Content Analysis

Science textbooks and raters who conduct data collection are the data sources of textbook content analysis. There are two trends in deciding on the proportion of the text to use for analysis. Trend one is studies that randomly selected samples of the texts; five studies in Table 1 adopted 5% of the pages from each text. Trend two is a whole-text examination for desired content such as: STS inclusion in the whole texts or diagram characteristics of every text. Garcia (1985) asserted 5 percent of the pages of each textbook's findings sufficiently large to represent textbook content. Whereas, Hershey (1996) warned that the technique of randomly selecting science textbook pages for themes analysis may have "easily skewed the results because some chapters emphasize [one theme] much more than the other [themes]" (p. 328). The decision of whether to use sample pages or whole texts relates closely to the decision of "who will be the raters."

Krippendorff (1980) warned that utilizing a single rater leads to the weakest reliability of the resulting content analysis. To assure the reproducibility of any content analysis, two or more raters should perform the investigation. In addition, Krippendorff alerted researchers who adopt a multiple-rater technique that they have to strictly follow the rule of letting raters work *independently*; even the least communication between the framework designer and the raters is not to be allowed.

Some studies shown in Table 1 were examinations of entire texts, and since science textbooks are known for lengthy content, only one rater performing the test-retest during a certain period of time is common for a whole-text-analysis. This is because that there are too many pages for analysis and there are considerable difficulties in finding a skilled rater besides the procedure-developer. One investigator analyzed whole texts in the study by Chiang-Soong & Yager (1993), and three weeks later another randomly selected textbook had 50 pages randomly chosen from it for a second analysis. The 50 pages were given to another rater to perform the analysis. This method might provide researchers an alternative in reexamining their large amount of data. Chiappetta, Fillman, & Sethna (1991a) developed a 25-page training manual for novice raters. Raters practiced the technique according to the manual, before starting to analyze the texts assigned to them. When raters have comprehensive guidelines establishing how to perform content analysis, the problem of finding a skilled rater is minimized.

Common Instrumentation of Content Analysis

The methodology applied in these studies varied. The approaches ranged from merely counting words, paragraphs, or pages, using a self-defined framework; to simply adopting others' analyzing frameworks and procedures, applied to different data sources; or to utilizing thoroughly developed guidebooks incorporating a well-established framework through triangulation with "experts" (e.g., science educators, research findings, or educational organizations). Constructing conceptual frameworks or foundations is only the first step in establishing the validity of content analysis (Krippendorff, 1980). However, whether or not the frameworks do measure desired content (what they intend to measure), these approaches reflect a more serious need for content analysis. One noteworthy example of establishing a valid framework is a study by Garcia (1985), who chose scientific literacy themes to orient the research.

The frameworks of scientific literacy were developed through several stages. First, Garcia identified "descriptors" of scientific literacy by examining relevant literature and publications of science education organizations. Each descriptor was put on a card. Two science educators were given all the cards to categorize. The procedures generated four general but discrete scientific literacy themes, which became the conceptual framework. Garcia's framework was initially targeted at earth science. Chiappetta, et al. (1991b) extended the framework to physical and life science and chemistry. This framework was applied to five studies included in Table 1.

Another approach to obtaining a conceptual framework is oriented toward an exploratory style -- a qualitative approach. Adopting qualitative approaches to analyze written materials is a common technique used to obtain rich insights and in-depth understanding for "un-familiar" concepts (Dey, 1993; Miles & Huberman, 1994). Jeffery and Roach (1994) were interested in how "evolutionary protoconcepts" were being presented in elementary and middle school science textbooks. Because of the lack of a specific list of concepts identified as evolutionary protoconcepts before they started a content analysis study, their first task was to collect these concepts. Jeffery and Roach adopted a thematic-type approach, in which information (the associated 'terms') gleaned from the texts is clustered (classified, language standardized, tabulated, and evaluated) and presented by the theme (the evolutionary protoconcepts). Generating such a list of categories was not a linear process; researchers had to constantly go back to the texts simultaneously while analyzing the data in order to validate the categories. Jeffery and Roach's categories were grounded in the data collected. Moreover, their life science categories were additionally validated by matching with literature.

There is no single perfect approach to framework construction. Construction of a conceptual framework is closely tied to the nature of the study, and grounded with the purposes of the data needs. One rule is that in order to draw reliable inferences from the target texts, it is necessary to make valid classifications. A better result is obtained when concepts are well-grounded by the literature or validated by "experts." Thus, the next step is to elaborate on the establishment of general, simple, and ready-to-be-used procedures. The guidelines can help rater handle data "clerically." When less judgment is required during applying the conceptual framework, the more likely the technique is to be reliable (Krippendorff, 1980).

