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ABSTRACT

This project examines the degree to which fourth and fifth grade children can master the skills needed to operate a full-text CD-ROM database, the New Grolier Electronic Encyclopedia, following minimal instruction. Fourth and fifth graders in an elementary school receive a group introduction to the CD-ROM encyclopedia during their library orientation period. Two groups of 15 students each are chosen at random from each grade to receive a small hands-on training session with the encyclopedia. Each child then has one session alone with the experimenter to assess mastery of the encyclopedia using a checklist of pass-fail skills. Children are also asked a question about their preference for the CD-ROM or print encyclopedia for their next research project. The results yield descriptive data on the skill mastery and preference. The project shows that ordinary fourth and fifth graders can benefit from electronic encyclopedia training, but that adequate training sessions were required to make the learning as efficient and effective as possible. The appendices consist of a letter of permission and a consent form, specification for the test of electronic encyclopedia skills, the question about encyclopedia preference, and data analysis tables and figures. (Contains 21 references. (DGM)

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MASTERY OF CD-ROM ENCYCLOPEDIA SKILLS BY ELEMENTARY STUDENTS

A Master's Research Paper submitted to the
Kent State University School of Library and Information Science
in partial fulfillment of the requirements
for the degree Master of Library Science

by

Alice Stevenson

December, 1993

MASTERY OF CD-ROM ENCYCLOPEDIA SKILLS
BY ELEMENTARY STUDENTS

Choices about CD-ROM use in the school library or children's library must be made with an awareness of how cognitive development affects the information skills of children. Children who are not capable of abstract thinking may be unable to master the mechanics or the logic involved in searches. This project examines the degree to which fourth and fifth grade children can master the skills needed to operate a full-text CD-ROM database, the New Grolier Electronic Encyclopedia, following minimal instruction. Fourth and fifth graders in an elementary school receive a group introduction to the CD-ROM encyclopedia during their library orientation period. Two groups of 15 students each are chosen at random from each grade to receive a small group hands-on training session with the Grolier. Each child then has one session alone with the experimenter to assess mastery of the Grolier using a checklist of pass-fail skills. Each child is also asked a question about their preference for the CD-ROM or print encyclopedia for their next research project. The results yield descriptive data on the percentage of students to achieve mastery of each skill. Differences by age are highlighted in the variables skill mastery and preference. The results will be used to develop a plan for introducing the electronic encyclopedia into the library program.

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INTRODUCTION

CD-ROM technology has been embraced enthusiastically by many kinds of libraries. The possibility of unlimited, full-text searching minus the costs of online services makes the CD-ROM especially appealing to the smaller library. As databases on CD-ROM have become more affordable, even school media centers have been able to add the technology. This study arises from an increasingly common scenario: the acquisition by an elementary school of a Macintosh workstation and a full-text database, the New Grolier Electronic Encyclopedia.

Databases such as the electronic encyclopedia are being heavily marketed for this age group. The Grolier CD-ROM disk (1991 edition) contains the complete text of the 21 volume Academic American Encyclopedia including more than 2,000 pictures, maps, and sounds. Several modes of searching are permitted. The simplest, the title index and the word index, allow the user to scan and select from a list of close matches. Complex Boolean searches may also be performed using AND, OR, and NOT to combine terms. Truncation and proximity settings may be used to control the scope of the search. Articles may be saved on a "notepad" and printed. The New Grolier is available in a Macintosh as well as an IBM version. The Macintosh version uses pull-down menus and icons for a relatively user-friendly format.

Other CD-ROM encyclopedias are now available (such as the Compton's MultiMedia Encyclopedia and the World Book's Information Finder), but the Grolier is popular because of its low cost and because it was the first on the market. One major disadvantage of

the Grolier in use with children is that it contains the text of an encyclopedia which is targeted at secondary and middle school students. See Dickinson (1990) for a discussion of how to critically evaluate CD-ROM encyclopedias; and Trivette (1990) for a comparison of the three electronic encyclopedias mentioned.

However, little information is available to the librarian about how to use the electronic encyclopedia with elementary school children. Few studies have been done on training the average elementary child to make use of the features of a CD-ROM database. Is there a good match between the cognitive abilities of elementary age children and the complex skills required to operate such a database? Are children unable to make use of the powerful searching capabilities that are a major advantage of CD-ROMs? Will they require extensive training and assistance by the librarian in order to use even the simplest searches? Will they be frustrated and discouraged by their first exposure to the CD-ROM database? Poor choices will result in the expensive technology sitting unused.

As a first step in deciding how to integrate the CD-ROM into a school library, this study will examine the ability of fourth and fifth grade children to master some of the skills involved in operating the Grolier database following minimal training.

LITERATURE REVIEW

The relevant literature will be examined in four sections: a theoretical background on cognitive development; studies involving novice adult searchers; studies involving secondary school students; and studies involving elementary school students.

Cognitive Development and Library Skills

Research done by psychologist Jean Piaget suggests that children and adults have different ways of thinking; indeed, so do young children and older children. This difference is due to more than the amount of information to which they have access. Piaget's studies indicated that there are four major stages of cognitive development in children (Rohwer, Ammon, and Cramer 1974). During infancy the child passes through the "sensorimotor" stage. He is learning concepts through motor activities and sensory exploration. The next developmental period, the "preoperational", covers ages two to seven. The child is learning the concept of symbolic representation and is beginning to deal with objects that are not physically present in time or space. His thinking is still egocentric and based on direct experience. The third stage, the period of "concrete operations", covers roughly ages seven to twelve. The child is beginning to develop thought that is flexible and reversible, and to identify with other points of view. However, true critical reasoning based on a logical analysis of a hypothetical situation is not developed until the last stage, that of "formal operations", during adolescence.

Carol Kuhlthau points out that many times library research assignments are given to children with no understanding of their stage of cognitive development (Kuhlthau 1987, 46). She has adapted Piaget's concepts to create a sequential library skills program for the school library (Kuhlthau 1981). For example, second graders, who operate on a concrete level, are to locate the encyclopedias in the library and find a topic with adult assistance. Third graders are to learn that encyclopedias are a source of information about people, places and things, and how to use the alphabetical arrangement of volumes to find articles. Fourth graders learn how to use the encyclopedia's index volume as a starting point for research. Not until fifth grade, when children approach the age of abstract reasoning, should they be asked to use a combination of sources to prepare a written report.

Moore and St. George (1991), in a study of children as information seekers, also observe that children as young as eleven years are often incorrectly assumed to have many of the skills needed for completion of independent research projects. Rather than using Piaget's stages, their theoretical framework makes the distinction between cognitive and metacognitive skills in information seeking. Metacognition involves "thinking about thinking" and is required for planning, monitoring, and regulating the information search process. Moore and St. George show that metacognitive abilities are necessary to conduct a card catalog search.

