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Differences and similarities in teachers' information exploration strategies for lesson planning using the Physics InfoMall: A large physics database on CD-ROM

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DIFFERENCES AND SIMILARITIES IN TEACHERS' INFORMATION EXPLORATION STRATEGIES FOR LESSON PLANNING USING THE PHYSICS INFOMALL--A LARGE PHYSICS DATABASE ON CD-ROM

by

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Abstract

Physics teachers in high schools and elsewhere have a wide range of specialization and teaching experiences. A recent survey found seventy-five percent of physics teachers do not earn their degrees in physics. Physics InfoMall, a resource on CD-ROM was developed to provide these teachers and other physics educators access to a wide variety of teaching materials. Along with a search engine, Physics InfoMall included materials such as textbooks, reference books, laboratory and demonstration books and activities, indexes and selected articles to physics education journals, pamphlets and other documents related to teaching. Field test versions of the Physics InfoMall were distributed to teachers around the country and feedback on the use of the Physics InfoMall for lesson planning was collected over a period of a year.

This study investigated how teachers with different specialization and experiences used the Physics InfoMall. Specifically, this study probed into teachers' choice of lesson components, stores entered, query modes and information seeking categories when preparing lesson plans. Overall, demonstrations, laboratories, lectures, and teacher background readings were the primary lesson components chosen and these choices were highly reflected in the stores teachers entered for shopping. Additionally, teachers queried for information using Boolean searching but failed to refine their searches by searching in selected fields of documents.

Comparisons were made between crossover teachers (little or no physics background) and prepared teachers (significant physics background), between teachers with different teaching experiences and between crossover and prepared teachers with

similar teaching experiences. Differences were tested for statistical significance using z-test for proportion, ANOVA, Chi Square and t-test for independent samples. Crossover teachers queried materials for lecture more than prepared teachers but no differences were observed in their query modes. On average, crossover teachers chose more lesson components and spent more time than prepared teachers for each observation. Teaching experiences were found to have no influence on choice of lesson components, stores entered, query modes and information seeking categories. However, comparisons between crossover and prepared teachers with similar teaching experiences revealed a number of variables showing significant differences.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

Acknowledgments

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Chapter 1

Introduction

According to the 1985-1986 National Survey of Science and Mathematics Education (Weiss, 1987), 38% elementary teachers reported physics as being the hardest subject to teach. This was followed by Earth Science at 21% and Chemistry at 19%. Forty-four percent of the teachers indicated that they needed assistance in learning basic concepts. Another 42% indicated the need for instructional materials. Sheila Tobias (1985) quoted Robert Fuller at the University of Nebraska as saying

> "Professors intentionally or unintentionally contribute to this reputation (physics being hard). Opening lectures often describe the high standards maintained by the department, the firm mathematical prerequisites and the poor grade records of previous classes. Even when they do not make such explicit statements, teachers convey the message that physics is a particularly difficult subject and this damages students' confidence."

It is no wonder that physics is considered hard by many high school and college students as well as teachers. Findings from a nationwide survey (Neuschatz and Alpert, 1994) indicated only 21% of high school students enrolled in physics although no direct claim is made if this is related to physics being hard. While giving a convocation lecture at

Kansas State University on September 16, 1994, Leon Lederman, a Nobel-prize winning physicist defined physics as:

> ".....Physics, a subject inducing fear and loathing in students and most teachers. It's synonyms include incomprehensible, waste of money and mind numbing......."

Tobias (1985) identified two groups of students shying away from taking physics:

> ".....those whose anxiety are the results of exposure to physics courses and those whose apprehension kept them from trying physics even once."

In a different work, Tobias (1986, 1988) recruited highly regarded professors from the humanities to become "students" in four physics lectures. The experiment, Peer Perspectives, was done at the University of Chicago and was designed to see how much liberal arts students can digest information in a physics lecture class. The "students" attended lecture with demonstrations given by two physics professors and the students' task was to try and "learn the subject matter and then systematically explore the reasons for their inability to grasp the materials presented in the lecture."

The results of the experiment pointed to problems such as the way materials were presented by lecturers in terms of pace and language, ambiguity of demonstrations and the lack of students' understanding regarding the reciprocal nature of physics to math. The conclusion is physics, as it is traditionally taught, is hard even to exceptionally good non-science "students".

In recent years, much work has concentrated on difficulties students have in learning physics. This was evident by results obtained by Halloun and Hestenes (1985). The duo devised an instrument (a diagnostic test) to measure students' conceptual understanding on motion and administered the test to about 1000 incoming students and students who have completed introductory physics courses. All the students were taught by the conventional physics instruction in the sense that the topics covered were taken from standard textbook content and taught using the lecture-recitation format. They only found a small gain in understanding between the pretest and posttest. Furthermore, the small gain was independent of instructor.

Some researchers attributed the results to preconceptions that students bring into the classroom. McDermott et al. (see, e.g., Trowbridge & McDermott, 1980, 1981; Lawson & McDermott, 1987; Goldberg & McDermott, 1986, 1987; McDermott, Rosenquist & Van Zee, 1987; Van Zee & McDermott, 1987; McDermott & Shaffer, 1992) have done considerable studies about preconceptions in the field of mechanics, kinematics and optics. The results of their work showed that preconceptions have been deeply rooted in students' minds for a long time, and one lecture or even one course, will not change how they have organized their experiences with the physical world.

A second factor in the lack of conceptual understanding is the students' view of physics. Their mental picture of physics is nothing but formulas and facts (Hammer, 1989; Karplus, 1977; Van Heuvelen, 1991; Arons, 1976, 1983, & 1984). After all, that is the training they receive in lecture. More importantly, it is the bulk of all the test and quiz questions they have to answer to receive good grades. Thus, conceptual understanding as measured by Halloun and Hestenes (1985) is neither seen as important nor fostered in a traditional course.

Efforts to change the lack of understanding have been a topic of recent interest among physics education reformers. Researchers have been turning their attention to student-oriented or inquiry-based learning as opposed to the traditional chalk-and-talk lecture format. Proponents of logical reasoning and learning by inquiry (see, e.g., McDermott, 1993; Laws, 1991; McDermott & Rosenquist, 1987; Arons, 1990 &1993; Zollman, 1990; Hake, 1992; Thornton & Sokoloff, 1990) have reasoned that students lack conceptual understanding (Halloun & Hestenes, 1985; Hestenes & Wells, 1992). The traditional method of teaching was found to be too quantitative in nature and failed to bolster conceptual understanding and logical reasoning. Arons (1990) noted in his book that "he wants to make clear and explicit the conceptual and reasoning difficulties many students encounter". Tobias (1992) provided a summary of many research studies regarding preconceptions, learning by inquiry and problem solving.

1.1 Technology in Physics Teaching

A stress on hands-on activities by the students is common to almost all researchers in this inquiry-based paradigm. Such activities include traditional laboratory experiments as well as interactive work with instructional media. Arons (1990) mentioned that a teacher is free to use any instructional media in his/her effort to facilitate students in their learning by logical reasoning. Instructional media range from a simple, low-cost demonstration (see, e.g., Frier & Anderson, 1981; Meiners, 1970) to advanced multimedia (Redish & Wilson, 1994; Wolf, 1993). Whichever media are used for the inquiry-based learning, it must be used with caution and not without guidance (Arons, 1993).

Frequently, teachers use computers as a medium to meet the needs for students to do and discover physics. Computers played a major role in reforming the way physics is being learned (see, e.g., McDermott, 1990; Eisenstein, Millman & Pallrand, 1991; Laws, 1991; Wilson & Redish et al., 1988, 1989, 1992, 1993). Salinger (1991) summed this effort best by saying:

> ".....this reform puts the learner and learning at the center, not the teacher and teaching. Instead of the students being treated as an empty vessel into which knowledge is poured, students are encouraged to construct knowledge using skills they already have and things they already know. The teacher, instead of being mainly a transmitter of knowledge and central authority, is there to facilitate learning."

Salinger also provided an overview concerning some of the research on computer that were developed towards inquiry-based learning such as MBL tools (Mokros & Tinker, 1987; Thornton, 1987; Thornton & Sokoloff, 1990), Workshop Physics (Laws, 1991), M.U.P.P.E.T. (Wilson & Redish et al., 1988, 1989, 1993), CUPLE (Wilson & Redish, 1994), science databases on CD-ROM such as Science Helper, MathFinder and CD-ROM Toolkit (now called *Physics InfoMall*). Most of the courseware cited by Salinger have either been implemented and utilized or are still being field-tested.

Thornton and Sokoloff (1990), showed that microcomputer-based laboratories where students do real-time graphing of a physical phenomenon helped students understand kinematics much better. Molitoris and McDermott (1990) indicated that the use of computers can improve physics teaching and hence improved learning among students.

The latest technology used video and computer that can interact and allowed students to see real-world events (Zollman & Fuller, 1994; Dengler, Luchner & Zollman, 1993). Zollman and Fuller worked with videodiscs such as Cinema Classics (Fuller & Lang, 1992), Physics of Sports (Zollman & Noble, 1988), Studies in Motion (Fuller & Zollman, 1983) and The Puzzle of Tacoma Bridge Collapse (Fuller & Zollman, 1982) as tools for students to collect, analyze and model data from events outside the classroom. It also allows analysis and modelling of the more complex models of physics principles. Vitale and Romance (1992) showed that interactive video integrated into lecture, significantly increased the mastery of science concepts in physical and earth sciences of preservice teachers.

Thus, computers and multimedia are becoming common tools for physics teachers in the classrooms. It helps students to see events that otherwise have to be visualized. This, in turn, increases students' conceptual understanding of physics, making them better learners.

1.2 Teachers' Specialization

Most high school physics teachers are not trained to teach the subject. Neuschatz and Alpert (1994) grouped physics teachers into three categories. Specialists are those who both earned degrees in physics and have considerable experience teaching the subject. Career physics teachers are categorized as those who do not earn degrees in physics but have been teaching physics more frequently than any other subject. Another way of looking at it is that these teachers have taught physics two-thirds of their teaching career or at least ten years. The term occasional teachers, is used for those who neither earned degrees in physics nor had substantial experience teaching physics in their career. These teachers are identified to have degrees in sciences such as math, chemistry or biology. Only 25% of teachers surveyed are specialists while 39% are career physics teachers. The other 36% are occasional physics teachers.

For the purpose of the present study we included occasional and career teachers in a group which we have called crossover (little or no physics background) teachers. They have crossed-over from another discipline; other sciences or humanities. We categorized teachers with degrees in physics as prepared (significant physics background) teachers. Figure 1 was taken from Neuschatz and Alpert's survey.

American Association Physics Teachers (AAPT) published a report in 1988 (AAPT, 1988) outlining four groups of teachers who teach physics. The groups are:

- Teachers with excellent physics background. These teachers earned physics degrees.

- Teachers with minimal physics background. These teachers earned degrees in other sciences but took physics courses that would qualify them to minor in physics.
- Teachers with limited physics background. This group earned degrees in fields other than physics but took only a few physics classes that required calculus.
- The Unprepared Teachers. This group took only one or two undergraduate physics as part of their graduation requirement. They majored in fields such as the humanities.

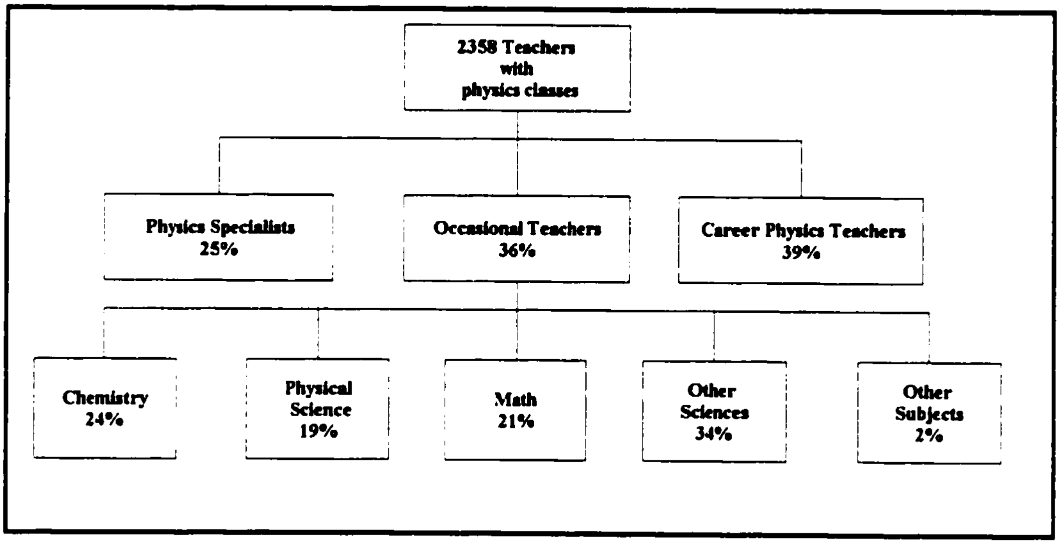


Fig 1: Areas of Specialization of High School Physics Teachers. Source: 1989-1990 AIP High School Physics Teacher Survey

The report suggested that physics teachers must have undergraduate preparation in physics, mathematics and related sciences equivalent to physics majors and sufficient pedagogical courses to become skilled teachers. In addition, they also need to acquire skills such as laboratory maintenance, construction and grading of laboratory activities, demonstrations and history of physics which are specific to physics teaching. Seventy-five percent of physics teachers cited by Neuschatz and Alpert do not earn degrees in physics and may lack a good grasp of the much needed content.

As outlined by the AAPT report, teachers with minimal physics background and the unprepared physics teachers require more in-service training to become reliable teachers, content wise. Fortunately, Neuschatz and Alpert found only 2% unprepared physics teachers teaching physics in 1989-1990. Another interesting finding from their survey is the fact that virtually all physics teachers, including those who have little physics background, enjoy teaching the subject and look forward to teaching it as often as they can.

Beginning teachers, with or without physics degrees, can benefit from another document published by AAPT, Guideline for High School Physics Program (1986). This pamphlet presented guidelines regarding teaching loads, curriculum developments, professional growth, classroom demonstration, laboratory, resources as well as many more useful tips for beginning physics teachers. The AAPT document (1988) also outlined remedial steps that had to be undertaken by teachers who lacked both physics content and pedagogical skills. Although the suggestions were meant to help teachers who are not specialists, time and funding may prevent teachers from upgrading their skill and knowledge. In the meantime, they still have to teach physics.

Specialists and experienced teachers, on the other hand, having physics degrees or any other science degrees, looked for other resources to create a more interesting, different and effective way of teaching. Neuschatz and Alpert found that of all physics teachers, 19% have taught between one and five years, 15% between six and 10 years, 33% between 11 and 20 years and 33% for more than 20 years. Table 1 shows the relation between teaching experience and the areas of physics that teachers are not comfortable teaching.