A different aspect of instrumentation seen in Table 1 relates to the statistical techniques applied. These studies commonly reported reliability of agreement. Inter-rater reliability is the agreement coefficient between two raters. Intra-rater reliability is the agreement coefficient of two coding results (test and retest). Krippendorff (1980) explained the calculation of agreement coefficient, in which maximum agreement is 1 and 0 means no agreement:

> Reliability is expressed as a function of the agreement achieved among coders regarding the assignment of units to categories. If agreement among coders is perfect for all units, then reliability is assured. If the agreement among coders is not better than chance . . . reliability is absent . . . reliability . . . always boils down to measuring the agreement achieved among observers, coders, or judges regarding how they independently process scientific information. (p. 133)

The agreement coefficient (α) is derived from a process considering percentages of "agreement by chance" (the agreement *presumably* occurred merely by chance), "observed co-occurrences" (the matched data set occurred between raters), and "maximum agreement" (the calculated maximum matched incidence rate occurred between raters). In defending the actual or "absolute" agreement value (the observed co-occurrence) instead of Krippendorff's agreement coefficient, Tinsley and Weiss (1975) suggested that the actual inter-rater agreement is more appropriate when the data is continuous (nominal scale). The agreement coefficient α is more useful for categorical data. However, Krippendorff (1980) asserted that the agreement derived from different raters always has the possibility of occurring by chance. "When the coefficient α is only 10% . . . conclusions to which such data would lead are largely misleading or true only by chance. The fact that 60% . . . matched, turned out to have no meaning" (p.135).

For nominal data, Fillman (1989) introduced Cohen's (1960) kappa because it takes agreement by chance into consideration. As reported by Chiappetta, et al. (1991b), the kappa statistic is applied to compute inter-rater agreement when (a) two raters are working independently, (b) the units of analysis are independent, and (c) the categories are independent, mutually exclusive, and contain nominal data. Krippendorff (1980) believed that there is no set answer for "how high the agreement is preferred?" He implied that the agreement coefficient is more context-grounded. Cohen's (1960) kappa, on the other hand, was agreed upon by Rubenstein and Brown (1984), which kappa greater than .75 indicates excellent agreement beyond chance; kappa between .40 and .75 represents fair to good agreement beyond chance; kappa below .40 indicates fair to poor agreement beyond chance.

All researchers in the Table 1 reported that a high reliability obtained. Despite the fact that most studies were not clear about data-type collected, the absolute agreement percentages were cited as evidence of "reliability." These studies are wholly deceptive in the ill-methods. Five studies in Table 1 reported kappa values to sustain their agreement coefficient. The study by Chiang-Soong & Yager (1993) included a disagreement percentage (disagreement among both sets of data) in their study to filter out "unreliable" data.

Data reliability is another feature explained by Krippendorff (1980) as one important statistical technique to be considered in content analysis. "The ultimate aim of testing reliability is to establish whether data obtained in the course of research can provide a trustworthy basis for drawing inferences, making recommendations, supporting decisions, or accepting something as fact" (p.146). There is no single study in Table 1 addressing data reliability.

Finally, Krippendorff (1980) urged that many preliminary and detailed reliability tests be conducted during the framework development stage and before the data reliability tests. This provides early warning of the potentially unreliable sources. It may lead to modifications of the analytic categories, changes in coding instructions, or decisions on choosing qualified raters.

Conclusions

Table 1 summarizes studies that applied content analysis to review textbooks by science educators published during 1989 to 1996. The four categories: research questions, research objectives (data needs), data sources, and methodology (instrumentation) has provided a database to reflect several issues such as reliability and validity in qualitative data analysis indicated by Miles and Huberman (1993). It also presented a few common strategies likely to be adopted when researchers conducted a textbook analysis. The reanalysis of past science textbook studies has suggested a wide numbers of content analysis approaches applied, and yet, there was no consensus in the criteria used to determine the appropriateness of such research methodology. This study found that most of the researchers had fragmented uses in content analysis as a textbook study method. Trends found in the reanalysis have provided a basis for inquiry of approach likely to be adopted by researchers.