The studies cited above are limited in that they deal only with traditional print-based library skills (reference books, card catalogs, etc.) There is a need for studies that approach electronic search skills from a developmental point of view.

Studies With Novice Adult Searchers

Although the results may not be generalizable, the following studies with adult novice searchers yielded some helpful suggestions regarding data collection methods for a developmental approach. Both studies used methods which were more than a summative evaluation of the final product of the search.

Puttapithakporn (1990) performed a case study of novice searchers to identify and categorize the problems they encountered in a database-searching task on ERIC on SilverPlatter. Three procedures were used to gather data: participant observation during the search session, a self-administered questionnaire on perceived problems, and informal interviews with selected subjects. Bostian and Robbins (1990) attempted to discover the best method of CD-ROM instruction by assigning college students to one of four levels of instruction prior to their first search on SilverPlatter's PsycLIT database. The searches were saved to disks and were rated by assigning points for performing various actions such as successfully entering a search statement regardless of content, using a Boolean AND, using truncation, etc. A Likert-type questionnaire was also administered to measure reaction to the CD-ROM. The only level of instruction that resulted in a significant difference in the variables "search strategy" and "reaction to search" was exposure to a live demonstration.

Studies With Secondary School Students

Piaget's theory would predict that adolescents, who have attained the highest cognitive level, should be able to handle CD-ROM logic. Current practice in the school library does not

contradict this. Mendrinos, in a survey of 381 secondary school media specialists in Pennsylvania and Maine, found that 80 percent were already using CD-ROM workstations. She concluded that "the information literacy process is stimulated and perpetuated by the use of high tech tools" (Mendrinos 1992, 29). In her survey, the most highly ranked commercial databases were the electronic encyclopedias, with Grolier's being first.

Two studies will serve as examples of the abilities of high school students to learn CD-ROM search techniques. Both projects involved Gary Marchionini, who has been a leader in the investigation of electronic information search skills. Barlow, Karnes, and Marchionini (1987) looked at the introduction of the Grolier into a high school library. Of particular interest was the ability of students to use the most complex Boolean searches as well as the simpler "browse" mode. Students were not hesitant to try Boolean searches but there was some confusion resulting in inefficient searches. The researchers felt it was most important to note that students <u>were</u> successful in finding the information they needed.

The second study, by Liebscher and Marchionini (1988), compares the effectiveness of "browse" and "analytical" CD-ROM search strategies in a more controlled environment. Students in a ninth grade science class received Grolier training emphasizing either a simple "browse" strategy or an "analytical" strategy. On the basis of two kinds of data (keystroke data captured during the search and an essay grade), no significant differences were found between the two groups. The study had several major difficulties including lost keystroke data and an unexplained failure of four students to produce an essay. The experimental design did not control for confounding variables such as length of time between

training and search session, and the writing ability of students. One conclusion of the experimenters is consistent with the previous study: that high school students can be successful in applying powerful information systems with minimal training.

Studies with Elementary School Children

Few studies have been done involving searching electronic databases with elementary students. A study by Marchionini and Teague (1987) trained children to search the online version of the Grolier. Children in a gifted and talented program were allowed to use the online encyclopedia to write reports on topics of their own choosing. The primary group (second and third grade) was compared to the upper group (fourth through sixth grade); overall, no significant differences were found in the various measures used. Three crucial factors limit the generalizability of these findings: the small sample size, the selection of gifted subjects, and the failure to use a standard search question. It is not possible to be sure that differences between the groups are not due to differences in the complexity of search questions.

The same use of gifted children limits the usefulness of an otherwise exceptional study by Marchionini of information-seeking strategies of children using the Grolier (Marchionini 1989). Twenty-eight third and fourth graders and twenty-four sixth graders in a gifted program experienced two demonstrations of the Grolier and then conducted two searches of assigned questions. Three outcome measures were considered: success, time to complete the search, and total number of tactics used. Complex statistical operations were conducted on the data to determine information-seeking patterns, but the most interesting results came from the observer's field notes. Younger students were more likely to

enter actual sentences as queries rather than appropriate terms. Subjects inappropriately used Boolean AND to further narrow an unsuccessful search. Disturbingly, they sometimes called up pertinent articles--even ones in which the first paragraph held the necessary answer--and then rejected them. On the whole, subjects showed a lack of strategy but were eventually able to retrieve relevant articles. Older searchers were more successful overall.

As a children's librarian evaluates the literature on use of CD-ROMs with children, several vital research needs can be distinguished:

1. The need for more studies with younger children before CD-ROM databases are indiscriminately added to the library. Children's librarians should not make choices on the basis of publisher promotions or glowing reports from older age groups.

2. The need for studies with average children on the database rather than gifted children. Results using gifted children will be seriously biased for normal applications.

3. The need for results in a form which may be used by the librarian in devising a library skills program. Esoteric information on search patterns may be of help to scientists designing computer interfaces, but the librarian or teacher will be helped more by information on the results of teaching specific skills to children of a certain age. For example, at what age do children master various CD-ROM skills? In what order should skills be presented?

4. Finally, the reviewed studies were done on older versions of the database. Technology changes rapidly, and new electronic encyclopedias have exciting features which may make them easier to handle and more fun for younger children.

METHODOLOGY

Objectives

This project will attempt to address those needs by making a study of fourth and fifth graders, randomly selected from an elementary school and therefore assumed to have a range of abilities, operating the New Grolier Electronic Encyclopedia, 1991 edition (NGEE). All students receive the same training, which is described in detail in the methodology section. Two variables will be studied: "skill mastery" and "preference".

The study asks the research question, What percentage of children can master each individual NGEE skill following training? The examiner has conceptualized these skills as falling into three groups, in a pattern suggested by the Liebscher and Marchionini study (1988) and the Marchionini analysis of the information-seeking task (1992). Ten of these skills have been chosen for training and testing in this experiment.

Article manipulation skills are those needed to examine and extract information from an article which has already been located. These skills are fairly concrete and produce instant feedback in terms of information delivery.

Skill 1. Scanning the article
Skill 2. Calling up related tables, outlines, factboxes
Skill 3. Finding pictures
Skill 4. Finding sounds
Skill 5. Printing the article

Simple information search skills use only a single word or title to call up an article (or picture) from an index list. A simple "scan and select" strategy is sufficient.