TABLE 1

AREAS OF PHYSICS THAT TEACHERS OF DIFFERENT LEVELS OF EXPERIENCE ARE NOT PREPARED TO TEACH. SOURCE: 1989-1990 AIP HIGH SCHOOL PHYSICS TEACHER SURVEY

	Years of High School Teaching			
	1-5	6-10	11-20	20+
Overall	19%	15%	33%	33%
Teachers feel **unprepared** to teach:	%	%	%	%
Basic Physics	4	4	3	1
Recent developments	36	42	36	31
Lab techniques	33	26	18	14
Application to everyday life	18	12	12	7

1.3 Teaching Resources

A physics teacher must have a good grasp of physics, access to demonstrations, laboratories, problems, articles about recent development in physics, and contacts with other physics teachers or professional organizations in their quest to become excellent physics teachers. Textbooks often serve as the major source of knowledge for physics content. Reference books, accompanying materials for textbooks, journal articles and colleagues are sources for finding demonstrations, laboratory experiments, problems, examples and recent developments in physics. In the light of research done about inquiry-based learning or learner-centered paradigm, materials that are currently used by teachers in high schools are insufficient to make changes as suggested from the outcome of research. In addition, teachers need to expand their horizons and search for new materials to make their class presentations exhilarating, more effective and consistent with the growth of technology.

The fast development in technology made it possible for some universities and private companies to disseminate knowledge by making it accessible to teachers. An easy way of accessing knowledge, software and interesting discussions is through the use of Internet (see, e.g., Minor, 1988). Internet offers resources for teachers to share information with others on the network, access free or shareware computer programs, exchange lesson materials, and much more. Eagan (1993) wrote about various kinds of databases and searches that can be done to find any kind of information regarding sciences such as trying to find answers for standards on RS-232 connectors, information on National Science Foundation (NSF) grants and information on weather statistics. James Powell (1994) expanded the discussion about internet capabilities by including hypertext (see, e.g., Berilacqua, 1989) through a connection called the World Wide Web (WWW). WWW allows teachers to access not only textual information all around the world but also any multimedia associated with the text. Many professional organizations are beginning to place information on the WWW to be shared among academicians, students and professionals. Therefore, through WWW a wide variety of information is much more accessible.

Another means of disseminating knowledge in the form of a database is by using Compact Disc-Read Only Memory or CD-ROM (see, e.g., Conkling and Osif, 1994; Salinger, 1991). A CD-ROM can store as much as 660 megabytes of information or equivalently 471 high density (1.4 megabytes) floppy diskettes. It can store textual information, graphics, animation and best of all it is not easily erasable or destroyed. Examples of CD-ROM-based programs for science teachers that are currently in the market are *Science Helper* (Rowe, et.al., 1993) and *MathFinder* (*MathFinder* User's Guide, 1992) while *Physics InfoMall* (Fuller, Zollman & Jantan, et.al., 1994) is for physics teachers and is presently being field tested at selected sites around the country. In addition, there are also professional organizations which are providing journals both on-line and on CD-ROM (Ingoldsby, 1994).

The *Science Helper* is a collection of resources for science teaching and curriculum development and developed for teachers in kindergarten through eighth grade. It is a database of about 1000 hands-on science and mathematics lesson plans which were scanned as images with each image having an abstract prepared for ease of searching and browsing. It can be operated in both the PC-DOS and Macintosh platforms. Needed information can be retrieved by specifying criteria such as grade level, subject content or theme for specific lesson plans or by browsing in the database using title selection.

The *MathFinder* is yet another database on CD-ROM. This database contains text for forty curriculum standards from the National Council of Teachers of Mathematics

(NCTM) Curriculum and Evaluation Standards for School Mathematics, and about 1100 lesson plans from curriculum programs for the past 35 years indexed according to the NCTM curriculum standards. The lesson plans were scanned as images with abstracts written for each image. Information can be retrieved by using the table of contents to browse through the accessible levels.

The *Physics InfoMall*, previously known as Every Physics Teacher's CD-ROM Toolkit, is a physics database consisting of textbooks, reference books, laboratories, demonstrations, problems, journal indexes from American Journal of Physics, The Physics Teacher and Physics Today, selected articles from those journals and many more documents. It uses the consumer mall metaphor by having information or goods stored away in different stores. These stores are categorized according to the goods they offer. In addition to stores, InfoMall also provides utilities which allow access to physical constants, equation dictionary, today in physics history (physics calendar of events), lesson objectives and table of contents for four commonly used high school textbooks. Developed under the leadership of Professor Robert Fuller at the University of Nebraska-Lincoln and Professor Dean Zollman at Kansas State University, the CD-ROM has been field-tested since December, 1992.

There are two modes of accessing information from the InfoMall. Both, casual browsing and searching by performing queries, capitalize on the hypertext format of the information structure. Casual browsing is done by clicking on a hypertext link to retrieve documents. Searching is done by doing a query. A word or phrase query in a store or stores will retrieve documents and allow teachers to choose which of the retrieved documents to browse. This form of searching is known as a Simple Search. Another form of searching, a Compound Search, permits more choices to increase or reduce occurrences in a query. Teachers can use Boolean options (AND, OR, NOT), select fields and select word proximities when querying. Hence teachers can control the number of retrieved documents and avoid going through large number of documents or too limited documents in order to decide which documents are best for their purposes.

The first version of the *Physics InfoMall* (First Field Test Version) was previewed by participants at the AAPT Summer Meeting in 1992 in Orono, Maine. It was distributed to field testers in December, 1992. However, its evaluation concentrated on simple useability and design issues. The Second Field Test Version of the *Physics InfoMall* was distributed in May, 1993. In October, 1993, a systematic way of evaluating how teachers used the InfoMall was developed and distributed to all field-testers. A revised evaluation form was distributed in March, 1994 along with the Second Field Test Version to a new group of field-testers. The same forms were also sent to an earlier group (the October group) of the Second Field Test Version field-testers.

1.4 Purpose of the Study

Teachers who received the Second Field Test Version of the *Physics InfoMall* were expected to provide evaluations as part of an agreement in becoming field-testers. In return, they only pay for shipping and handling cost when the Third Field Test Version is ready for distribution. The evaluation or feedback will help the InfoMall team provide better design, more user friendly search engine and most importantly improve the content of the database.

This study concentrates on how the content of the InfoMall is used, its organization and its accessibility as viewed by the diverse group of teachers who are teaching physics and using the database for teaching. It is hoped that this study will reveal the lesson components that are most used by teachers of different specialization and experiences and hence the kind of documents that teachers used most often. This will help the *Physics InfoMall* developers decide on what kind of documents to add in revised versions of the CD-ROM.

In addition, based on the query modes that teachers used most often to increase querying efficiency, developers can refine or change the search engine on the InfoMall in future versions. Since this is the first project to place large amount of resources on CD-ROM in the field of physics and sciences, we believe that results of this work could motivate scholars in other field of sciences to follow our footsteps and develop better and enhanced CD-ROM databases in their own respective fields.

This study attempts to answer the following questions: When using the InfoMall to prepare a lesson plan:

1) what lesson components are chosen and how will specialization, experience or the combination of both affect the choices?,
2) what stores are entered to access goods and how will specialization, experience or the combination of both affect the choices?;
3) how does specialization, experience or the combination of both affect the way querying is performed?, and

4) how will specialization, experience or the combination of both have an impact on the average number of information-seeking categories per observation (topic)?

Chapter 2

Review of Literature

The bulk of this study was to document and distinguish the exploration strategies that teachers with different specialization and experiences utilized when using the *Physics InfoMall*. Since the *Physics InfoMall* was only a field test version, no report or studies regarding its use had been documented. Furthermore, the variables we measured were closely related to the *Physics InfoMall* and hence, no comparisons can directly be made with other studies. However, there had been numerous studies in the field of information science regarding searching behavior and their implications on electronic database development (see, e.g., Marchionini, 1989; Ford, Wood & Walsh, 1994; Hurd, Weller & Curtis, 1992; Tilson & East, 1994). As for studies related to teaching experiences, specialization and its impact on information exploration for lesson planning, we failed to locate any related materials. However, a number of manuscripts published by AAPT and AIP which were published only recently had some very helpful information related to our study.

Users of the InfoMall are concerned with developing physics lesson from the resources available in the database. Since no other CD-ROM database in physics or any other sciences of similar nature to the *Physics InfoMall* has been created, no literature regarding lesson planning from such a resource could be located. Consequently, this study is exploratory in nature and is designed to identify patterns helpful to those involved with models of how and why teachers access information..

2.1 Laboratories in Physics Curriculum

Laboratories has always been considered as an integral component for instruction (Spears & Zollman, 1977; Philips, 1980). The history of physics laboratories in high schools and colleges began in 1886 when Edwin Hall was given the responsibility to draw a list of experiments that prospective students at Harvard would have done. Beginning in 1890, high school curricula had been transformed which required about 40% of students time doing laboratory work. Since then, physics had undergone two revolutions (Swartz, 1994), each with different outcomes and producing different approaches to laboratories. Nonetheless, laboratories had been and remain to be an essential component of any physics curriculum.

The school laboratory is a place where students do practical physics. The activities in laboratories include manipulating apparatus, observing, asking questions, measuring, recording data, analyzing data, making inferences and communicating results to others (Rogers, 1987). Arons (1994) outlined the most common objectives for doing laboratory work. For example, laboratories are done to: (1) verify or confirm laws, relations, or regularities asserted in text, class, or lecture; (2) have some experience with actual physical phenomena; (3) have the experience of, and develop some skill in, handling instruments and making significant measurements; (4) encountering the "processes of science" through planning and experiencing; and (5) learn to minimize error, treat and interpret experimental data. Many authors have done research to observe if doing practical activities really help students to fulfill the objectives of laboratories.

Kruglak (1952) investigated the learning outcomes of students who performed laboratory activities and those who had activities demonstrated to them. It was found that the only advantage the former group had was efficiency in experimental techniques, setting up apparatus and acquiring skill to solve problems regarding the use of materials and apparatus in the laboratory. In another study, Kruglak (1952) performed the same investigation but added another group of students who took the lecture class but did not do the laboratory activities. He concluded that students with lab experiences, conventional or otherwise, showed higher means on tests related to laboratory work but not on the mechanics theory tests.

Brown (1957) studied the effect of high school laboratory courses on freshmen laboratory performance at Massachusetts Institute of Technology and found no correlation between the two variables. Long (1985) investigated how laboratory enrollment affected the lecture performance of 2500 general physics students and concluded that only the intermediate students showed higher overall grade point averages. The laboratory activities did not help improve the overall grade point average for both good and poor students.

Toothacker (1983) reviewed many articles regarding the effect of laboratories on lecture performance and concluded that laboratory work failed to achieve its objectives. The author suggested restructuring of laboratory curriculum which included eliminating freshmen and sophomore physics laboratory work. In addition, it was suggested that only those students who desire doing experimental physics should be asked to attend laboratory activities. The author added that a separate laboratory class not associated with lecture, and a revamped laboratory curriculum be created. In Toothacker's view, the students must first observe how experiments were carried out by physicists before attempting to do the activities on their own.

Despite findings showing the deficiency of laboratories in improving students' performance in physics classes, laboratories continue to become a major part of the physics curriculum. Michels (1961) argued that only in laboratory can the students experience physics as it actually develops. As was reviewed in the Introduction chapter, many scholars have advocated and implemented hands-on activities to promote better learning and understanding. Hands-on is by no means limited to activities in a laboratory setting, but extends to activities beyond the classroom.

Arons (1990) noted in his book that "unless students (pre-service teachers) start at the beginning with hands-on materials and proceed at a pace that allows learning and understanding, they will not develop the requisite reasoning capacities and subject matter knowledge." In his article (1993), he suggested using Socratic guidance (Hake, 1992) to do hands-on laboratory in leading students towards understanding physics. Zollman (1990) employed the learning-cycle instruction format introduced by Karplus (1977). In his course, students get to explore and report, through hands-on activities in the laboratories, their perception of certain physical events before being formally introduced to the concepts. Using the lecture only group as a control group, Zollman concluded that the "learning-cycle format contributed positively to students' understanding of forces and energy". In yet another report, Zollman (1994) emphasized the significance of hands-on activities by students to succeed in learning physics. The success is reflected in students' course evaluations.

At the national level, the AAPT Committee in Physics developed a position paper on the role of laboratory in the physics curriculum. Laws (1991, 1994) reported implementing laboratory-centered introductory physics course without lecture where students "make observations, do experiments and discuss findings with the aid of computers, to afford an opportunity to relate concrete experiences to scientific explanation." Morse (1994) pointed out that hands-on activities and letting students discover answers to physical questions should be integrated into all laboratory programs to increase efficiency of laboratories. Willis (1994) reported techniques that were used which required students to demonstrate proficiency in mathematics and understanding of physics concepts in the laboratory. Laboratories remained an important part of physics even though research reported its deficiency in improving students' performance in lectures.

Based on recent developments regarding the importance of hands-on activities and the availability of computers and multimedia, laboratories remain to be a very important component of a physics course. Hence, we will not be surprised if a big proportion of physics educators will query for laboratories while using the *Physics InfoMall* in developing lessons.

2.2 Lecture Demonstrations

Lecture demonstrations are aimed to illustrate and clarify lecture materials but not to become the sole aim of a lecture period (Bartlett, 1970). Demonstrations, like laboratories, form an integral part of a physics course (Bartlett, 1970; Sachs, 1970). Jensen (1970) wrote:

> "In order to convey the idea that physics deal with objects and the interactions between objects and that the analysis is

> but a special means of relating and describing these interactions, a direct confrontation of students with phenomena seems essential. This is accomplished to some extent in the laboratory where a limited number of phenomena are experienced in greater depth. But it is the demonstration table that allows the presentation of the experimental aspects of physics in its great variety........
> Aside from all of this, it must not be forgotten that a demonstration-filled classroom can be the source of enjoyment - fun - so generally experienced by every physicist......."

Demonstration is a vital part of physics instruction (French, 1970). It is an effective way of teaching even though no scientific evaluation has been made as to why this is so (Frier, 1970). Often times, demonstrations are not meant to convince a class of the validity of a physical principle. Rather, it is meant to leave memorable impression on students after they leave the classroom (Shiff, 1970).

It has been a tradition among lecturers to give demonstrations when giving lectures. It enlightened the audience, reduced anxiety of having to concentrate on formal learning and provided a mean of perceiving a physical principle. Oersted, while doing a demonstration, discovered that a current-carrying wire can deflect a compass needle (Thomas, 1991). This discovery stimulated Faraday's work in electromagnetism. Hence, many educators strived to promote demonstrations in their classes. The impact of enjoyment yet learning aspect of demonstration can be observed in many of AAPT

Summer Meetings. In addition, volumes of books on demonstrations had been published (see, e.g., Meiners, 1970; Frier & Anderson, 1981) to aid teachers in accessing demonstrations appropriate for the different areas of physics.

Literature has provided evidence that physics educators are seeking hands-on materials for their laboratory and demonstration activities. Hence, more accessible resources must be provided to teachers. *Physics InfoMall* has the resources and we need to know how teachers query for laboratory and demonstration documents in order to explore the querying technique employed by teachers with different specialization and experiences.