With such information, questions arose for how these studies can be utilized by school science teachers. A pilot Textbook Decisions Questionnaires was designed and administrated by fifty-six science teachers at the Los Angeles Unified School District. The reliability (α) was not higher than .60, which indicated the need for revision. According to TIMSS population one (3rd and 4th grader) survey to school policy decision of determining textbooks, out of 189 schools sampled, there are 69 schools (36.5%) reports that teachers have greater responsibility in making the decision. Thus, there is a pressing need to further provided teachers with proper tools and skills that help them to make decision through study like this.

One crucial lesson learned from this pilot survey reflected TIMSS report – teachers tend to try to "use" all topics displayed in science textbooks (Schmidt, McKnight, & Raizen, 1997). Most teachers believed that the decisions of whether to adopt a science textbook or not is related to their future use of the book to guiding their instruction. Teachers also indicated that the when inspecting a science textbook, most of them tend to choose the section/topic interested them to examine. They tended to have limited time to make their final decision.

Lastly, while science textbooks still play a profound role in science instruction and learning, this study explored the need for generating an effective and efficient approach or "tool" to conduct examination in textbooks for science teachers. The gap between the approaches by researchers and teachers is wide. In order to design a teacher "friendly" content analysis method, researcher must start to survey teacher's needs.

References

Anderson, C. W., & Smith, E. (1986). Teaching science. In V. Koehler (ed.) The educator's handbook: A research perspective. New York: Longman.

Baker, D. R. (1991). Textbooks and text comprehension: What does textbook analysis tell us about the quality of science textbook? Science education, 75(3), 359-367.

Ball, D. L., & Cohen, D. K. (1996). Reform by the book: What is—or might be—the role of curriculum materials in teacher learning and instructional reform? Educational researcher, 25(9), 6-8.

Barrow, L. H. (1990). Elementary science textbooks and potential magnet misconceptions. School science and mathematics, 90(8), 716-720.

Bazler, J. A., & Simonis, D. A. (1991). Are high school chemistry textbooks gender fair? Journal of research in science teaching, 28(4), 353-362.

Berelson, B. (1952). Content analysis in communication research. New York: Free Press.

Borger, B. (1990). An evaluation of science and geography documents and texts in Ontario schools from an environmental perspective. Master's Thesis, Queen's University, Ontario, Canada.

Chiang-Soong, B., & Yager, R. E. (1993). The inclusion of STS material in the most frequently used secondary science textbooks in the U.S.. Journal of research in science teaching, 30(4), 339-349.

Chiappetta, E. L., Fillman, D. A., & Sethna, G. H. (1991a). Procedures for conducting content analysis of science textbooks. Texas: University of Houston.

Chiappetta, E. L., Fillman, D. A., & Sethna, G. H. (1991b). A method to qualify major themes of scientific literacy in science textbooks. Journal of research in science teaching, 28(8), 713-725.

Chiappetta, E. L., Sethna, G. H., & Fillman, D. A. (1991c). A quantitative analysis of high school chemistry textbooks for scientific literacy themes and expository learning aids. Journal of research in science teaching, 28(10), 939-951.

Chiappetta, E. L., Sethna, G. H., & Fillman, D. A. (1993). Do middle school life science textbooks provide a balance of scientific literacy themes? Journal of research in science teaching, 30(7), 787-797.

Cohen, J. (1960). A coefficient of agreement for nominal scales. Educational and psychological measurement, 20(1), 37-46.

deBerg, K. C. (1989). The emergence of quantification in the pressure-volume relationship for gases: A textbook analysis. Science education, 73, 15-35.

deBerg, K.C., & Treagust, D. F. (1993). The presentation of gas properties in chemistry textbooks and as reported by science teachers. Journal of research in science teaching, 30(8), 871-882.

Dey, I. (1993). Qualitative data analysis: A user-friendly guide for social scientists. New York: Routledge.

Eltinge, E. M., & Roberts, C. W. (1993). Linguistic content analysis: A method to measure science as inquiry in textbooks. Journal of research in science teaching, 30(1), 65-83.

Evans, R. H. (1989). Profiling elementary science teacher's manuals from different perspectives. A paper presented at the Annual Meeting of the National Association for Research in Science Teaching, San Francisco, CA. ED 306 088.

Fillman, D. A. (1989). Biology textbook coverage of selected aspects of scientific literacy with implications for student interest and recall of text information (Doctoral dissertation, University of Houston). Dissertation Abstracts International, 50, 1618-A.

Finley, F. Lawrenz, F., & Heller, P. (1992). Analysis of science textbooks. Science education, 76(3), 313-316.