Skill 6. Performing title index search
Skill 7. Performing word index search
Skill 8. Performing picture index search
Skill 9. Performing map index search

Complex information search skills involve combining terms with Boolean operators.
Skill 10. Performing Boolean AND search

"Skill mastery" will be measured by evaluating the child's success in solving problems posed by the examiner. Three problems are posed for each of the ten skills. If the child can solve three out of three problems, he/she will be said to have mastered that skill. (The development of the test of electronic encyclopedia skills is described in a later section.)

The study also asks the research question, What percentage of children prefer the CD-ROM to the print encyclopedia following training? "Preference" will be defined on the basis of response to the question, "Which kind of encyclopedia would you prefer to use for your next library research project--the electronic encyclopedia or the print encyclopedia?"

In addition to collecting descriptive data, the data on skill mastery and preference will be compared as a function of grade level (fourth and fifth grade compared). Piaget's developmental theory would predict the older children would perform better than the younger children, especially in the more complex searching skills. The following research hypotheses are of interest to the media specialist because a significant difference in the skill mastery or preference between grade levels would imply that different policies should be instituted for the different grades in areas such as supervision and computer privileges. These hypotheses will be tested, using a chi-square test of significance:

H_{1-10}: Following training, more fifth graders will demonstrate mastery of a NGEE skill than fourth graders (each skill tested individually).

In regard to preference, both groups are expected to have a good response to the electronic encyclopedia. However, older children are expected to experience less frustration and have a better attitude toward the CD-ROM search than younger children. The following hypotheses will be tested:

H_{11}: Both groups will state a preference for the NGEE over the print encyclopedia for their next research project.

H_{12}: A greater proportion of fifth graders will state a preference for the NGEE than fourth graders.

Experimental Design

The descriptive aspect of this study seeks to find information about the encyclopedia skills and preference of children in fourth and fifth grades. The random sampling of subjects (described below) is expected to measure the dependent variables with less sampling bias than the use of intact classes or teacher-selected subjects. Two instruments were devised for collecting data: a test of electronic encyclopedia skills and a brief questionnaire of encyclopedia preference. The creation of these instruments is described in the following section.

However, it was also of interest to the experimenter to test the observed data to see whether or not there would be a significant difference in skills and preference between the grade levels. Because of the limited scope and exploratory nature of this project, a pre-experimental design was chosen--a post-test comparison of static groups. It was impractical to use a pre-test to measure score change because no subjects had CD-ROM skills before training.

This design does have a weakness: it is not possible to be sure that the groups are equal in respect to all factors except the independent variable. The design would have been improved by matching subjects, perhaps using their Iowa Cognitive Abilities Test scores, but it was not possible to have access to school records. Attempts were made to control for situational differences by treating all subjects exactly alike. For example, all subjects experienced the same training procedures, used the same apparatus in the same room, and took the same test items with identical test instructions. To limit the possibility of introducing confounding variables related to reading, spelling, and writing abilities, the test instruments were designed to require very little reading. In all cases, the question is both read aloud and shown to the student, who merely indicates the answer or performs the search correctly.

Subjects

All subjects are students at Robert Frost Elementary School, a K-5 public school in Westerville, a suburban Columbus (Ohio) community. The ethnic group breakdown of the school district as a whole is 91% white, 7% black, the rest other (Westerville City Schools 1992). Total enrollment of the Robert Frost School is 486, of which 84 are fourth graders and 84 are fifth graders. The report of building averages for the Cognitive Abilities Test (test date 3/92) indicates that the current class of fourth graders was at the 62nd percentile in verbal ability and the 71st percentile in quantitative ability, when compared with national norms. The current class of fifth graders was at the 69th percentile in verbal ability and the 78th percentile in quantitative ability, when compared with national norms. It is assumed that the

school's students would represent a distribution which is essentially normal, and random sampling would result in a wide range of abilities. It was not possible to have access to individual student records (grades or results of standardized tests) to confirm this assumption.

A stratified random sample of 15 fourth graders and 15 fifth graders was selected to participate in the study. The subjects were selected by listing all students in fourth and in fifth grades, and then generating two lists of random numbers using standard random number tables. The first 15 students matching each random number in each grade were chosen. Any child who later stated experience with the Grolier Electronic Encyclopedia would have been eliminated, and replaced with the next number on the list. (This situation did not occur.) All students did have class experience with the Apple II computer, largely with educational games.

The Human Subjects Review process was followed. The consent form relating to this process is in Appendix A. Written consent was obtained from parent and child; verbal assent was also obtained from the child before beginning training/testing. The students were assured that the test results would not affect their grades or be added to their school records, and that individual results would not be published or revealed to teachers.

Apparatus

The electronic encyclopedia was the New Grolier Electronic Encyclopedia (1991 edition). Searches were conducted using a Macintosh LCII computer with a color monitor, driving a NEC "Intersect" CD-ROM disk reader, and an ImageWriter printer. The computer workstation was in a private room in the media center.

Training and Testing Procedures

As instructional method was not an independent variable, all subjects received the same training. The first contact all subjects received with the Grolier was a brief introduction which was presented to every fourth and fifth grade class in the school by the media specialist as part of library orientation. Advantages and disadvantages of CD-ROM and print encyclopedias were discussed. It was stressed that both methods were useful means of obtaining information.

The subjects participating in the experiment were then scheduled to receive hands-on training in groups of three students. (Student absences and teacher schedule conflicts caused some groups to have two students.) Under the direction of the examiner, each child observed and conducted exercises using the ten NGEE skills. Each group experienced the same searches in the same order. The training sessions lasted 45 minutes and occurred during the afternoon library periods. For the purposes of this experiment, it was necessary to adhere to a rigid training routine. However, students were assured that they would be permitted more practice with the encyclopedia after the experiment was concluded.

Following training, each child had an individual session with the experimenter to assess mastery of the skills presented. Each testing session occurred within two school days of the training session; this minimized the effects of different lengths of time between training and testing. First, the experimenter conducted the test of the skill mastery (see below). Then, the preference question form was shown and read out loud to the student, and

he/she was asked to answer it immediately and leave it in a sealed box at the testing desk.

Test of Computer Skill Mastery

It was necessary to develop an instrument to measure the variable "skill mastery". The test which has been designed attempts to measure ten key skills that learners must master on their way to becoming NGEE encyclopedia masters. According to Popham (1981), the most appropriate way to measure the student's skill mastery in this situation is through the use of a criterion-referenced test, rather than a norm-referenced test. A criterion-referenced test references the examinee's performance to a defined set of criterion behaviors, the behavioral domain.