2.3 Methods of Information Seeking

In this study, we are interested only in the process of information seeking rather than the cognitive stages of information seeking (Brown, 1991, Guthrie, 1988; Kuhlthau, Spink and Cool, 1992). Information seeking, a special case of problem solving, is a process driven by needs and tasks (Wang and Liebsher, 1988). In our study, we specified the tasks required of teachers and we observed their information seeking options, quantitatively. Specifically, we presented the options that were available for searching in the *Physics InfoMall* and asked teachers to identify those options that they utilized when lesson planning. We want to explore whether if these options depend on teacher specialization and experiences.

Individuals differ in the way they solve problems (Saracevic, 1991). Given the same database with the same search options, how will teacher characteristics affect their searching techniques? Spink (1993) studied the relationship between user characteristics and the outcome of online searches. The results obtained showed that academic status and experience of using a specific database to locate documents in users' field of interest, significantly affected the online search outcome. Allen (1990) investigated the effect of users' academic backgrounds on their interaction with information systems. Users with philosophy and psychology background queried for information on interdisciplinary topics and answered questions on simulated information retrieval task. Academic background was found to affect responses pertaining to the user's statement in finding information on a topic.

Information can easily be accessed through the use of hypertext linking of text and has been a subject of interest in the field of information science for more than a decade. A study on user performance of electronic searching versus paper searching revealed that users with a high level of computer experience, searched a hypertext-based database with fewer documents selections, in less time and by viewing fewer articles and pages (Wang and Liebsher, 1988). This, in turn, increased search efficiency in terms of time. Hence, reducing the number of hits (occurrences) in a database (store) or databases (stores), is an important goal.

While most articles and studies in electronic databases investigated query time, precision and relevance as variables, our study concentrated on the different search strategies instead. In fact, time was considered only to observe if academic background and teaching experiences had any effect on the amount of time needed to complete a lesson plan.

Literature concerning the information seeking strategies by physics teachers and science educators is very limited. In addition, literature about searching in a CD-ROM database regarding physics is almost nonexistent. Hence, we will restrict ourselves to reporting our observations and making comparisons only within the variables in this study.

Chapter 3
Methodology

3.1 Field Tester's Profile

Subjects in this study are teachers and physicists who volunteered to evaluate the Second Field Test Version of the *Physics InfoMall*. Their obligations as field testers were to provide information on their use of the *Physics InfoMall* to the evaluation team. In return, they received future field test versions for the cost of shipping and handling only. This study is an analysis of data from subjects who returned their feedback and indicated use of the Second Field Test Version of the *Physics InfoMall* for teaching or research purposes.

Seventy-two subjects returned and indicated use of the InfoMall for the purpose of teaching. Four of the subjects did not submit their application forms. However, they provided enough information on the feedback forms. Hence, their data were included in this study. Others who returned their evaluation were clearly first time users who were trying out the *Physics InfoMall*. They did not perform the tasks that were required of them and thus, their observations were excluded from this study. Of the final population of 72 field testers, 28 subjects identified themselves as crossover teachers while another 44 claimed to be prepared teachers. Neuschatz and Alpert (1994) used the term career physics teachers and occasional teachers to refer to crossover teachers, and specialists for those who have significant physics background (prepared teachers).

Subjects' degree specialization are shown in Table 2. Due to the lack of complete information for some subjects, the numbers in the table do not add up to 72. In addition, four subjects who claimed to be prepared teachers do not have physics degrees at all. Instead, degrees in pharmacy, chemistry, natural science and education were cited for B.S. while education was cited for one individual with a M.S. The distinction of which area of specialization a teacher belongs to was strictly self-identified based on the description of a crossover teacher described in the application form.

TABLE 2

TEACHERS' QUALIFICATIONS AND AREA OF SPECIALIZATION

Group	Crossover Teachers			Prepared Teachers		
Degrees	B.S.	M.S.	Ph.D.	B.S.	M.S.	Ph.D.
Frequency	5	21	1	5	22	9
Areas of Specialization	Math, Chemistry, Physical Science, Biology, Natural Science, Behavioral Science, Engineering, Education, Math Education, Vocational Education			Physics, Education, Pharmacy, Chemistry, Natural Science		

Teaching experience for crossover teachers in this study range between zero and 30 years with an average of 12.2 years and a median of 12.5 years. The prepared teachers taught between one and 31 years with an average of 14.2 years and a median of 14.5 years. All of the subjects were comfortable using computers and their expertise ranged from moderate users to experts (the levels of expertise were self proclaimed). Overall, out of 63 subjects, 11% are experts, 57% are heavy users, 30% are moderate users and only 2% (one person) is a light user. Table 3 shows the proportion of crossover and prepared teachers regarding their computer expertise. Values for z from the z test for proportion and its confidence level, α, are included to check for significant differences. In using the z-scores, we are assuming a distribution of computer experiences from light to expert users. The table indicates that more than 80% of prepared teachers are at least heavy computer users but only 46% of crossover teachers are heavy users. Except for one user, a crossover teacher, the rest do not have any experience using CD-ROM applications before this.

TABLE 3

TEACHERS' COMPUTER EXPERIENCE

	Specialization f (% with respect to group)		2-tailed z values and confidence level	
Computer Experience	Crossover N=26	Prepared N=36	z	α
Expert	2 (7%)	5 (14%)	-	-
Heavy	11 (41%)	25 (69%)	2.28	0.023
Moderate	13 (48%)	16 (17%)	-2.68	0.007
Light	1 (4%)	0 (0%)	-	-

The *Physics InfoMall* can be operated in both the PC-Windows and Macintosh environment. Those subjects receiving copies in 1993 received User's Guide which combined the use for both the PC-Windows and Macintosh platforms. On the other hand, subjects receiving copies in March, 1994, had separate User's Guide for the two platforms. The only other form of help that subjects received were access to technical support which can be obtained by dialing the *Physics InfoMall* toll-free number. In addition to the User's Guide in the package that subjects received, they were provided with about ten copies of the feedback forms along with instructions on how to complete the forms.

Our study is based on subjects' lesson development using two different feedback forms. Those who received their *Physics InfoMall* in October, 1993, had different feedback forms than those who received their CD-ROM in March, 1994. The design of the March evaluation form was guided by some initial responses from the October feedback. The author realized potential problems after the feedback forms were distributed. Changes were made to accommodate variations that could not be detected by using the October evaluation form. The forms were the only measuring instrument for this work. More descriptions of the instrument are discussed in the last section of this chapter.

3.2 The InfoMall database-Preparing Teachers to Shop

Subjects used the InfoMall to find information from the variety of stores. Each store is unique and offers different goods. These stores include Textbook Trove, Demo and Lab Shop, Articles and Abstract Attic, Book Basement, Problem Place and many more. The stores and the goods they offer are shown in Table 4. The list in the table was taken from the Second Field Test Version of the *Physics InfoMall* (FTV2) User's Guide.

Information in the stores can be retrieved in two ways; casual browsing through individual stores and searching by querying. Searches can be made by typing a word, a phrase or using Boolean logic in either individual stores or in the Entire InfoMall (simultaneous searching in all stores). The user's guide was the only source of help for the subjects to learn about browsing through stores and searching in the stores.

TABLE 4

STORES IN THE INFOMALL AND THE GOODS THEY SELL

Name of Stores	**Goods**
Articles & Abstracts Attic	1. American Journal of Physics Index and some selected articles. 2. The Physics Teacher Index and some selected articles. 3. Selected articles from the Physics Today.
Pamphlet Parlor	A lot of pamphlets such as The Bicycle, The Camera and so on.
Book Basement	1. Biography of Physics by G. Gamow, 1961. 2. A Physicist's Desk Reference (AIP) edited by Herbert L. Anderson, 1989. 3. A Potpourri of Physics Teaching Ideas (AAPT) edited by Berry. 4. Teaching High School Physics (unpublished) by D. Kutliroff.
Catalog Corner	1992-1993 catalogs from Central Scientific, Vernier & Pasco.
Colleague Collection	Directory of educators willing to share talent & interests.
Demo & Lab Shop	1. Demonstration Handbook for Physics by G.D. Frier & F.J. Anderson, 1981. 2. Laboratory Manual to Accompany Physics Including Applications by H.Q. Fuller, R.M. Fuller & R.G. Fuller, 1978. 3 Physics Demonstrations and Experiments For High School by G.E. Jones.

TABLE 4 - CONTINUED

Keyword Kiosk	A list of structured or alphabetically ordered physics keywords.
Problems Place	1. Progressive Problems in Physics by Fred Miller, 1949. 2. Regent's Physics Review by Nancy Ann Moreau, 1991. 3. Problems in General Physics for College Courses by M. Masius.
Study Guide Store	1. Study Guide to accompany Physics Including Human Applications by H.Q. Fuller, R.M. Fuller & R.G. Fuller, 1978. 2. Elementary General Physics by H.Q. Fuller, R.M. Fuller & R.G. Fuller, 1988.
Teachers Treasures	Demonstrations, labs activities and quizzes contributed by teachers all around the country.
Textbook Trove	1. An Introduction to the Meaning & Structure by L.C. Cooper, 1968. 2. Instructor's Manual for Modern College Physics by H.E. White, 1972. 3. Modern College Physics by H.E. White, 1972. 4. Physics for the Inquiring Mind by E.M. Rogers, 1966. 5. Physics Including Human Applications by H.Q. Fuller, R.M. Fuller & R.G. Fuller, 1978. 6. Physics: Foundation & Frontier by G. Gamow, 1960. 7. The Fascination of Physics by J.D. Spears & D. Zollman, 1985.

As an example, browsing through the Book Basement is done by clicking on that store to view the name of books that are available in the store. Figure 2 shows the stores in the InfoMall. Choosing "Teaching High School Physics" after clicking the Book

Basement store, will display the book's table of contents as shown in the right window of Figure 3.

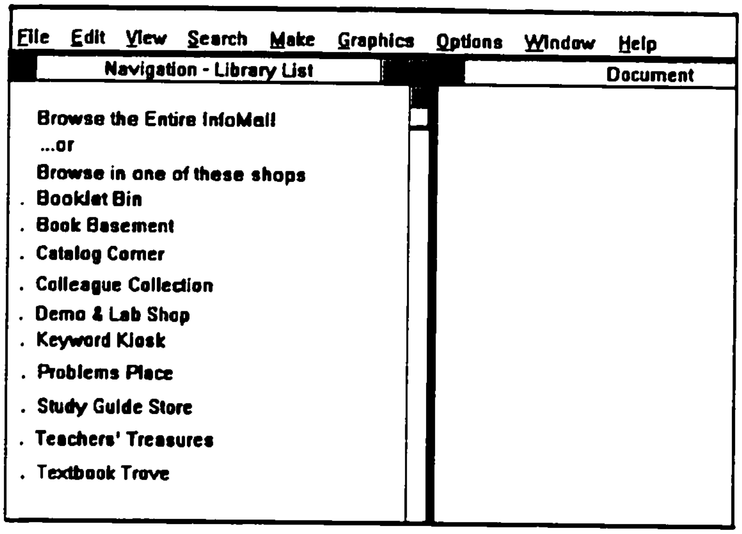


Fig 2
Stores in the *Physics InfoMall.*

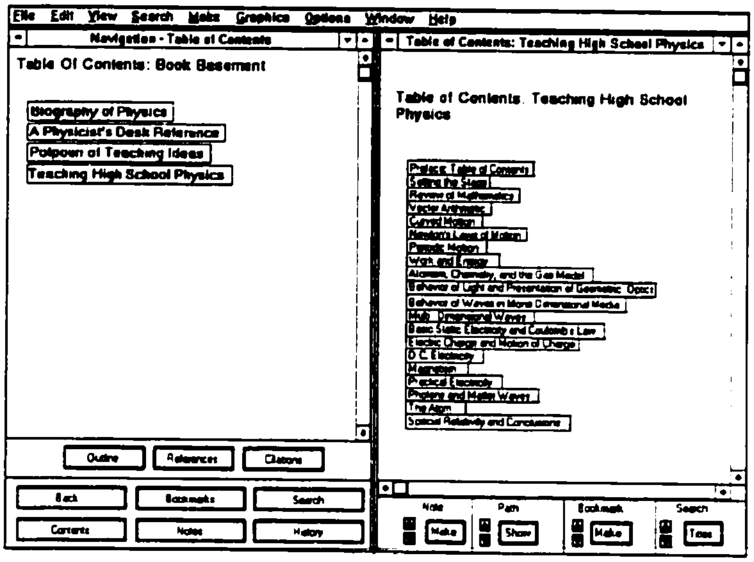
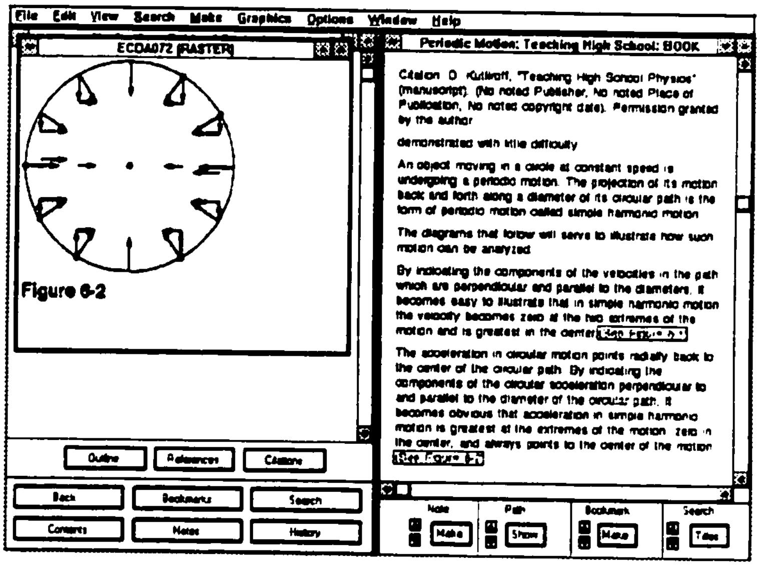


Fig 3
Goods in the Book Basement and content of the document, Teaching High School Physics.

Viewing text for a certain topic can be done by just clicking on the topic. For example, clicking "Periodic Motion" will display text for that topic in the Document window. Hence, subjects can read, make bookmarks, make notes or even copy the text into a word processor. Whenever there are graphics associated with the text (indicated by hypertext link in the text), subjects can just click on the word in the text to display the graphics, enlarge it for better resolution or copy it into a word processor. For example, Figure 4 shows a section of the Periodic Motion topic with a graphic associated with the text.

Fig 4
Graphic alongside textual information. is displayed if [See Figure 6-2] in the document window is clicked.



All of the InfoMall documents are based on hypertext format. Waterworth and Chignell (1991) referred to this kind of browsing through information as mediated browsing.