Garcia, T. D. (1985). An analysis of earth science textbooks for presentation of aspects of scientific literacy. Unpublished dissertation. University of Houston.

Glenn, W. H. (1990). Treatment of selected concepts of organic evolution and the history of life on earth in three series of high school earth science textbook, 1960-1989. Science education, 74(1), 37-52.

Good, R. (1993). Editorial: Science textbook analysis. Journal of research in science teaching, 30(7), 619.

Hamm, M., & Adams, D. (1989). An analysis of global problem issues in sixth and seventh-grade textbooks. Journal of research in science teaching, 26, 445-452.

Harms, H., & Yager, R. E. (1981). What research says to Science Teaching, 3. Washington, D.C.: NSTA.

Hehr, T. J. H. (1989). Content validation of Texas State-Adopted life, earth, physical, and biological science textbooks. (Doctoral dissertation, Texas A & M University, 1988). Dissertation Abstract International, 49, 3247-A.

Hershey, D. R. (1996). Random samples not always best. The American biology teacher, 58(6), 328.

Jeffery, K. R., & Roach, L. E. (1994). A study of the presence of evolutionary protoconcepts in pre-high school textbooks. Journal of research in science teaching, 31(5), 507-518.

Krippendorff, K. (1980). Content analysis: An introduction to its methodology. Beverly Hills: Sage.

Lederman, N. G., Gess-Newsome, J., & Zeidler, D. L. (1993). Reading and writing. Science education, 77, 472-477.

Lin, S. H. (1990). An analysis of the earth science textbook used in junior high school in Taiwan in terms of new goals for science education and a comparison of it with a similar U.S. textbook. (Doctoral dissertation, University of Iowa.) Dissertation abstracts international, 51(5), 1567-A.

Lloyd, C. V. (1990). The elaboration of concepts in three biology textbooks: Facilitating student learning. Journal of research in science teaching, 27(10), 1019-1032.

Lumpe, A. T., & Scharmann, L. C. (1991). Meeting contemporary goals for lab instruction: A content of two secondary biology textbooks. School science and mathematics, 91(6), 231-235.

Lumpe, A. T., & beck, J. (1996). A profile of high school biology textbooks using scientific literacy recommendations. The american biology teacher, 58, 147-153.

Miles, M. B., & Huberman, A. M. (1993). Qualitative data analysis. Thousand Oak, CA: SAGE.

National Research Council. (1996). National science education standards. Washington, D.C.: National Academy Press.

Otero, J. C., & Campanario, J. M. (1990). Comprehension evaluation and regulation in learning from science texts. Journal of research in science teaching, 27(5), 447-460.

Rubenstein, R. A., & Brown, R. T. (1984). An evaluation of the validity of the diagnostic category of attention deficit disorder. American journal of orthopsychiatry, 54(3), 398-414.

Schmidt, W., McKnight, C., & raizen, S. (1997). A splintered vision: An investigation of U.S. science and mathematics education. London: Kluwer Academic.

Seldon, S. (1991). Selective traditions and the science curriculum: Eugenics and the biology textbook, 1914-1949. Science education, 75(5), 493-512.

Shepardson, D. P., & Pizzini, E. L. (1991). Questioning levels of junior high school science textbooks and their implications for learning textual information. Science education, 75(6), 673-682.

Staver, J. R., & Lumpe, A. T. (1993). A content analysis of the presentation of the mole concept in chemistry textbooks. Journal of research in science teaching, 30(4), 321-337.

Strube, P. (1989). The notion of style in physics textbooks. Journal of research in science teaching, 26, 291-299.

Tinsley, H. E., & Weiss, D. J. (1975). Research methodology. Journal of counseling psychology, 22(4), 358-376.

Vachon, M. K., & Haney, R. E., (1991). A procedure for determining the level of abstraction of science reading material. Journal of research in science teaching, 28 (4), 343-352.

Weber, R. P. (1985). Basic content analysis. Beverley Hills: SAGE.

Weiss, I. R. (1978). Report of the 1977 national survey of science, mathematics, and social studies education. Washington, D.C.: U.S. Government Printing Office.

Wheller, A. E., & Hill, D. (1990). Diagram-ease: Why students misinterpret diagrams. Science Teacher, 57(5), 58-63.