As previously mentioned, the examiner's analysis of the NGEE suggests that successful use requires basic skills which might be subdivided into three areas. First, article manipulation skills are those needed to examine and extract information from an article which has already been located. This would include skills of scrolling though the article and calling up related tables, outlines, factboxes, pictures, and sounds. Printing the article is also included in this category. These skills are fairly concrete and produce instant feedback in terms of information delivery. The next skill level is that of the simple information search. This is a search that uses only a single word or title to call up an article (or picture) from an index list. A simple "scan and select" strategy is sufficient. The most difficult level is the complex information search. This involves combining terms with Boolean operators. Only the Boolean operator AND was included in the current test, due to training time limitations. In all, ten skills were selected for testing. These skills were

refined and verified by consultation with the school's media specialist. According to Popham, this item analysis stage helps to ensure the content validity of the instrument being prepared.

The next step, following Popham's program, was to generate test specifications for constructing the criterion-referenced test. Rigorously following this procedure helps improve the reliability of the test, because each item is designed to cover the same area, be of the same type, and have the same level of difficulty. A set of test specifications was generated for each of the ten skills. Each set of specifications includes an objective, a sample item, the stimulus attributes (the question format and instructions which will be presented to the subject), and the response attributes (the form the subject's response will take). This material may be found in Appendix B.

Using these specifications, three test items were selected for each skill. Following the suggestions of Berk (1984, 135) each item was reviewed at this point for content bias--language that is stereotypic, culture specific, or offensive to particular sex or racial or ethnic subpopulation. A list of the test items is found in Appendix C.

Standards were set for achieving mastery of the skills. If a subject correctly answers three out of the three items, he is said to have mastered the skill. A checklist form was constructed for administering the test. The checklist may also be found in Appendix C. The test and checklist were field-tested on a fourth grader and a fifth grader who had been trained (the examiner's own children.)

In the future, it would also be desirable to collect empirical data on the validity of this test. For example, the test could be administered to a group of known masters of the

various skills of the NGEE and also to a group of novices. The extent to which the items discriminate between masters and nonmasters could be calculated. At this preliminary stage it was not possible to conduct this analysis because there was no group of "masters".

All the training and testing was to be done by a single experimenter, so inter-rater reliability was not a factor. However, consistency of scoring was verified by having the library media specialist observe some sessions and give a second opinion on the experimenter's scoring.

Questionnaire on Encyclopedia Preference

In order to measure the variable, "preference", a one-item question sheet was presented to the student. The question was also read out loud: "Which kind of encyclopedia would you prefer to use for your next library research project--the electronic encyclopedia or the print encyclopedia?" The student was asked to answer the question privately by circling his choice on the answer sheet, and to drop the sheet into a box before leaving the testing room. Questionnaires were identified only with the grade level of the student. This assurance of confidentiality was to reduce the chance of the student fearing to displease the experimenter by giving the "incorrect" answer. The question sheet appears in Appendix D.

ANALYSIS OF DATA

The results are organized into three categories: Skill Mastery Data; Preference Data; and Discussion of Results. The GreatWorks spreadsheet program was used in the calculation of results and the preparation of charts.

Skill Mastery Data

The data collected is in the form of pass/fail frequencies. A set of 10 contingency tables (Appendix E, Table 2) has been constructed. To answer the descriptive research question, What percentage of children can master each individual NGEE skill following training?, the data is also expressed in percentage form and displayed graphically (Appendix E, Figure 1). In summary, these are the descriptive results, when both grades are grouped together:

1. Four skills had mastery percentages of 100% to 97%. All of these skills are article manipulation skills: scrolling through the article, and finding associated pictures, sounds, factboxes, or outlines.

2. The three next most difficult skills included performing the title search (93%) and the map search (93%). Printing an article (83%) was also of moderate difficulty.

3. The three hardest skills were performing the Boolean AND search (73%), the word index search (63%), and the picture index search (60%).

Next, the research hypotheses were tested in order to determine if students differed in their NGEE skill mastery by virtue of their grade level. Before testing the research

hypotheses H_1-H_{10}, it is important to note that no assumptions can be made about a normal distribution of responses. In criterion-referenced tests, items are not selected with the purpose of creating a wide range of scores. They are selected on the basis of how well they measure the specific set of instructional objectives (Ary, Jacobs, and Razavieh 1990, 229). For some skills, almost all students may achieve mastery. For other skills, very few students will achieve mastery. Moreover, data is measured on an ordinal scale (pass/fail). For these reasons, a nonparametric statistic, the chi-square test of independence, was used to find whether or not there is a significant relationship between the variables "grade level" and "skill mastery". For each skill, the null hypothesis is that the number of students achieving mastery in fourth grade is equal to the number of students achieving mastery in fifth grade. The alpha level was set at .05 and the degrees of freedom at 1. The value of the chi-square statistic and the results for each skill are included in Table 2 (Appendix E). None of the null hypotheses were rejected; there was no evidence for a significant difference between fourth and fifth graders on any of the computer skills.

Preference Data

The data collected is in the form of frequencies of electronic/print preference. To determine if students differed in their preference by virtue of grade level, a contingency table was constructed (Appendix E, Table 3). To answer the descriptive research question, What percentage of children prefer the CD-ROM to the print encyclopedia following training?, the data was also expressed in percentage form and displayed graphically (Appendix E, Figure 2).

The chi-square test was also used to test research hypotheses H_{11} and H_{12}. For H_{11}, the null hypothesis is that the number of students preferring the electronic encyclopedia is equal to the number of students preferring the print encyclopedia. For H_{12}, the null hypothesis is that the number of fourth grade students preferring the electronic encyclopedia is equal to the number of fifth grade students preferring the electronic encyclopedia. For each test, the alpha level was set at .05 and the degrees of freedom at 1. The value of the chi-square statistics and the results are included in Table 3 (Appendix E).

Results showed a significant preference for the electronic encyclopedia, supporting H_{11}. However, H_{12} was not supported. There was no evidence to support a conclusion regarding a difference between fourth and fifth graders on encyclopedia preference.

Discussion of Results

On the basis of this experiment, several observations may be made regarding the use of the Grolier Electronic Encyclopedia with elementary school children.

1. Children were delighted with the electronic encyclopedia. A typical comment was "Awesome!" The ease of performing the search was celebrated almost as highly as the exciting pictures and sounds. Most requested to use it for their next research project. One child was overheard to say he hoped his teacher would assign a report soon; many others entered the library asking if it was available for general use yet. It appears this new technology will have a favorable impact on student motivation.

2. Most children experienced a high degree of success with the electronic encyclopedia. Following a single training session, nine out of ten fourth and fifth graders can perform a simple title search, and almost 100% of children are able to extract some information from an article that has been retrieved. With practice, mastery totals should increase.