In addition to browsing, subjects can perform a query by doing either a simple search or a compound search. A simple search for the phrase "projectile motion" is shown in Figure 5. An example of a compound search using Boolean logic is shown in figure 6

Fig 5
The Simple Search Window with a search phrase projectile motion.

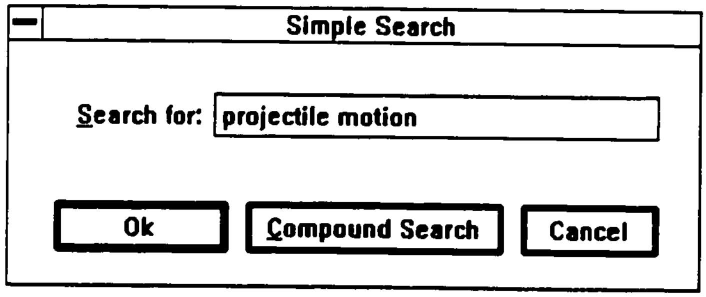


Fig 6
A Compound Search window showing all the possible options.

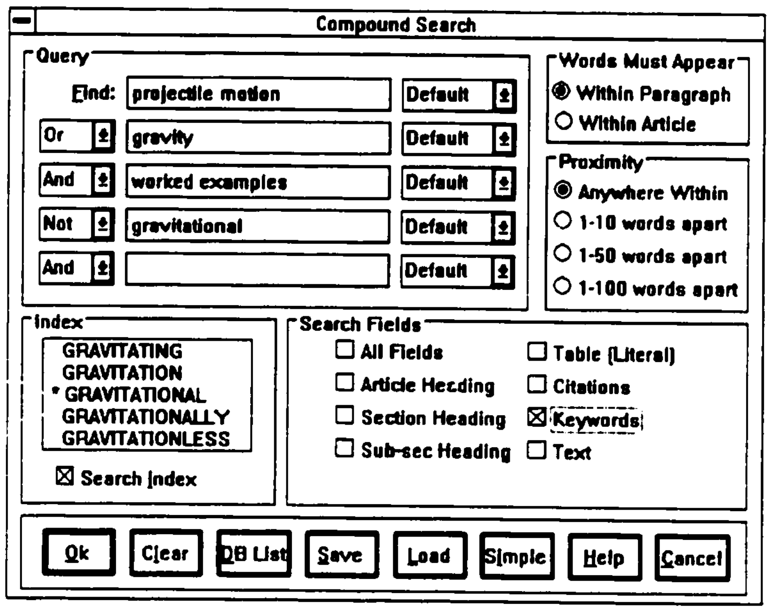


Fig 7

Results of doing a Simple Search for the phrase *projectile motion* in the Book Basement.

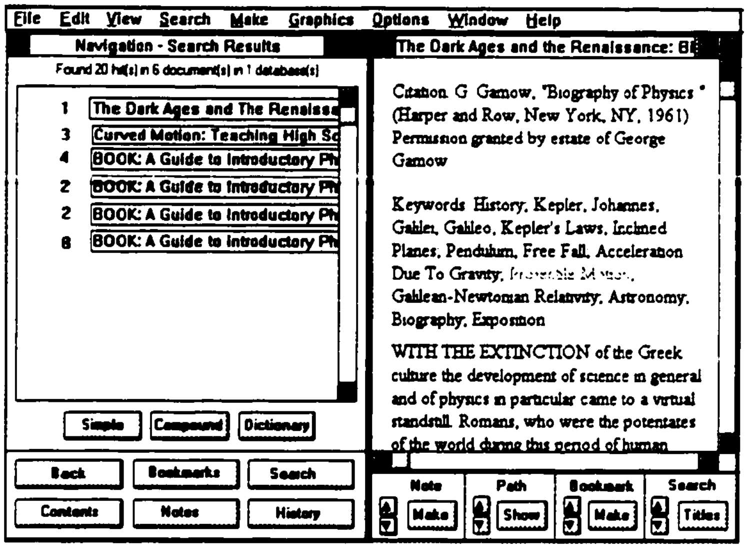
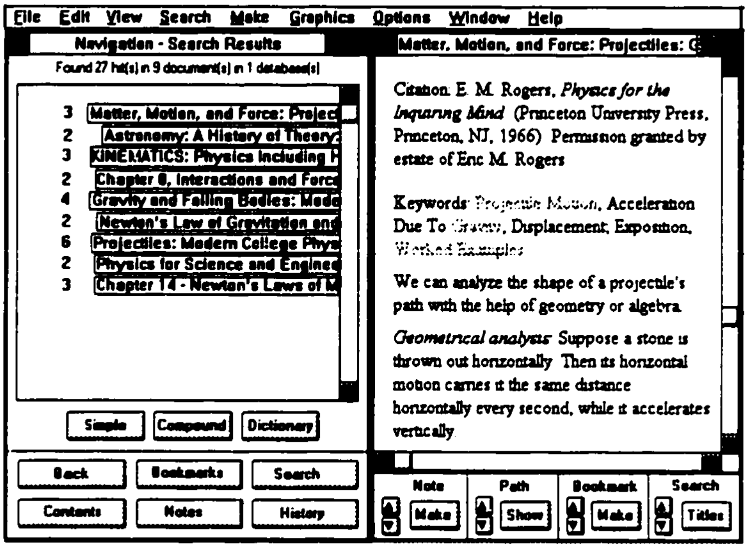


Fig 8

Results of doing a Compound Search using Boolean logic in the Textbook Trove.



The compound search also allow users to choose which field and how close queried words were to be found. Results of query from Figure 5 and Figure 6 are shown in Figure 7 and Figure 8 respectively. This method of searching (compound search) was termed mediated querying by Waterworth and Cignelll (1991). More information regarding shopping in the InfoMall can be found in the *Physics InfoMall* User's Guide.

3.3 Measuring Instruments

Data gathering for this study was a challenge since our subjects were scattered all around the country. In addition, the subjects were volunteers and the only incentive for them was getting the Third Version of the *Physics InfoMall* at a reduced cost. Subjects were teachers at high schools and it was just amazing for them to find time, amidst their teaching responsibilities, to contribute data for our study. Hence, we cannot expect to receive many subjects to participate in the study. In fact, the participation of 72 subjects (about 20%) of the total sampling was very encouraging.

One method of collecting information on how teachers use a CD-ROM was by capturing keystrokes. This method was used by Brueggeman (1989) to capture CD-ROM usage in the DOS environment. Data which accumulated during the day was collected by the researchers at the end of the day to prepare the system for another day of data collection. This method of data collection was feasible since subjects for the study are at a centralized location.

We opted not to use the keystroke method to collect data. Teachers in our study were located in many parts of the country and hence, do not use the same machine when shopping in the *Physics InfoMall*. Furthermore, teachers would use the *Physics InfoMall* in many sessions and any attempt to keep track of all the information in all the sessions would get very confusing to both the teachers and us, the evaluators. Thus, we designed feedback evaluation forms to collect information on how teachers use the *Physics InfoMall*. These feedback forms were unique to the *Physics InfoMall* but could be adapted for use with other databases.

The feedback forms were distributed along with the *Physics InfoMall* package that teachers received. In addition, teachers also received a list of physics topics that we had selected, and instructions on how to record their information exploration strategies. The topics were chosen in anticipation of the order in which physics topics are usually taught.

For example, the October group was asked to record information for sessions when they were seeking information on Projectile Motion, Momentum and Energy Conservation. Teachers who do not teach the suggested topics were asked to choose any other topic and to indicate the topic in the returned feedback form. The March group was asked to work on Electricity and Magnetism, Waves and Light, and Quantum (Modern) Physics, in addition to the topics similar to the October group. In the letter that was sent to teachers along with the feedback forms, the groups were given instructions on how to record their sessions,. A copy of the letter is included in Appendix B. In addition to a Sample feedback form, the March group received additional instructions on how to complete the feedback form. The instructions are printed at the top of the evaluation form.

The feedback forms can be found in Appendix C. In both forms, subjects were asked to record the lesson components for the lesson they were preparing for each of the topics. For each of the lesson component, they would then identify the stores that they entered to access information. Once in the store, they recorded the means of retrieving information. Simple searching was categorized into searching for a word or searching for a phrase. Compound searching was categorized by either all fields or selected fields. Notice that the instrument allowed us to collect details of compound searching. This information was not analysed in this current study, but is very useful for future evaluations.

For each lesson component of a topic, subjects were asked to use a different feedback sheet. Unfortunately, this aspect was not made clear in the October feedback form. As a result, many just lumped together all information in one sheet. Detailed analysis of searching information for a component on each topic is not possible because of this confusion. The present analysis does not require this level of detail and is not hampered by the lack of information. However, it will pose problems for future work. This flaw was remedied in the revised feedback form sent out in March. Using flowcharts and a coding scheme as indicated in the sample feedback (Appendix C), it is possible to track down all the possible iterations for each component. The specific command at the end of the flow diagram asking subjects to use a new sheet for a different component seemed to work very well. Except for two observations (an observation is a topic that each individual did), the field testers used different sheets for different components.

The feedback forms were designed to collect, for each observation, the following information:

- For what lesson components are teachers choosing when using the *Physics InfoMall*?
- Which store was entered?

- What was the query mode--browsing, simple search-word, simple search-phrase, compound searching in all fields of the documents or compound searching in selected fields of the documents?
- How was a compound search executed? What keywords were used? Which fields selected? What choice of word proximity was used?
- How much of the retrieved information was utilized for teaching?
- For each lesson component and for each topic, how many iterations did the teachers use?
- How much time did they spend to complete a plan?

All of the questions above can be answered qualitatively and quantitativley using the March evaluation sheet while the October sheet lacks the accuracy for good quantitative analysis due to grouping of many lesson components on the same sheet.

3.4 Preparing Data for Analysis

Information for each observation was entered into a spreadsheet. For the October feedback form, all the information on the form was entered into spreadsheet including subjects' remarks and comments. However, the volume of information from the March feedback form was remarkably big and prohibited us from doing a similar analysis. Hence, the information was transferred to a master sheet and categorized according to academic specialization and computer platform. Only the data required for this study was entered into a spreadsheet for the March feedback.

Analysis of the data was mostly done on Quattro Pro for Windows Version 1.0®. This includes converting raw frequency to frequency proportion, graphing the proportion, determining statistical significance in the proportion using z test, chi square analysis, t-test for two independent samples and analysis of variance (ANOVA). Chi square analysis, t-test two for independent samples, ANOVA, Mann-Whitney and Kruskal-Wallis were either done or validated in another spreadsheet called Joe Statistical Spreadsheet.

The z-test for proportion was used to do comparisons in relative frequencies where the number of lesson plans in the groups being compared were unequal. We used this statistic to test if differences for variables between the crossover and prepared teachers and variables for the October and March instruments were statistically significant. ANOVA was used to check if the mean values for information exploration categories between three groups with different teaching experiences were significantly different. The Kruskal Wallis test was used in the case where the lesson plans in any one of the three groups were less than 20. When differences for mean values of information exploration variables between crossover and prepared teachers were checked for significance, the t-tests for two independent samples were used. Having three groups for teaching experiences, the chi square analysis was chosen to detemine if differences in frequency between the groups were significant. For the differences in mean values between the groups, the Mann-Whitney test was used to check if the differences is statistically significant.

Chapter 4
Results and Discussion

4.1 Overall Results - Ranking and Effect of Instruments

The analyzed data will be presented in descriptive ways throughout the rest of this chapter. Wherever applicable, results of statistical analysis will be tabulated and significant differences will also be indicated in the graphs.

The frequencies for each of the variables in this work were translated into frequency proportion since the total frequency for each variable was different. This translation will give readers a better understanding when looking at differences for each of the variables. For example, out of 169 observations (lesson plans), 96 observations were for demonstrations. This translated to 57%. Out of the same 169 observations, 74 planned for laboratories. Here the proportion was only 44%. Since each lesson component was a separate variable, the proportion of each was independent of the proportion of other variables. Most analysis for statistical significance was between the proportion of variables belonging to different groups comprised of areas of specialization and teaching experience.

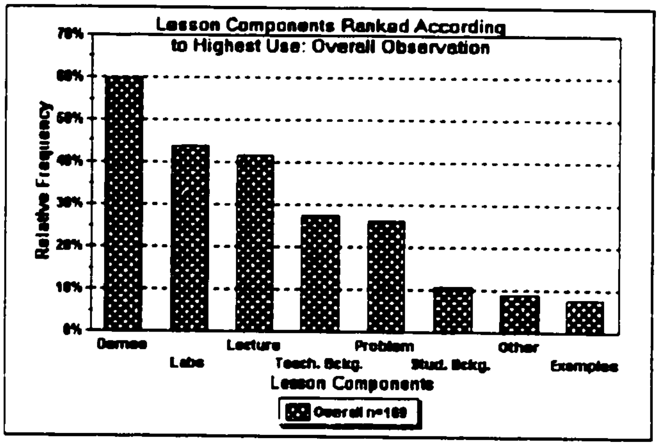
4.1.1 Ranking of Variables

The total number of observations reported in this work was 169. Figures 9a through 9c showed the lesson components, stores entered and query modes, ranked according to hierarchy of proportion.

4.1.1.1 Lesson Component

Teachers predominantly looked for more demonstrations, laboratories, and lectures as compared to problems, teachers' and students' background reading, and examples (see figure 9a). This result was not so surprising to us. In Neuschatz and Alpert's (1994) survey, they asked teachers for suggestions on how to expand and improve physics programs in the high school. Out of 80% who responded, 40% cited improvement of laboratory and laboratory equipment. Only 5% suggested the need to improve teacher's background while 12% suggested increasing students' background and skill. The high percentage of teachers suggesting that laboratories needed improvement was consistent with the high proportion we obtained. It was also consistent with the way courses were structured in which laboratory activities formed a major core of a course (AAPT Guidelines, 1989).

Fig 9*a*
Overall results: A plot of frequency proportion as a function of lesson components.



The low percentage on the need to improve teachers' and students' background reported by Neuschatz and Alpert was not exhibited by our results. Our results indicated a high proportion of teachers wanting to improve their background. We attributed this to the way the question was asked. In our study, teachers used the information available to them to improve themselves while Neuschatz and Alpert merely asked for suggestions on what needed improvement. Another difference was in the way this study was designed. We looked at lesson planning by teachers when using a large physics database as a resource. The Neuschatz and Alpert survey was based on teachers' suggestions only. Hence, the comparisons between the two studies are limited.