S8061787

U.S. Department of Education
Office of Educational Research and Improvement (OERI)
National Library of Education (NLE)
Educational Resources Information Center (ERIC)

ERIC®

REPRODUCTION RELEASE

(Specific Document)

I. DOCUMENT IDENTIFICATION:

Title: Science Textbook Studies Reanalysis: Teachers "Friendly" Content Analysis Methods?	
Author(s): HsingChi A. Wang	
Corporate Source: University of Southern California	Publication Date: April, 1998

II. REPRODUCTION RELEASE:

In order to disseminate as widely as possible timely and significant materials of interest to the educational community, documents announced in the monthly abstract journal of the ERIC system, *Resources in Education* (RIE), are usually made available to users in microfiche, reproduced paper copy, and electronic media, and sold through the ERIC Document Reproduction Service (EDRS). Credit is given to the source of each document, and, if reproduction release is granted, one of the following notices is affixed to the document.

If permission is granted to reproduce and disseminate the identified document, please CHECK ONE of the following three options and sign at the bottom of the page.

The sample sticker shown below will be affixed to all Level 1 documents	The sample sticker shown below will be affixed to all Level 2A documents	The sample sticker shown below will be affixed to all Level 2B documents
PERMISSION TO REPRODUCE AND DISSEMINATE THIS MATERIAL HAS BEEN GRANTED BY Sample TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC) 1	PERMISSION TO REPRODUCE AND DISSEMINATE THIS MATERIAL IN MICROFICHE, AND IN ELECTRONIC MEDIA FOR ERIC COLLECTION SUBSCRIBERS ONLY, HAS BEEN GRANTED BY Sample TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC) 2A	PERMISSION TO REPRODUCE AND DISSEMINATE THIS MATERIAL IN MICROFICHE ONLY HAS BEEN GRANTED BY Sample TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC) 2B
Level 1 ☑	Level 2A ☐	Level 2B ☐
Check here for Level 1 release, permitting reproduction and dissemination in microfiche or other ERIC archival media (e.g., electronic) *and* paper copy.	Check here for Level 2A release, permitting reproduction and dissemination in microfiche and in electronic media for ERIC archival collection subscribers only	Check here for Level 2B release, permitting reproduction and dissemination in microfiche only

Documents will be processed as indicated provided reproduction quality permits.
If permission to reproduce is granted, but no box is checked, documents will be processed at Level 1.

I hereby grant to the Educational Resources Information Center (ERIC) nonexclusive permission to reproduce and disseminate this document as indicated above. Reproduction from the ERIC microfiche or electronic media by persons other than ERIC employees and its system contractors requires permission from the copyright holder. Exception is made for non-profit reproduction by libraries and other service agencies to satisfy information needs of educators in response to discrete inquiries.

Sign here,→ please

Signature: HsingChi Wang	Printed Name/Position/Title: Research Associate	
Organization/Address: 2250 Alcazar ST. CSA103/HSC, LA. California 90033	Telephone:	FAX:
	E-Mail Address: hawang@scf.usc.edu	Date: 6-3-98

(over)

III. DOCUMENT AVAILABILITY INFORMATION (FROM NON-ERIC SOURCE):

If permission to reproduce is not granted to ERIC, or, if you wish ERIC to cite the availability of the document from another source, please provide the following information regarding the availability of the document. (ERIC will not announce a document unless it is publicly available, and a dependable source can be specified. Contributors should also be aware that ERIC selection criteria are significantly more stringent for documents that cannot be made available through EDRS.)

Publisher/Distributor:
Address:
Price:

IV. REFERRAL OF ERIC TO COPYRIGHT/REPRODUCTION RIGHTS HOLDER:

If the right to grant this reproduction release is held by someone other than the addressee, please provide the appropriate name and address:

Name:
Address:

V. WHERE TO SEND THIS FORM:

Send this form to the following ERIC Clearinghouse:

THE UNIVERSITY OF MARYLAND
ERIC CLEARINGHOUSE ON ASSESSMENT AND EVALUATION
1129 SHRIVER LAB, CAMPUS DRIVE
COLLEGE PARK, MD 20742-5701
Attn: Acquisitions

However, if solicited by the ERIC Facility, or if making an unsolicited contribution to ERIC, return this form (and the document being contributed) to:

ERIC Processing and Reference Facility
1100 West Street, 2nd Floor
Laurel, Maryland 20707-3598

Telephone: 301-497-4080
Toll Free: 800-799-3742
FAX: 301-953-0263
e-mail: ericfac@inet.ed.gov
WWW: http://ericfac.piccard.csc.com