3. Fourth and fifth graders seemed to perform equally as well on encyclopedia skills. It is likely that fourth and fifth graders are too close in age for the difference to be apparent. This does suggest that the media center may use the same policies regarding adult supervision and training methods for both grades.

4. The encyclopedia's use of different systems to search different indexes was confusing to many children. The majority of children who failed to master these skills did not search in the wrong index; instead, they could not remember how the correct index operated. The skill of categorizing subjects, which is required to operate the picture index, proved to be even harder than performing the Boolean search.

CONCLUSIONS

The Grolier electronic encyclopedia is a powerful and exciting reference tool in CD-ROM format. One of its greatest strengths is that it is based on a highly rated print encyclopedia, the Academic American Encyclopedia. Paradoxically, this strength is in some ways a weakness when the encyclopedia is used with elementary school children, because of the difficult reading level.

This research project has shown that ordinary fourth and fifth graders can benefit from electronic encyclopedia training; the CD-ROM need not be restricted to the "able and talented" class. The project has identified which encyclopedia skills children are able to master following a single training session. It is recommended that elementary children be taught how to operate the easier title index as their primary means of research; all pictures and maps may also be retrieved through the title search. Boolean searches should be reserved for a second lesson for those students who have mastered the simple searches. The test which was developed in this project would be a useful instrument to identify children who have mastered basic skills.

However, making the CD-ROM encyclopedia available to all students creates a new problem: at the school where this experiment was conducted, there are almost ninety children in each grade to train. Future projects with the Grolier Electronic Encyclopedia should revolve around refining the training sessions and making the process as efficient and effective as possible.

Questions that deserve further research include: What is optimum size for the training group? Can students learn skills adequately in a larger group? How long should the training session be? Would it be beneficial to present less information at a time and reserve the more complex searches for those students who have shown mastery of the easier skills? Could student "masters" function as peer tutors? Future experiments may involve exploring the abilities of student "masters" to handle even more complex search strategies such as the different kinds of Boolean searches, truncation, saving articles on notepads, etc. Finally, extending research to the abilities of children in the lower primary grades is also a future goal. It may still predicted that the younger the child, the less he/she will be capable of mastering complex computer skills.

While children can master certain basic search skills on the electronic computer, it does not necessarily follow that the Grolier is the best choice for the elementary school media center. It would be of interest to see what use the students are actually making of the adult-level articles they have retrieved. A comparison of student reports prepared with the Grolier encyclopedia and other encyclopedias (print as well as CD-ROM) would be enlightening. Teacher surveys and content analysis of student reports may be suggested.

The results of the current study are expected to have applications on several levels. First, the data is being used to construct an electronic encyclopedia training program for all fourth and fifth grade students at Robert Frost School. Supplemental materials, including an instruction manual, are being prepared. The current study is seen as only a portion of a larger project of integrating the CD-ROM into the school library. The

training and assessment process, when performed with all grades, is a vital stage in determining library policies for computer research in the media center.

Although this study is limited to the Grolier encyclopedia database, the skills taught to children must be presented in a fashion which will increase transferal to other CD-ROM databases they will encounter at this library and others. Already a newer "multimedia" version of the Grolier encyclopedia is on the market; and the school is also considering the purchase of a second CD-ROM encyclopedia such as the Information Finder. The conceptual division of skills into article manipulation, simple search techniques, and complex search techniques is expected to improve training transferal.

It is hoped that the information will be applicable to children in other schools, at least within the school district, which are considering adding CD-ROM technology. For example, inservice workshops are being planned for the other media specialists within the district. The findings should also be of interest to local public libraries. As Tenopir has mentioned in her article on changes wrought by CD-ROM, "one of the most fundamental changes is a shift in the expectations of library patrons" (Tenopir 1991, 110). Students who routinely use CD-ROM databases in their school library will expect, even demand to find them in their public libraries.

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APPENDIX A

LETTER OF PERMISSION AND CONSENT FORM

CONSENT FORM: MASTERY OF CD-ROM ENCYCLOPEDIA SKILLS BY ELEMENTARY STUDENTS

I am a graduate student at Kent State in the field of library science. I want to do research on the ability of elementary students to master electronic encyclopedia skills following brief training. This will help Robert Frost School decide how to integrate CD-ROM technology into the library skills curriculum. I would like you to let your child,_____, take part in this project. If you decide to do this, your child will be asked to receive training from me on the Grolier Electronic Encyclopedia and then have his or her mastery of ten skills assessed. This will involve two sessions of 45 minutes each over a one or two week period. The sessions will usually occur during your child's library/computer period.

Perhaps you might be concerned that your child would feel pressure in this situation. Let me assure you that this project will not affect your child's school grades in any way, and that the individual results will not be published or made available to the child's classroom teacher. Nor will your child's school records be made available to me.

All fourth and fifth graders at the school will eventually receive training on the electronic encyclopedia. However, if your child takes part in the research project, he or she will receive the benefits of taking the training first and spending an extra session with me on the Macintosh computer. Taking part in this project is entirely up to you, and no one will hold it against you or your child if you decide not to do it. If your child does take part, he or she may stop at any time without penalty.

If you want to know more about this research project, please call me, Alice Stevenson, at 891-7188 (local call). The project advisor is Dr. Carolyn Brodie, telephone (216) 672-2782. This project has been approved by Kent State University. If you have questions about Kent State University's rules for research, please call Dr. Eugene Wenninger, telephone (216) 672-2070.

If you decide to have your child participate, please return this entire consent form to Robert Frost School immediately, September 4 at the very latest, because training and testing will begin as soon as the forms are received. You will get a copy of this consent form. If you are interested, you may also receive a statement of the project results and your child's individual results.

Sincerely,

Alice R. Stevenson
Graduate Student, Kent State University

****

CONSENT FORM: MASTERY OF CD-ROM ENCYCLOPEDIA SKILLS BY ELEMENTARY STUDENTS

I agree to let my child, _____, take part in this project. I know what he or she will have to do and that he or she can stop at any time.

_____ _____
Signature (parent or guardian) Date

I agree to take part in this project. I know what I will have to do and that I can stop at any time.

_____ _____
Child signature Date

APPENDIX B

SPECIFICATIONS FOR THE TEST OF ELECTRONIC ENCYCLOPEDIA SKILLS

SPECIFICATIONS FOR THE TEST OF ELECTRONIC ENCYCLOPEDIA SKILLS
New Grolier Electronic Encyclopedia, 1991, Macintosh version

Note: Skills 1 to 5 may be performed on the same article window. Skills 6 to 10 may be performed on the same subject for coherence.