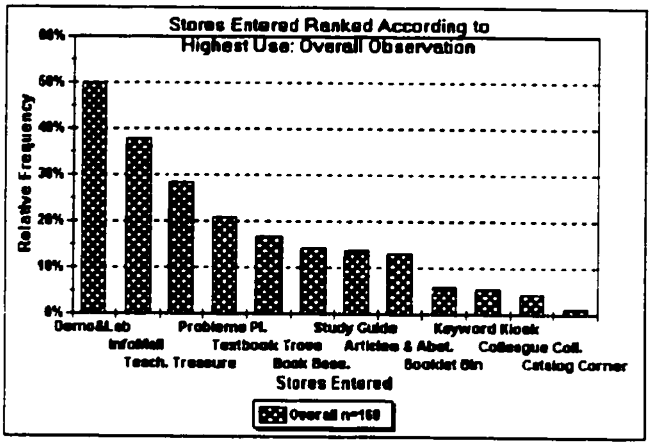
The rest of our results had no comparison with other work since *Physics InfoMall* and this study were the first attempt done in the area of physics. The high frequency percentage for demonstrations and lecture was natural since teachers still adhered to the traditional technique of knowledge dissemination in a classroom setting. Unlike the approach of Laws (1991) where classes were mostly done in an inquiry environment, most other physics educators structure their classes by giving lectures and providing demonstrations and laboratories.

We were surprised by the low percentage of teachers wanting worked examples in their lesson plans. We expected teachers to want more worked examples rather than make their own since it requires more time to make up an example. One reason for this could be the lack of combining qualitative and quantitative examples. It could be that the worked examples were hard to find in the database. It could also be that the examples in the database were mostly basic examples involving only plugging numbers into equations. Either way, the lack of advanced examples such as combining both qualitative (conceptual) and quantitative examples might reduce teacher motivation to use the database as a source of worked examples for lesson planning. Work by Halloun and Hestenes (1985) regarding students' conceptual understanding and the lack of it may have played a role on the teachers' decisions.

4.1.1.2 Stores Entered

Based on the results obtained for variables in the choice of lesson components, it is expected that the Demo and Lab Shop is the most entered store.(see figure 9b). Surprisingly, the Entire InfoMall was ranked high. Although it was usually the easiest way to find any relevant documents, teachers could be swamped by documents since this store contained all the documents in the database. This in turn might deter teachers who were not willing to look at each document before deciding which to incorporate in a lesson plan. On the contrary, our results indicated that the Entire InfoMall was the second most entered store indicating teachers were willing to peruse through large number of documents. The low proportions for Textbook Trove, Book Basement, Study Guide, and Booklet Bin were consistent with the low proportions in teachers' and students' background reading as choices for lesson components.

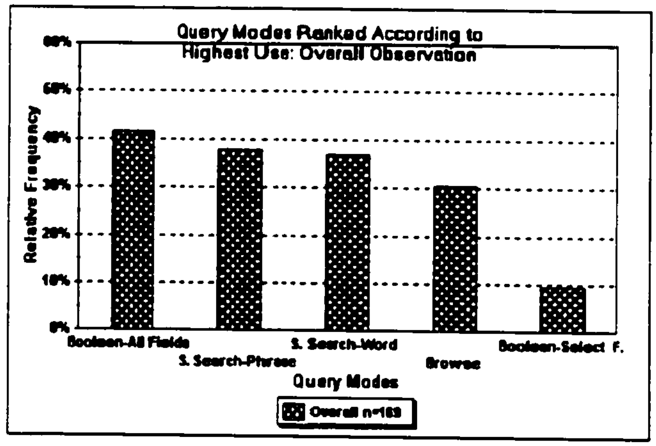
Fig 9b
Overall results: A plot of frequency proportion as a function of stores entered.



4.1.1.3 Query Modes

Our results did not indicate significant differences between the ways teachers queried for information (see Figure 9c). Statistical analysis is discussed in a different section of this chapter. The query modes mostly used was the Boolean searching in all fields of the documents. Recall that documents were structured in the database by title headings, subtitle headings, keywords paragraph document text, and a few others. Accepting the system default (searching in all fields) would result in retrieving more irrelevant documents than searching, for example, in just the keywords field. For example, finding demonstrations for momentum was best done by making the system "look" only in the Keywords paragraph. Boolean searching in selected fields of documents was the least used query mode. We felt that unfamiliarity with the database and the lack of experience working with similar search methods contributed to the result that we observed.

Fig 9c
Overall results: A plot of frequency proportion as a function of query modes.



The modes of querying, Simple Search-Word and Simple Search-Phrase, were partially topic dependent. For example, finding momentum was done by typing "momentum" and finding momentum conservation was done by typing the phrase "momentum conservation." Information retrieval would be more refined by the latter method. In order to understand better the nature of searching in the InfoMall environment, further studies using both the qualitative and quantitative techniques must be done.

The high proportion of teachers using Browse for finding information may not be a big concern here. Although we wanted to include data only from teachers who have used *Physics InfoMall* a few times, we did not have a way of telling the difference unless teachers specifically mentioned they were just browsing for information available in the database. Hence, the high proportion could be contributed by the groups who were using the *Physics InfoMall* the first or second time. We expected to see a lot of browsing among new users as they would be curious to find out what the *Physics InfoMall* had to offer.

4.1.2 Effect of Measuring Instruments

In this work, we used two different feedback forms to gather information. Both forms are attached in Appendix D. The first form was sent out in October, 1993 while the other was sent out in March, 1994. The March forms were sent out to both the October and March group of teachers.

There were 113 observations using the October form and 56 observations using the March form. Figures 10a through 10c showed the comparisons for each of the variables in this work. Table 5 summarized the z values from the z-test for proportion of the variables that showed significant differences.

The proportion for lecture and demonstrations using the March form was significantly lower than that for October (see figure 10a). This result was expected since the March form was designed to remedy flaws in the October form. Specifically, we wanted to isolate one component to one sheet rather than indicating all the choices of lesson components in one sheet. We also found the a lower proportion using the March form for laboratory but the difference was not statistically significant. Obviously, this trend was only visible for those components that were ranked high in figure 9a.

While the proportion of lesson components showing significant differences were lower using the March instrument, the proportion was higher in the stores entered with the exception of the Entire InfoMall (see figure 10b). We credited the high percentage using the March forms to the organization and flow that made the exploration report more structured.

TABLE 5

OVERALL EFFECT OF INSTRUMENTS: Z VALUES FOR LESSON COMPONENTS, STORES ENTERED AND QUERY MODES

Lesson Components	z_{obt} [z_{crit} = 1.96, 2.58, 3.30; α = 0.05, 0.01, 0.001]
Lecture	2.06, α = 0.04
Demos	3.82, α = 0.0002
InfoMall	2.77, α = 0.0056
Textbook Trove	-2.52, α = 0.0124
Articles & Abstracts	-2.77, α = 0.0056
Demo & Lab Shop	-3.00, α = 0.0026
Problems Place	-3.79, α = 0.0002

TABLE 5 -Continued

Simple Search-Word	-4.56, $\alpha = 0.0000$
Simple Search-Phrase	-3.64, $\alpha = 0.0004$
Boolean Search-All Fields	-5.24, $\alpha = 0.0000$

Fig 10a

Overall results on the effect of measuring instruments: A plot of frequency proportion as a function of lesson components.

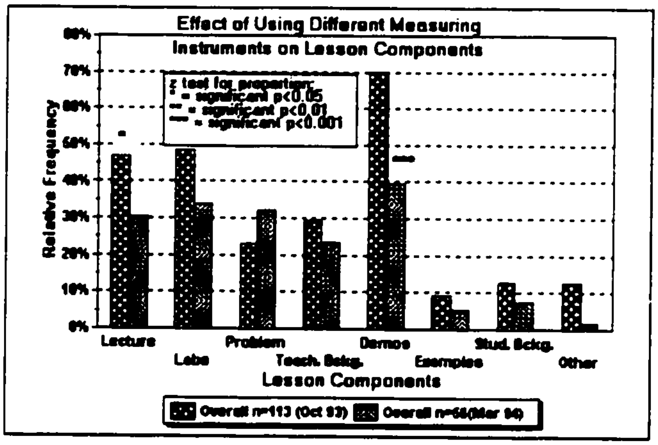
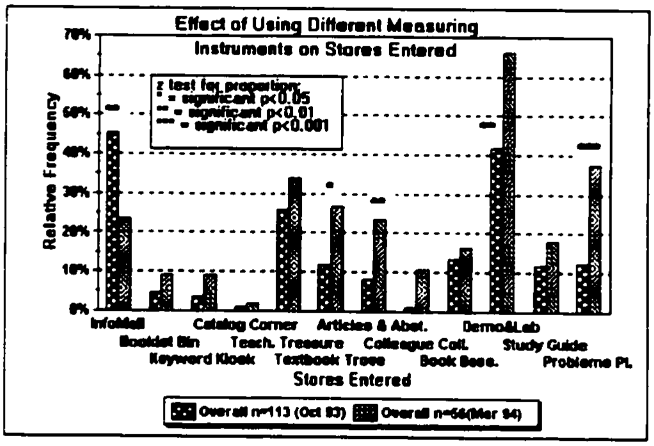


Fig 10b

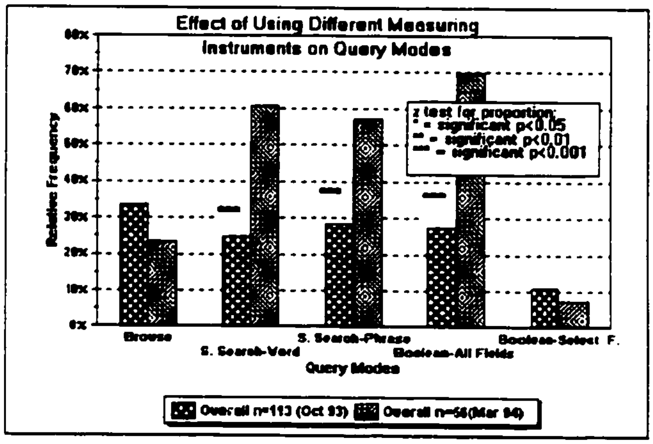
Overall results on the effect of measuring instruments: A plot of frequency proportion as a function of stores entered.



In the feedback forms, we asked teachers to indicate numbers of each store they entered for each lesson components. Since most components were on different sheets, the high frequency of stores entered can easily be accounted for. The stores entered using the October form may well have had the same proportion, but we cannot account for this from the data since many components were checked in the very same sheet. At present, we do not understand why the Entire InfoMall showed a higher percentage using the October sheet. This was inconsistent with the other stores that showed significant differences.

The effect of structuring in the March instrument was also very obvious in the result for query modes (see figure 10c). Simple searching using words or phrases and searching using Boolean logic in all fields of documents showed significantly higher proportion using the March instrument. We shall refer readers to Appendix A for further results on the effect of instruments due to teachers' areas of specialization and teaching experience.

Fig 10c
Overall results on the effect of measuring instruments: A plot of frequency proportion as a function of query modes.



4.2 Effect of Areas of Specialization

In the previous section, we discussed an overall result on how frequently teachers indicated their use of different lesson components, stores entered and query modes while exploring information in the *Physics InfoMall* for lesson planning. The overall results were made up of observations from crossover and prepared physics teachers. This section will present results and discussions regarding the same variables but comparisons will be made between two groups of teachers, the crossover and prepared teachers.

4.2.1 Lesson Components

Both crossover and prepared teachers used Demonstration, Lecture, Laboratory and Teacher Background Reading most frequently (see figures 11a and 11b). The other four components were chosen less frequently by both groups. Variable-by-variable comparison of the frequency of each lesson component between the two groups of teachers revealed only Lecture (see table 5 and figure 11c) as having a significant difference.

Fig 11a
Effect of specialization: A plot of relative frequency as a function of lesson components for crossover teachers.

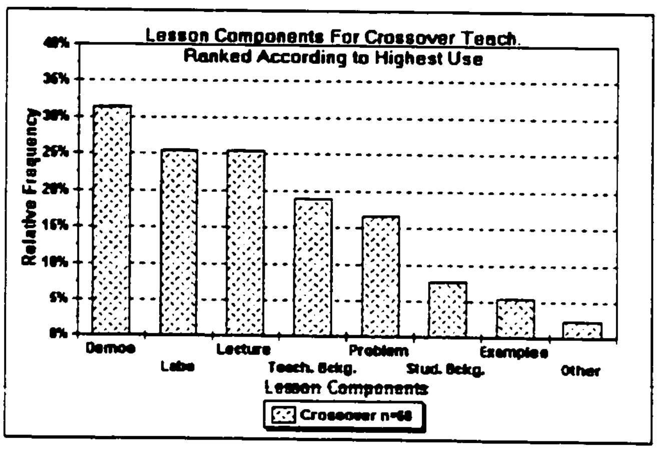
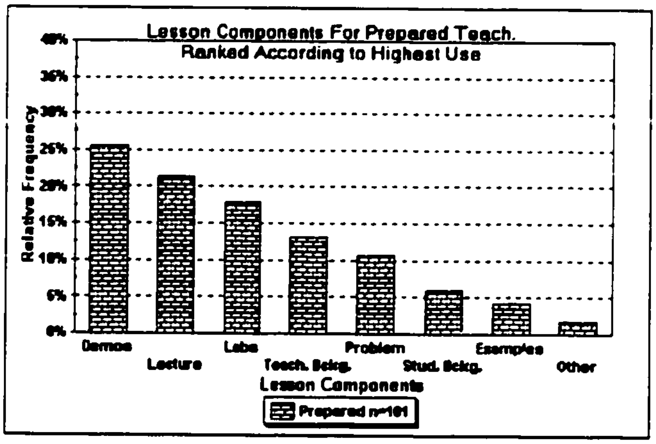


Fig 11b
Effect of specialization: A plot of relative frequency as a function of lesson components for prepared teachers.



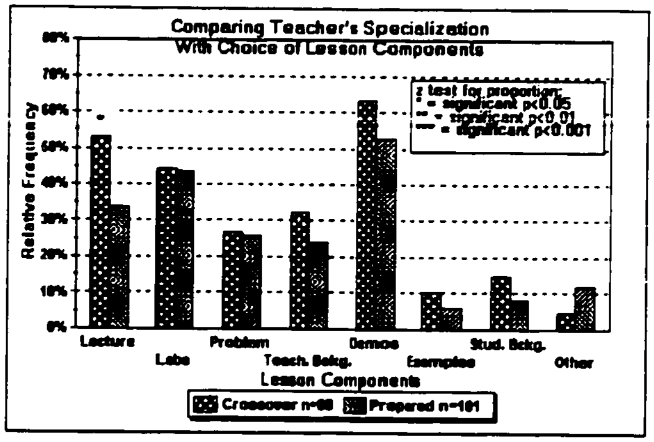
A higher proportion of crossover teachers used the *Physics InfoMall* to prepare for lectures than did the prepared teachers. This result could be attributed to the fact that crossover teachers lacked physics training. Thus, they needed materials from the *Physics InfoMall* more than prepared teachers when developing a lecture. We had anticipated a higher proportion of crossover teachers using the *Physics InfoMall* for background reading. Although it was higher, the difference was not statistically significant.The reason for this results needs further investigation.

TABLE 6

EFFECT OF SPECIALIZATION: z VALUES FOR LESSON COMPONENTS

Lesson Components	Crossover (XT) & Prepared (PT) Teachers-Combined Data z_{oht} [z_{crit} = 1.96, 2.58, 3.30; α = 0.05, 0.01, 0.001]
Lecture	2.49, α = 0.012

Fig 11c
Effect of specialization: A plot of relative frequency as a function of lesson components for crossover and prepared teachers.