SKILL 1 - ARTICLE MANIPULATION - Scanning articles

Objective: When presented with an article that has already been retrieved, the searcher will scan the article from title to the last line, then return to the first line in a single move.

Sample item: (The examiner retrieves the article "Kennedy, John F.") "This is an article from the Grolier electronic encyclopedia. I want you to quickly scan the article page by page without reading it, until you reach the last line. Then return to the top of the article in a single move, without going page by page."

Stimulus attributes: Articles will be chosen that are more than three "pages" or "screens" long. The article will be retrieved by the examiner and presented with the title at the top of the first screen.

Response attributes: The searcher will click the mouse with the cursor on the scroll bar so that the article scrolls quickly or moves a page at a time until the last line of the text is reached. A method that advances the text one line at a time will not be accepted as a correct response. If the searcher starts to use this method, the examiner may repeat the instructions. Upon reaching the end of the article, the searcher will drag the white box to the top of the scroll bar so the title is again revealed at the top of the screen. Discontinue when the searcher has been allowed as much time as he or she can profitably use.

SKILL 2 - ARTICLE MANIPULATION - Looking at pictures

Objective: When presented with an article that has already been retrieved, the searcher will retrieve the picture, if any, by choosing the picture icon.

Sample item: (The examiner retrieves the article "Kennedy, John F.") "I want you to find the picture that goes with this article."

Stimulus attributes: Articles will be chosen that have an attached picture. The article will be retrieved by the examiner and presented with the title at the top of the first screen.

Response attributes: The searcher will click the mouse with the cursor on the picture icon to retrieve the picture. The picture is not to be retrieved using the picture index.

Discontinue when the searcher has been allowed as much time as he or she can profitably use.

SKILL 3 - ARTICLE MANIPULATION - Listening to sounds

Objective: When presented with an article that has already been retrieved, the searcher will retrieve the associated sounds, if any, by choosing the headphones icon.

Sample item: (The examiner retrieves the article "Kennedy, John F.") "I want you to find the sounds that go with this article."

Stimulus attributes: Articles will be chosen that have an attached sound. The article will be retrieved by the examiner and presented with the title at the top of the first screen.

Response attributes: The searcher will click the mouse with the cursor on the headphones icon to retrieve the sound. The sound is not to be retrieved through the picture. Discontinue when the searcher has been allowed as much time as he or she can profitably use.

SKILL 4 - ARTICLE MANIPULATION - Finding more information

Objective: When presented with an article that has already been retrieved, the searcher will retrieve the outline, fact box, or table, if any, by choosing the appropriate icons.

Sample item: (The examiner retrieves the article "Kennedy, John F.") "I want you to find the (outline, fact box, or table) that goes with this article."

Stimulus attributes: Articles will be chosen that have an attached outline, fact box, or table. The article will be retrieved by the examiner and presented with the title at the top of the first screen.

Response attributes: The searcher will click the mouse with the cursor on the appropriate icon to retrieve the information. It is not necessary for the subject to read the information. Discontinue when the searcher has been allowed as much time as he or she can profitably use.

SKILL 5 - ARTICLE MANIPULATION - Printing the article

Objective: When presented with an article that has already been retrieved, the searcher will print the first page of the article.

Sample item: (The examiner retrieves the article "Kennedy, John F.") "I want you to print this article."

Stimulus attributes: The article will be retrieved by the examiner and presented with the title at the top of the first screen. The printer will already be attached to the computer, turned on, and loaded with paper.

Response attributes: The searcher will pull down the File menu and select Print. He will check if the printer is on and has paper. He will click on the appropriate place on the Print Dialog box to begin printing. The examiner may stop the printing by pressing "command-period" when desired. The searcher will tear off the finished sheet. Discontinue when the searcher has been allowed as much time as he or she can profitably use.

SKILL 6 - SIMPLE SEARCHES - Searching the title index

Objective: The searcher will locate an article by using the title index.

Sample item: "Using the title index, I want you to find the encyclopedia article, 'baseball'."

Stimulus attributes: The question will be given to the searcher in both written and oral form so that there is no question about how to spell the title. Subjects presented will be those familiar to the searcher and not too complex to spell (i.e., not like 'Aleksei Nikolayevich Kosygin'.) The search must be a "clean" search (i.e., no dead ends or cross-references).

Response attributes: The searcher will pull down the Search menu and select Browse Title Index. At the Title Index window, he will enter the name of the title in the form of a title. He will select the correct title from the title list and bring the article window on screen. It is not necessary for the searcher to read the article. Discontinue when the searcher has been allowed as much time as he or she can profitably use.

SKILL 7 - SIMPLE SEARCHES - Searching the word index

Objective: The searcher will locate an article by using the word index.

Sample item: "Using the word index, I want you to find the encyclopedia article in which the word 'baseball' appears the most times."

Stimulus attributes: The question will be given to the searcher in both written and oral form so that there is no question about how to spell the word. Subjects presented will be those familiar to the searcher and not too complex to spell. The search must not be a "dead-end" search.

Response attributes: The searcher will pull down the Search menu and select Browse Word Index. At the Word Index window, he

will enter the word he wants to find. He will select the first title from the title list and bring the article window on screen. It is not necessary for the searcher to read the article. Discontinue when the searcher has been allowed as much time as he or she can profitably use.

SKILL 8 - SIMPLE SEARCHES - Searching the picture index

Objective: The searcher will locate a picture by using the picture index.

Sample item: "Using the picture index, I want you to find a picture of a tiger."

Stimulus attributes: The question will be given to the searcher in both written and oral form so that there is no question about the word. Subjects presented will be those familiar to the searcher. The search must not be a "dead-end" search.

Response attributes: The searcher will pull down the Search menu and select Browse Picture Index. At the Picture Index window, he will select the category of picture he wants to find. He will select the correct picture from the next picture list and bring the picture on screen. The searcher will not be allowed to find the picture by searching for the article and retrieving the picture through the article. If he starts to, the examiner may say, "Please use the picture index." Discontinue when the searcher has been allowed as much time as he or she can profitably use.

SKILL 9 - SIMPLE SEARCHES - Searching the map index

Objective: The searcher will locate a map by using the map index.

Sample item: "Using the map index, I want you to find a map of Michigan."

Stimulus attributes: The question will be given to the searcher in both written and oral form so that there is no question about the word. Subjects presented will be those familiar to the searcher. The search must not be a "dead-end" search.