4.2.2 Stores Entered

The stores that teachers entered to extract information depended on the lesson components the information was for. Since teachers in both groups concentrated on demonstrations, laboratories and lectures, we expected to see similarities in the stores they entered. Our results showed that indeed this was the case (see figure 12a and 12b). One surprising result was the low percentage of teachers entering the Textbook Trove and Book Basement even though a high proportion indicated using *Physics InfoMall* to prepare for lectures. We were expecting to see a positive correlation between the two variables (preparing for lecture and entering the Textbook Trove and Book Basement), but our results did not show this.

Fig 12a
Effect of specialization: A plot of relative frequency as a function of stores entered by crossover teachers.

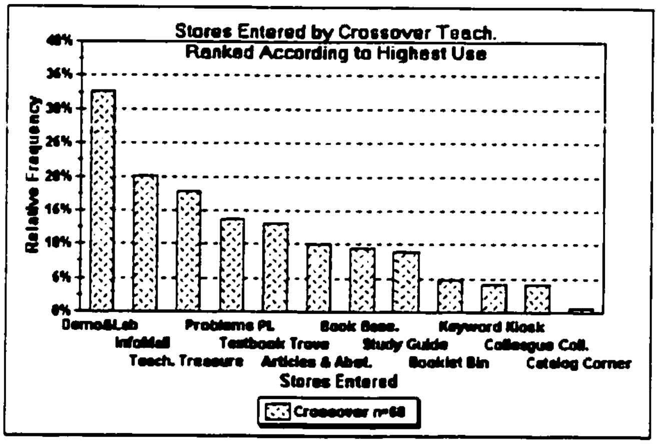
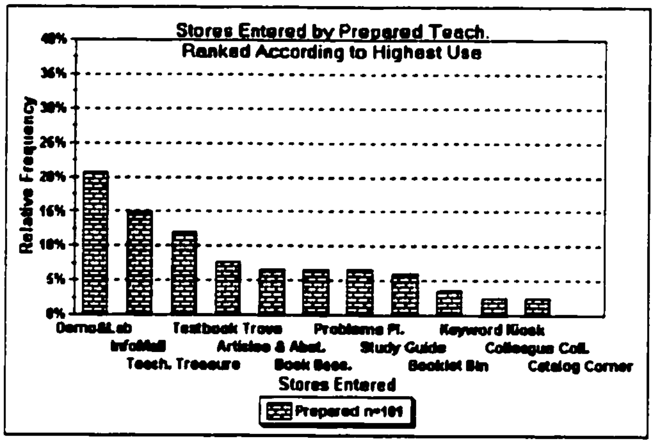
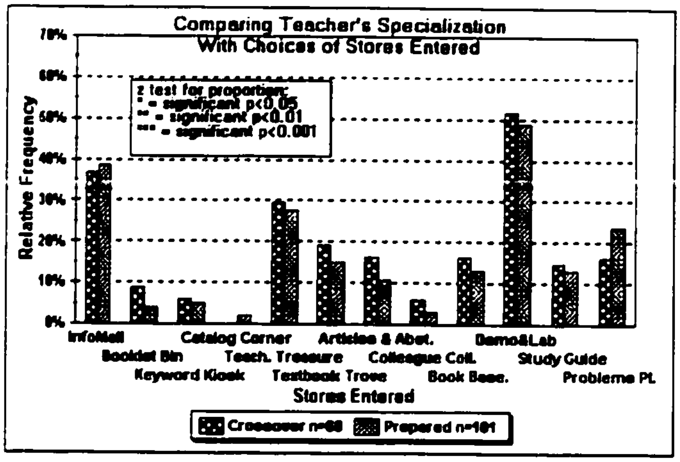


Fig 12b
Effect of specialization: A plot of relative frequency as a function of stores entered by prepared teachers.



Comparison of proportion for each store between the two groups of teachers (see figure 12c) did not produce any significant differences. This was consistent with the choice of lesson components on which both groups concentrated. Again, we were not able to identify where teachers would look for materials in preparing for lectures.

Fig 12c
Effect of specialization: A plot of relative frequency as a function of stores entered by crossover and prepared teachers.



4.2.3 Query Modes

Close similarities appeared in the way the groups queried for information. Both crossover and prepared teachers showed a very high percentage for Boolean searching in all fields of the documents and very low proportion on Boolean-searching in selected fields of the documents (see figures 13a and 13b). It did not seem that query modes were influenced by which group a teacher belongs to, crossover or prepared teachers.

A comparison made using z test for proportion failed to show significant differences for any of the query modes between the two groups. We expected that query modes should not depend on whether a teacher was a crossover or a prepared teacher. Rather, it was a function of familiarity with querying in electronic databases in general and the *Physics InfoMall* specifically. We speculated that if teachers have had experience in online searching offered by libraries, they might show higher efficiency in information retrieval independent of their area of specialization, as was found by Wang and Liebscher (1988).

Fig 13a
Effect of specialization: A plot of relative frequency as a function of query modes for crossover teachers.

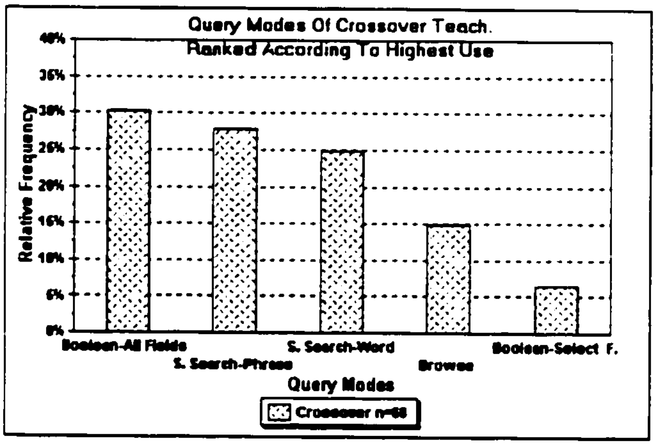


Fig 13b
Effect of specialization: A plot of relative frequency as a function of query modes for prepared teachers.

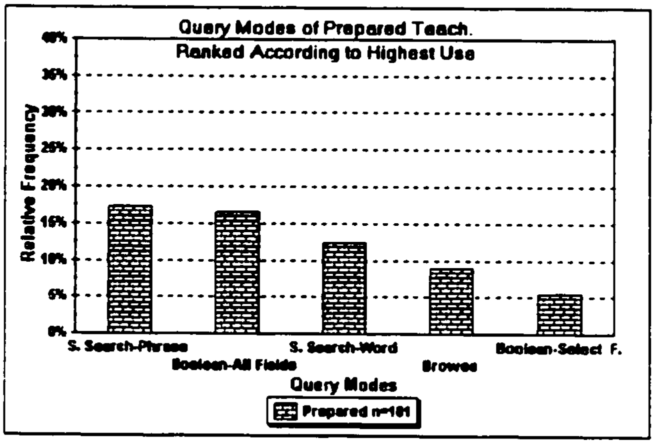
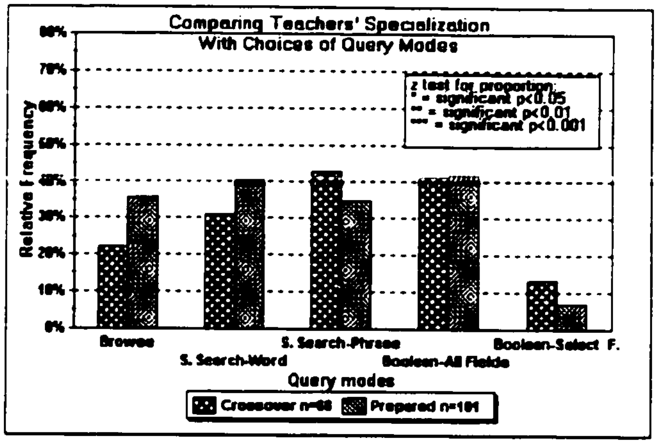


Fig 13c
A plot of relative frequency as a function of query modes for crossover and prepared physics teachers: Effect of specialization.



4.2.4 Mean Values for Information Seeking Categories

In addition to comparing lesson components, stores entered and query modes, we compared mean values for the above mentioned categories and a few more variables which formed the Information Seeking Category variables. These variables included time spent to complete an observation, the ratio of information used to information retrieved and the number of iterations per observation (Note that an observation is an act of lesson planning). We found that on average, the number of lesson components per observation for crossover teachers were significantly higher than that for the prepared teachers (see figure 14 and table 7).

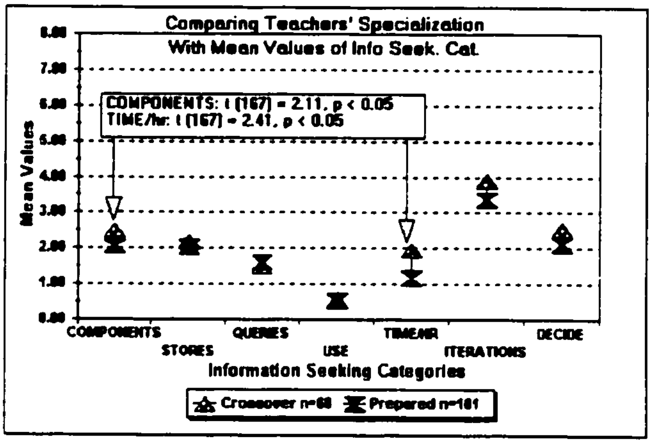
The same was true for the time spent to complete an observation. Crossover teachers, on average, spend significantly more time than did the prepared teachers to complete an observation. We believed this was due to content familiarity of prepared teachers. Crossover teachers were more likely to spend more time going through retrieved documents instead of quickly scanning through the content of each document. On the other hand, prepared teachers may have encountered some of the retrieved documents prior to *Physics InfoMall*. Hence, in efforts to spice up their teaching material, they would show interest only in documents which were new to them.

TABLE 7

EFFECT OF SPECIALIZATION: t VALUES AND MEAN VALUES FOR INFORMATION SEEKING CATEGORIES BETWEEN CROSSOVER AND PREPARED TEACHERS

Crossover (XT) & Prepared (PT) Teachers-Combined Data		
Information Seeking Categories	Mean Values	t values
COMPONENTS	XT=2.48, PT=2.05	t_{obt} (167) = 2.11 [t_{crit} =1.98, α<0.05]
TIME/hr	XT=1.93, PT=1.16	t_{obt} (167) = 2.41 [t_{crit} =1.98, α<0.05]

Fig 14
Effect of specialization: A plot of mean values as a function of information seeking categories for crossover and prepared physics teachers.



4.3 Effect of Teaching Experience

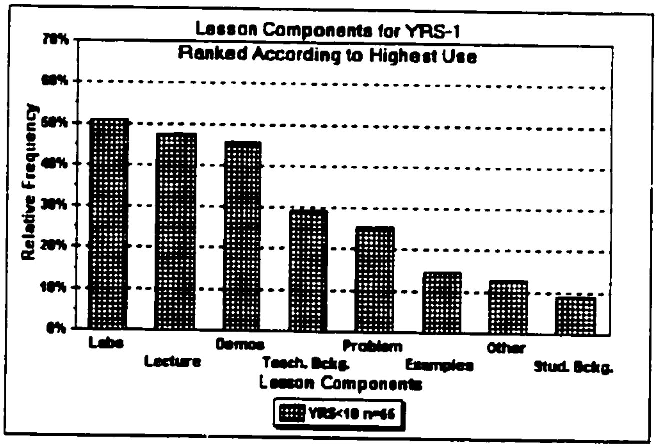
Teachers in this study had a large range of different teaching experiences. Some had taught for more than thirty years while a few had only begun to teach (see chapter 3). We were interested in looking at how the numbers of years of teaching experience affect the choice of lesson components, stores entered, query modes and mean values of the information seeking categories. In order to achieve this objective, we divided the observations received into three groups: YR-1 (less than ten years experience), YR-2 (greater or equal to ten but less than twenty years experience) and YR-3 (greater or equal to twenty years experience). We performed the same analysis as we did for areas of specialization.

4.3.1 Lesson Components

Figures 15a through 15c showed the relative proportion of use of the lesson components for all three groups. The bar graphs in each group were arranged in descending order. For the YR-1 group (see figure 15a), Laboratory, Lecture, Demonstration and Teacher Background Reading made up the first four highly chosen components with Student Background Reading being the least chosen component. The YR-2 group (see figure 15b), selected Demonstration, Lecture, Laboratory and Problem as the top four choices with Example as the least chosen component. The YR-3 group (see figure 15c) placed Demonstration, Laboratory, Teacher Background Reading and Lecture as the four most frequent choices with Example as the least frequently used.

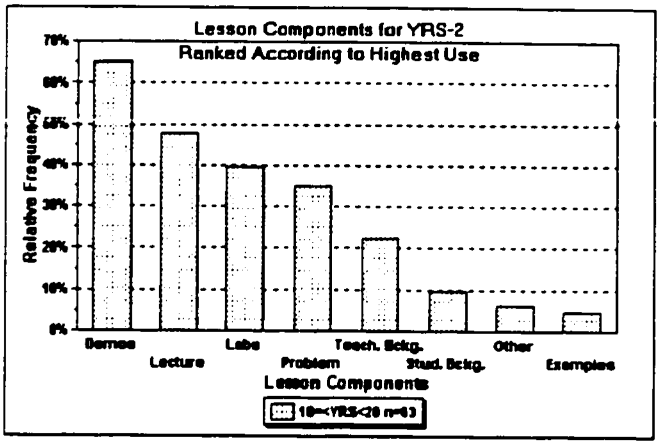
An interesting result was the fact that Teacher Background Reading placed very high for the YR-3 group compared to the other groups. In addition, Demonstration appeared to be the most frequent choice for teachers with more than ten years teaching experience but only placed third for teachers with less than ten years teaching experience. The latter group also chose Example more frequently than teachers with more than ten years teaching experience.

Fig 15a
Effect of teaching experience: A plot of relative frequency as a function of lesson components for teachers with less than ten years experience.



Neuschatz and Alpert (1994) found that teachers who had been teaching for more than ten years as teachers who were comfortable teaching physics. In their survey 59% teachers in the YR-1 group indicated not being comfortable teaching laboratory techniques as opposed to only 32% of teachers in the YR-2 and YR-3 groups. We believed that both specialists and career physics teachers knew the subject well in terms of the content and were fairly comfortable with laboratories and demonstrations skill. Enriching their lesson plans were best done by providing more visual physics, achieved through more demonstrations. Hence, our results show the high percentage for demonstrations in their lesson plans.

Fig 15*b*
Effect of teaching experience: A plot of relative frequency as a function of lesson components for teachers with greater than or equal to ten but less than twenty years experience.



Results also showed that teachers with less than ten years teaching experience considered laboratories and lecture as needing more attention (figure 15a). This was very consistent with Neuschatz and Alpert's findings. The teachers in this group also showed high frequency in retrieving information for the Example component of their lesson plans. This was neither discussed by Neuschatz and Alpert nor consistent with teachers with more than ten years teaching experience. One aspect of Neuschatz and Alpert's findings worth mentioning was that 22% of the teachers surveyed were female. Thirty five percent of the female teachers were not comfortable teaching physics laboratories and 24% not comfortable applying physics to everyday life as opposed to 31% and 17% of the male teachers. Female teachers accounted for one third of the teachers in the YR-1 group. This could be a factor why our results differ from those of Neuschatz and Alpert.

We were not able to explain the high proportion of teachers with over twenty years experience desiring more materials for Teacher Background Reading. We might expect the less experienced teacher to desire more background reading than the experienced ones, but our results indicated otherwise. We think that new teachers were worried about their day-day activities getting themselves ready with materials to disseminate in a classroom rather than worrying if they really knew the depth and breadth of the subject matter. On the other hand, experienced teachers, having taught physics for so long, spend less time gathering the day-day activities. Hence, they have more time to read through the textbooks available in the Physics InfoMall.

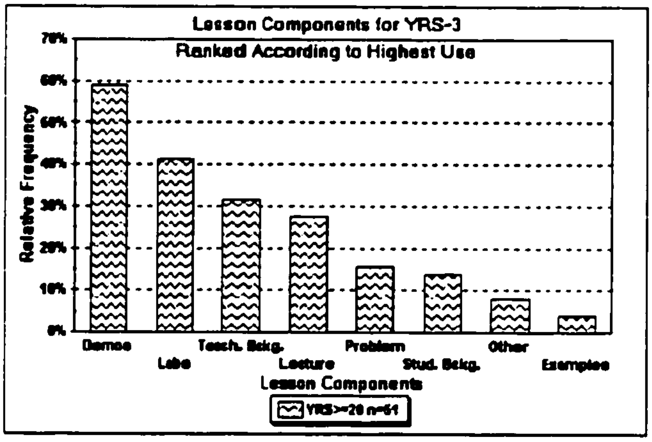


Fig 15c
Effect of teaching experience: A plot of relative frequency as a function of lesson components for teachers with greater than or equal to twenty years experience.

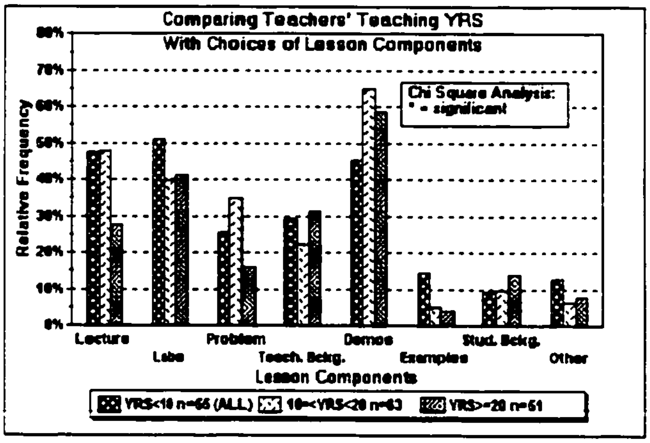


Fig 15d
Effect of teaching experience: A plot of relative frequency as a function of lesson components for teachers with different teaching experience.

Using the Chi Square analysis, we compared each variable for all three groups to see if the difference in proportion was significant. None of the variables showed significant differences between the three groups (see figure 15d). Even so, our results showed that teachers with less than ten years teaching experience concentrated more on materials for laboratories, demonstrations, lecture and examples. Our results also exhibited that the longer you teach, the more inclined you were to look for more demonstrations.

4.3.2 Stores Entered

Consistent with the choice of lesson components, Demo and Lab shop was the most entered store for all groups (see figure 16a through 16c). Teachers Treasure, containing many demonstrations and activities submitted by fellow teachers was also a favorite store along with the Entire InfoMall. Recall that entering the Entire InfoMall permitted a teacher to access every document available in the database.

Since teachers in the YR-3 group chose Teacher Background Reading as high in their choice of lesson components, naturally Textbook Trove would also place high on the stores they entered most. Nevertheless, a Chi Square analysis did not show any significant difference for any of these stores when a comparison is made between the two groups (see figure 16d). We may need more observations from all three groups and to restrict ourselves to one topic at a time to understand further our results. We will, if this study is extended, use only the March evaluation forms due to the results discussed in section 4.1 and Appendix A.2.

Fig 16a

Effect of teaching experience: A plot of relative frequency as a function of stores entered for teachers with less than ten years experience.

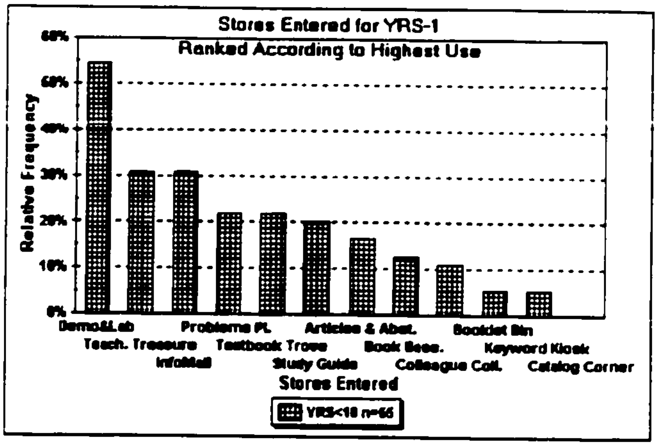


Fig 16b

Effect of teaching experience: A plot of relative frequency as a function of stores entered for teachers with greater than or equal to ten but less than twenty years experience.

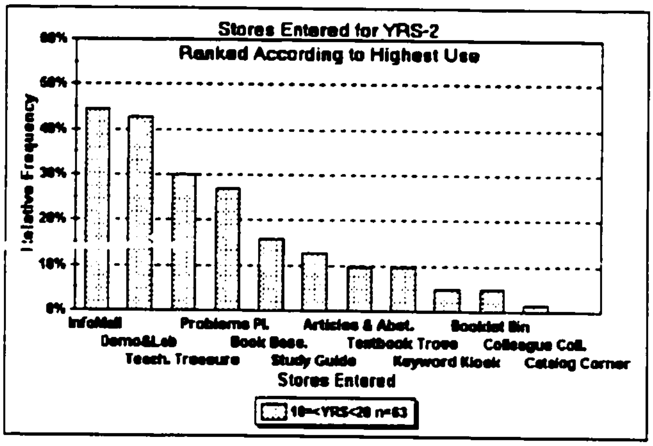


Fig 16c
Effect of teaching experience: A plot of relative frequency as a function of stores entered for teachers with greater than or equal to twenty years experience.

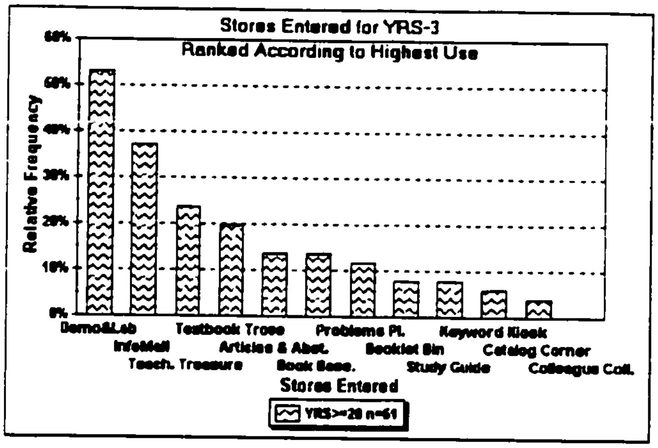
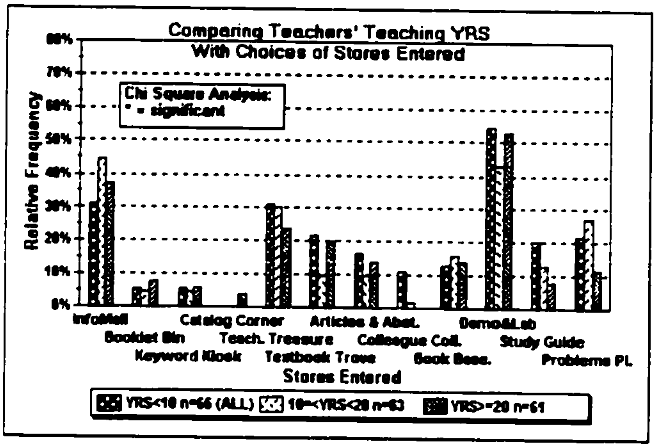


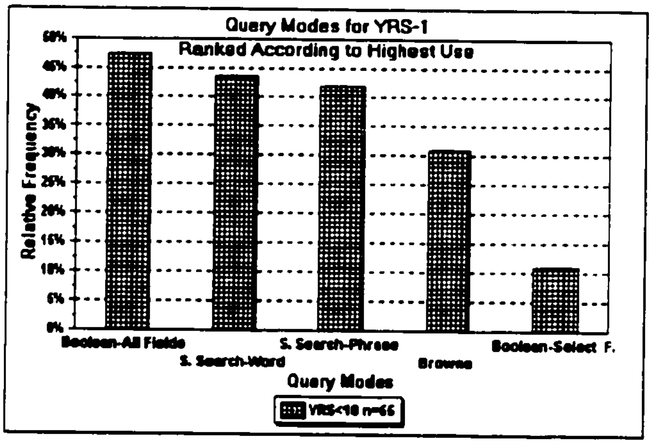
Fig 16d
Effect of teaching experience: A plot of relative frequency as a function of stores entered for teachers with different teaching experiences.



4.3.3 Query Modes

We did not see significant difference between the three groups' information seeking modes. All groups utilized the Boolean logic and accepted the system's default of searching in all fields of the documents (see figure 17a through 17c).

Fig 17a
Effect of teaching experience: A plot of relative frequency as a function of query modes for teachers with less than ten years experience.



A very small proportion of teachers selected specific document fields when doing the search. All groups browsed in the database to find information but most information seeking was done by searching, either by word or phrase or using Boolean logic. A Chi Square analysis to compare the groups' proportion for each query mode did not reveal any significant differences (see figure 17d). Hence, we inferred from our results that teaching experience had no effect on what query modes was used in information exploration. It had to do with some other experiences, not particularly related to experiences in teaching physics.

Fig 17b
Effect of teaching experience: A plot of relative frequency as a function of query modes for teachers with greater than or equal to ten but less than twenty years experience.

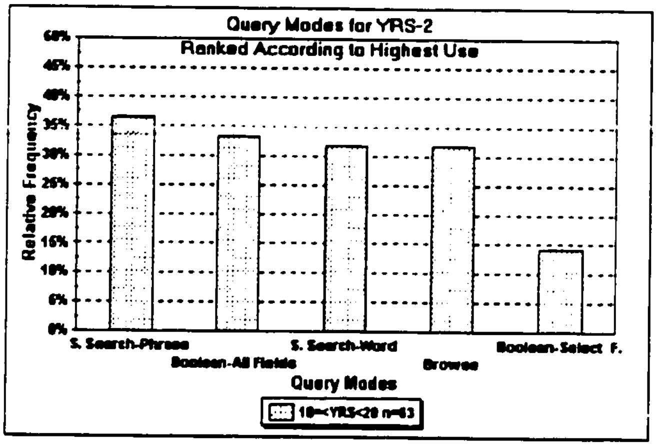


Fig 17c
Effect of teaching experience: A plot of relative frequency as a function of query modes for teachers with greater than or equal to twenty years experience.

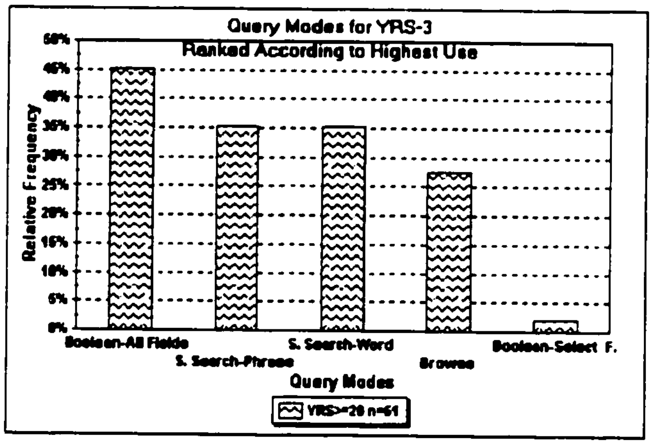
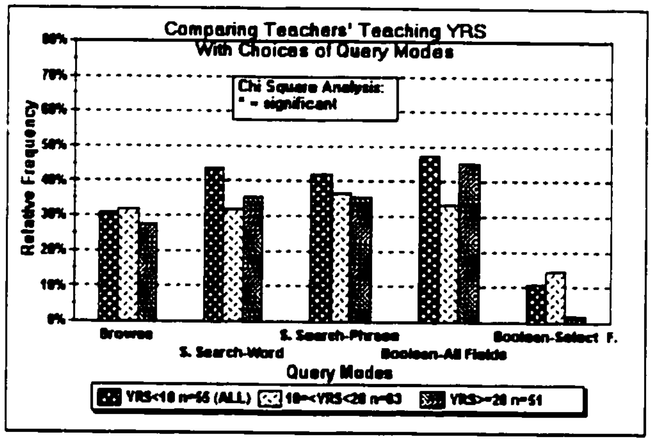


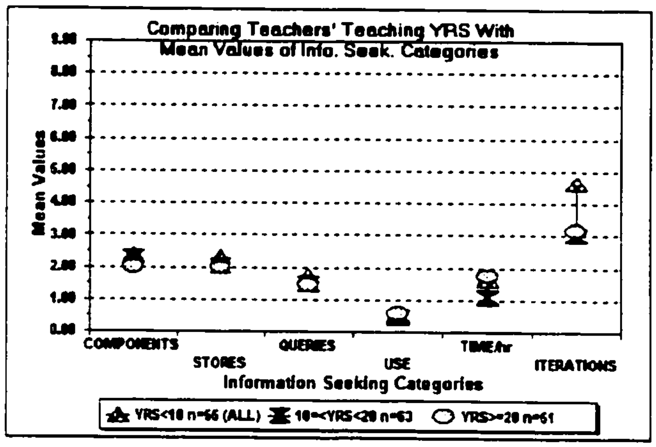
Fig 17d
Effect of teaching experience: A plot of relative frequency as a function of query modes for teachers with different teaching experiences.



4.3.4 Mean Values for Information Seeking Categories

Our results for the mean values between the three groups of experiences showed no differences between the groups except for iterations per observation but the difference was not significant (see figure 18).

Fig 18
Effect of teaching experience: A plot of mean values as a function of information seeking categories for teachers with different teaching experiences.