Response attributes: The searcher will pull down the Search menu and select Browse Map Index. At the Map Index window, he will select the category of map he wants to find. He will select the correct map from the next map list and bring the map on screen. The searcher will not be allowed to find the map by searching for the article. If he starts to, the examiner may

say, "Please use the map index." Discontinue when the searcher has been allowed as much time as he or she can profitably use.

SKILL 10 - COMPLEX SEARCHES - Word search with AND

Objective: The searcher will locate a collection of pertinent encyclopedia articles by performing a combining search with two words or terms.

Sample item: "Now I want you to find some articles using a combining search. Suppose you were writing a report on smoking as a possible cause of lung cancer. Find three articles in the encyclopedia that might have useful information on both lung cancer and smoking. You don't have to read the articles you find; just bring three articles on the screen and show them to me."

Stimulus attributes: The question will be given to the searcher in both written and oral form so that there is no question about the words or the spelling. Subjects presented will be those familiar to the searcher. The search must not be a "dead-end" search; at least three articles must be available. Query terms suggested by the wording of the question will be appropriate search terms.

Response attributes: The searcher will pull down the Search menu and select Word Search. He will enter two terms to be combined with a plus (and). He will select three articles from the title list that look pertinent to the subject and call each article on screen in succession. He will list his choice of three articles to the examiner. It is not necessary for the searcher to read the article or retrieve information on the subject. This is an open ended question; a variety of terms may be used to retrieve a variety of articles. Give credit if the article contains both concepts. Discontinue when the searcher has been allowed as much time as he or she can profitably use.

APPENDIX C

TEST OF ELECTRONIC ENCYCLOPEDIA SKILLS: ITEMS AND CHECKLIST

Table 1: Items for the Test of Electronic Encylopedia Skills

	Set A	Set B	Set C
Skill 1 Scan article Skill 2 Call up tables, factboxes, outlines Skill 3 Find pictures Skill 4 Find sounds Skill 5 Print article	Lincoln, Abraham	Mozart	frog
Skill 6 Search title index	Japan	condor	Wilder, Laura Ingalls
Skill 7 Search word index	origami	vulture	prairie
Skill 8 Search picture index	Datsun (car)	eagle	violin
Skill 9 Search map index	China	California	Oklahoma
Skill 10 Combine with AND	Japan/ earthquakes	extinct/ birds	Indians/ settlers

CHECKLIST FOR THE TEST OF ELECTRONIC ENCYCLOPEDIA SKILLS

Name_____ Date trained_____

Grade_____ Teacher_____ Date tested_____

PART 1: ARTICLE MANIPULATION

	A	B	C	P/F	NOTES
Skill 1: Scans article	___	___	___	___	
Skill 2: Finds picture	___	___	___	___	
Skill 3: Finds sound	___	___	___	___	
Skill 4: Finds outline/fb/table	___	___	___	___	
Skill 5: Prints article	___	___	___	___	

PART 2: SIMPLE SEARCHES

Skill 6: Searches title index	___	___	___	___
Skill 7: Searches word index	___	___	___	___
Skill 8: Searches picture index	___	___	___	___
Skill 9: Searches map index	___	___	___	___

PART 3: COMPLEX SEARCHES

SKILL 10: Combines terms (AND)	___	___	___	___

APPENDIX D

QUESTION ABOUT ENCYCLOPEDIA PREFERENCE

QUESTION ABOUT ENCYCLOPEDIA PREFERENCE

Please circle the letter of your choice. There is no right or wrong answer. You do not need to give your name, but please put your grade.

Which encyclopedia would you prefer to use for your next research project--

a. the electronic encyclopedia

b. the print encyclopedia

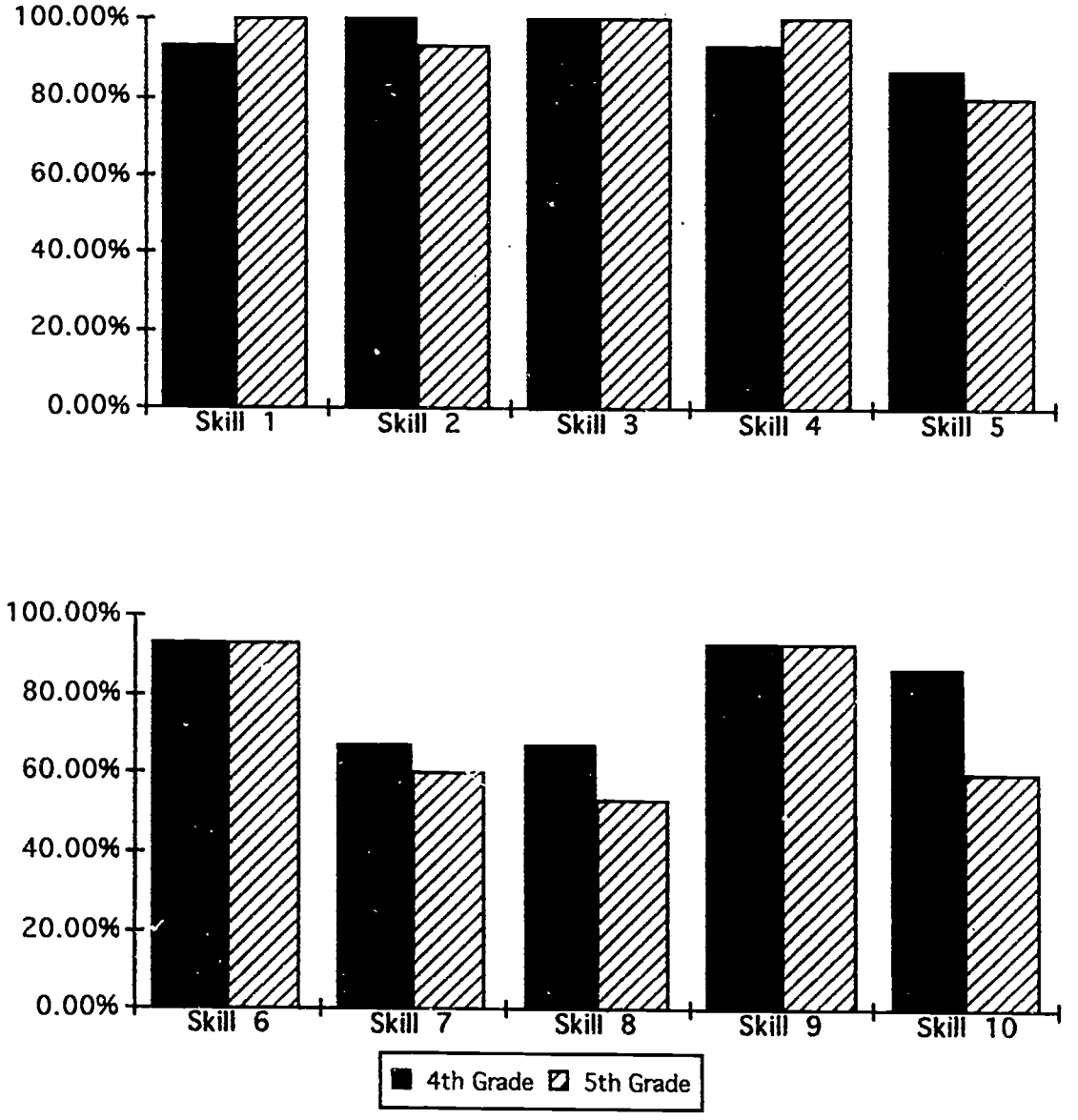
My grade level is _____ (fourth or fifth)

PUT THIS SHEET IN THE BOX ON THE DESK ON YOUR WAY OUT OF THE LIBRARY.

APPENDIX E

DATA ANALYSIS: TABLES AND FIGURES

Figure 1: Percentage of students mastering encyclopedia skills



Skill 1: Scanning articles
Skill 2: Finding pictures
Skill 3: Finding sounds
Skill 4: Finding outline/fb/table
Skill 5: Printing article
Skill 6: Performing title index search
Skill 7: Performing word index search
Skill 8: Performing pict. index search
Skill 9: Performing map index search
Skill 10: Combining terms with AND

Table 2: Mastery of encyclopedia skills by grade level

Skill 1: Scanning articles

	Masters	Nonmasters	Total n
Fourth grade	14	1	15
Fifth grade	15	0	15
Total n	29	1	30

chi-square = 1.034 ; df = 1; p = .05
The null hypothesis is not rejected.

Skill 2: Finding pictures

	Masters	Nonmasters	Total n
Fourth grade	15	0	15
Fifth grade	14	1	15
Total n	29	1	30

chi-square = 1.034 ; df = 1; p = .05
The null hypothesis is not rejected.

Skill 3: Finding sounds

	Masters	Nonmasters	Total n
Fourth grade	15	0	15
Fifth grade	15	0	15
Total n	30	0	30

Chi-square cannot be calculated (denominator = 0).
Values for both groups are equal;
therefore the null hypothesis is not rejected.

Skill 4: Finding outlines/factboxes/tables

	Masters	Nonmasters	Total n
Fourth grade	14	1	15
Fifth grade	15	0	15
Total n	29	1	30

chi-square = 1.034 ; df = 1; p = .05
The null hypothesis is not rejected.

Skill 5: Printing articles

	Masters	Nonmasters	Total n
Fourth grade	13	2	15
Fifth grade	12	3	15
Total n	25	5	30

chi-square = .24 ; df = 1; p = .05
The null hypothesis is not rejected.

Skill 6: Searching title index

	Masters	Nonmasters	Total n
Fourth grade	14	1	15
Fifth grade	14	1	15
Total n	28	2	30

chi-square = 0 ; df = 1; p = .05
The null hypothesis is not rejected.

Skill 7: Searching word index

	Masters	Nonmasters	Total n
Fourth grade	10	5	15
Fifth grade	9	6	15
Total n	19	11	30

chi-square = .1435 ; df = 1; p = .05
The null hypothesis is not rejected.

Skill 8: Searching picture index

	Masters	Nonmasters	Total n
Fourth grade	10	5	15
Fifth grade	8	7	15
Total n	18	12	30

chi-square = .5555 ; df = 1; p = .05
The null hypothesis is not rejected.

Skill 9: Searching map index

	Masters	Nonmasters	Total n
Fourth grade	14	1	15
Fifth grade	14	1	15
Total n	28	2	30

chi-square = 0 ; df = 1; p = .05
The null hypothesis is not rejected.

Skill 10: Combining terms with AND

	Masters	Nonmasters	Total n
Fourth grade	13	2	15
Fifth grade	9	6	15
Total n	22	8	30

chi-square = 2.7272 ; df = 1; p = .05
The null hypothesis is not rejected.

Figure 2: Percentage of students preferring print and electronic encyclopedias

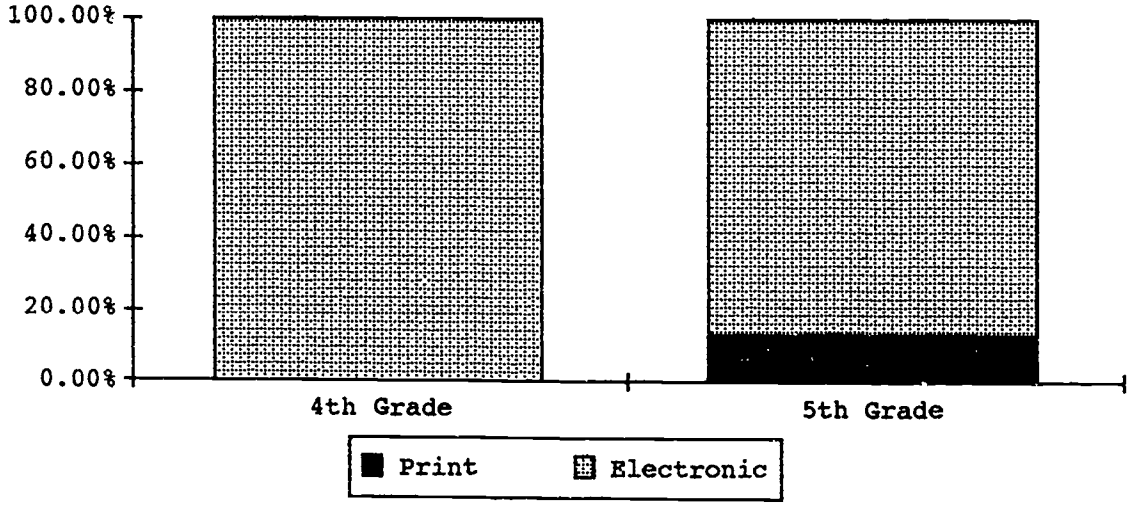


Table 3: Preference for encyclopedia by grade level

	Print	Electronic	Total n
Fourth grade	0	15	15
Fifth grade	2	13	15
Total n	2	28	30

Research hypothesis H_{11} (preference for electronic encyclopedia, all students)

chi-square = 23.07 ; df = 1; p = .05

The null hypothesis is rejected.

Research hypothesis H_{12} (preference for electronic encyclopedia, 5th vs. 4th graders)

chi-square = 2.1429 ; df = 1; p = .05

The null hypothesis is not rejected.