On average, all three groups completed the same number of components, entered the same number of stores, used the same number of query modes, extracted the same percentage of information retrieved and spent the same amount of time completing an observation. Teachers with less than ten years teaching experience appeared to go through a higher number of iterations (more than four) as compared to only three by the other groups. This difference was not statistically significant when the difference was checked using Analysis Of Variance (ANOVA). We suggest that more observations be taken to understand further the result.

4.4 Effect of Specialization and Teaching Experience

In the last two sections, we presented results on how specialization and teaching experience separately influenced factors such as choice of lesson components, stores entered, query modes and mean values for variables called information seeking categories. This section presents results for the same variables but here, we look at the combined effect of specialization and teaching experience.

4.4.1 Lesson Components

We wanted to look at differences, if any, for crossover teachers with less than ten years (YR-1), between ten and twenty years (YR-2) and more than twenty years (YR-3) teaching experience, on the choice of lesson components. We attempted to do the same with prepared teachers.

Using Chi Square analysis, we determined if differences between the three groups of crossover teachers and the three groups of prepared teachers for each component of the lesson components is significant. As shown in table 8, figure 19a and figure 19b, there were some components showing significant differences. Crossover teachers with less than ten years experience showed significantly higher proportion for components Laboratory and Examples. The percentage for Laboratory showed a decrease in going from less experience to very experienced teachers. On the other hand, we did not see this in Examples. None of the teachers in YR-2 chose to include examples in their lesson plan.

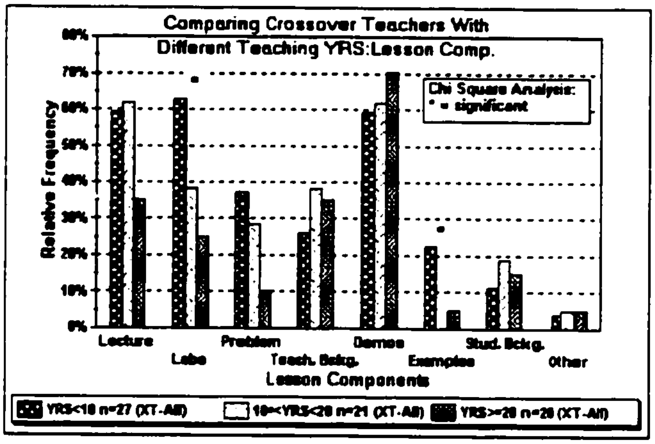


Fig 19a
Effect of specialization and experience: A plot of frequency proportion as a function of lesson components for crossover teachers with different experiences.

TABLE 8

EFFECT OF SPECIALIZATION AND EXPERIENCE: CHI SQUARE VALUES FOR LESSON COMPONENTS

Lesson Components	Crossover Physics Teachers $\chi^2_{obt}(2)$, $\alpha < 0.05$ $[\chi^2_{crit}(2) = 5.99, \alpha < 0.05]$	Prepared Physics Teachers $\chi^2_{obt}(2)$ $\alpha < 0.05$ $[\chi^2_{crit}(2) = 5.99, \alpha < 0.05]$
Lecture	Not Significant	6.73
Labs	8.41	Not Significant

TABLE 8 - CONTINUED

Problems	Not Significant	9.32
Teacher Background	Not Significant	7.03
Demos	Not Significant	11.95
Examples	8.10	Not Significant
Others	Not Significant	7.35

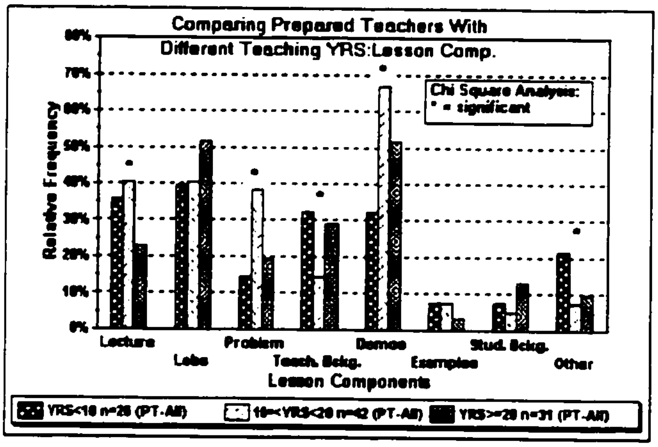
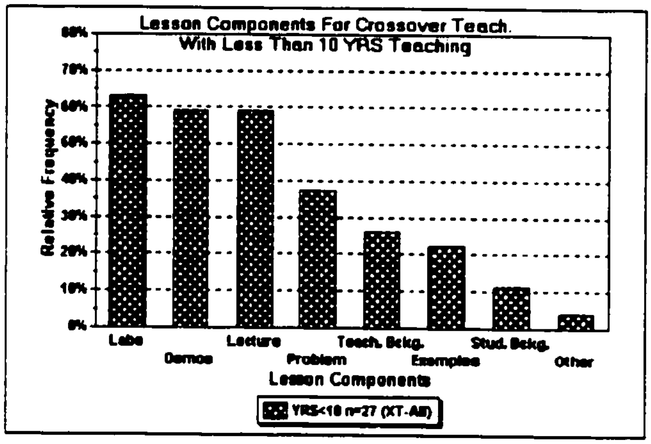


Fig 19b
Effect of specialization and experience: A plot of frequency proportion as a function of lesson components for prepared teachers with different experiences.

While crossover teachers in the YR-1 group chose Laboratory and Example more so than the other components, results for the prepared teachers did not share this trend. Lecture, Problem, Demonstration and Other components showed significant differences between the three groups of prepared teachers. No definite trend shows that one particular group had a higher proportion for all four components that exhibited significant differences. However, teachers with more than ten years experience showed much higher proportion for Demonstration component. In addition, the YR-1 and YR-3 groups showed higher proportion for Teacher Background Reading while Problem appeared to be a very frequent choice for teachers in the YR-2 group.

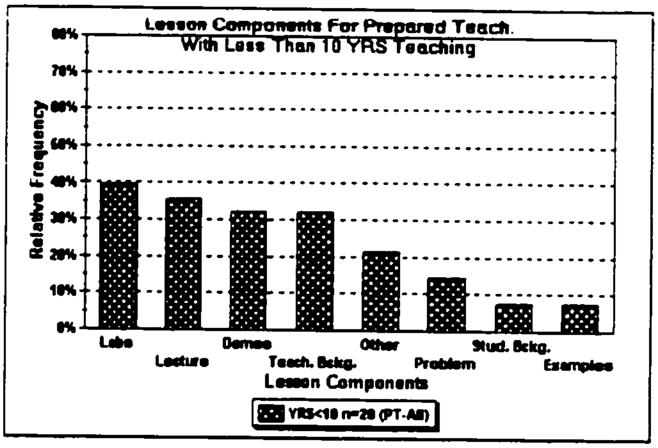
Figures 20a through 20c shows comparisons between crossover and prepared teachers with less than ten years teaching experience. Both the crossover and prepared teachers indicated Laboratory, Lecture and Demonstration as their favorite components. While crossover teachers chose Example as the sixth highest choice, prepared teachers chose this component as the least frequent component. In fact, prepared teachers in this group chose Teacher Background Reading as a highly preferred component compared to Example. This feature was not exhibited by the crossover teachers with the same teaching experience.

Fig 20a
Effect of specialization and experience: A plot of frequency proportion as a function of lesson components for crossover teachers with less than ten years experience.



A component-by-component comparison between the crossover and prepared teachers using the z-test for proportion revealed crossover teachers' proportion for Lecture, Laboratory, Demonstration and Problem to be significantly higher than prepared teachers' proportion (see table 9 and figure 20c). Due to the lack of any other studies, these results could not be compared. The significant differences for the four components were not surprising to us but we would expect to see the same result in Teacher Background Reading and Example.

Fig 20b
Effect of specialization and experience: A plot of frequency proportion as a function of lesson components for prepared teachers with less than ten years experience.



We performed the same analysis for teachers with the YR-2 group. The top three choices for lesson components were consistent with teachers in the YR-1 group. It was quite surprising that crossover teachers did not choose Example while prepared teachers did (see figure 21a and 21b). Comparisons using the z-test for proportion showed crossover teachers had a significantly higher proportion for Lecture and Teacher Background Reading (see figure 21c and table 9). Amazingly enough, crossover teachers in the YR-1 group showed a significant proportion only for the Lecture component and not the Teacher Background Reading.

TABLE 9

EFFECT OF SPECIALIZATION AND EXPERIENCE: z VALUES FOR LESSON COMPONENTS

	Years Teaching		
	z_{obt} [z_{crit} = 1.96, 2.58, 3.30; α = 0.05, 0.01, 0.001]		
Lesson Components	10<YRS	10≤YRS<20	YRS≥20
Lecture	3.50	3.41	Not significant
Labs	3.51	Not significant	-3.86
Problem	3.87	Not significant	Not significant
Teach Background.	Not significant	4.55	Not significant
Demos	4.04	Not significant	2.67

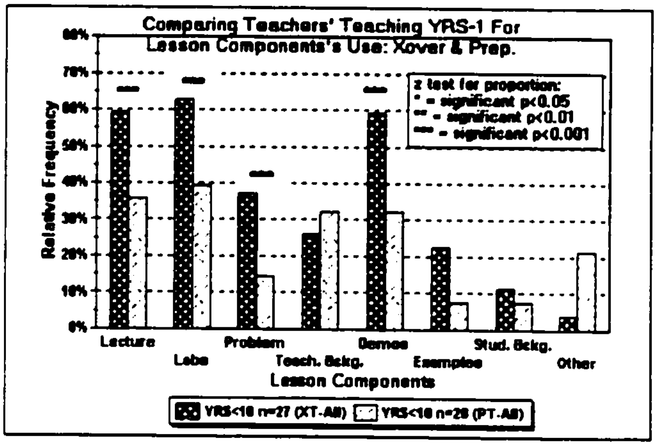


Fig 20c
Effect of specialization and experience: A plot of frequency proportion as a function of lesson components for crossover and prepared teachers with less than ten years experience.

Results for teachers in the YR-3 group showed a remarkable difference from the YR-1. Crossover teachers chose to look for more demonstrations and fewer laboratories while prepared teachers chose both demonstrations and laboratories as being equally important (see figures 22a and 22b). Both groups did not seek many examples for lesson planning when using the *Physics InfoMall*. Using the z-test for proportion, we found that prepared teachers had a significantly higher proportion for laboratories but a significantly lower proportion for Demonstration (see figure 22c and table 9).

Fig 21a
Effect of specialization and experience: A plot of relative frequency as a function of lesson components for crossover teachers with greater than or equal to ten but less than twenty years experience.

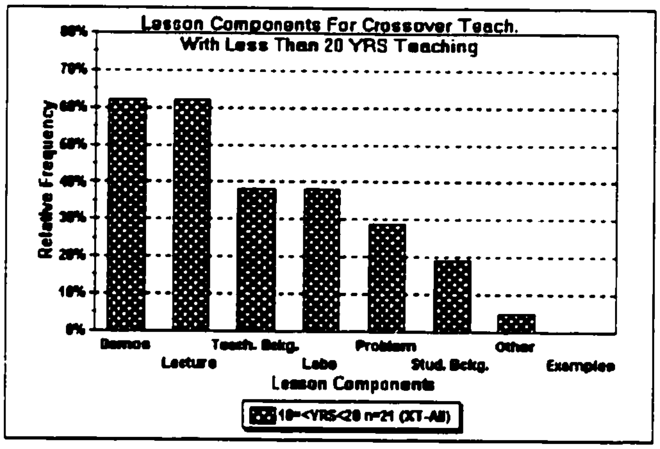


Fig 21b
Effect of specialization and experience: A plot of relative frequency as a function of lesson components for prepared teachers with greater than or equal to ten but less than twenty years experience.

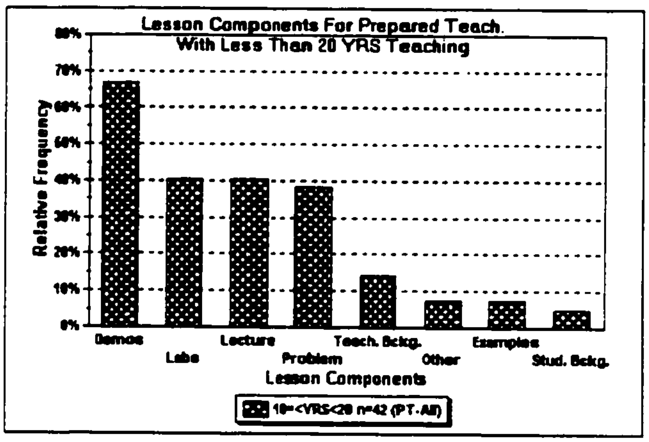


Fig 21c
Effect of specialization and experience: A plot of frequency proportion as a function of lesson components for crossover and prepared teachers with greater than or equal to ten but less than twenty years experience.

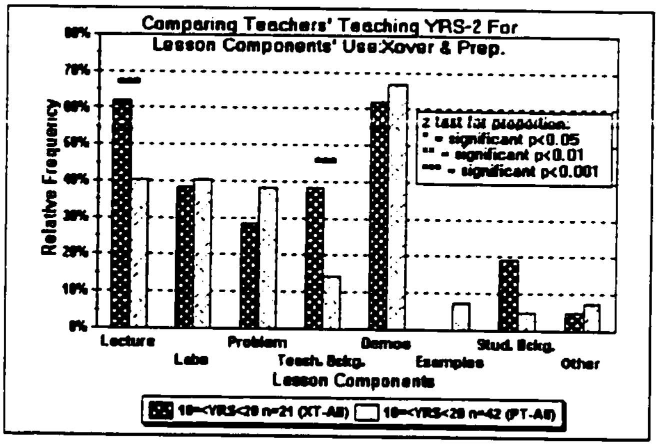


Fig 22a
Effect of specialization and experience: A plot of relative frequency as a function of lesson components for crossover teachers with greater than twenty years experience.

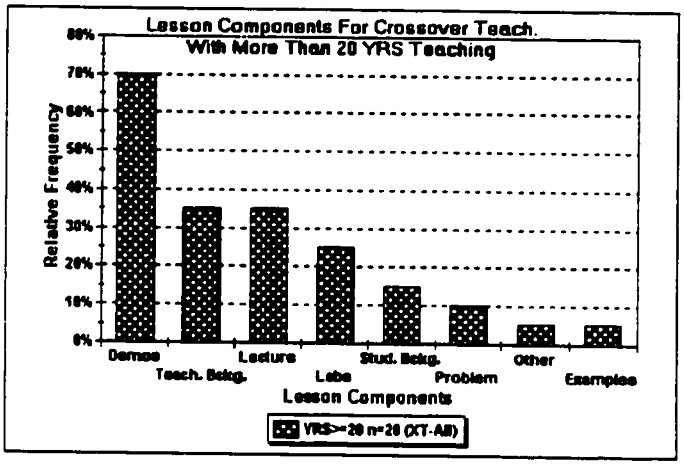


Fig 22b
Effect of specialization and experience: A plot of relative frequency as a function of lesson components for prepared teachers with greater than twenty years experience.

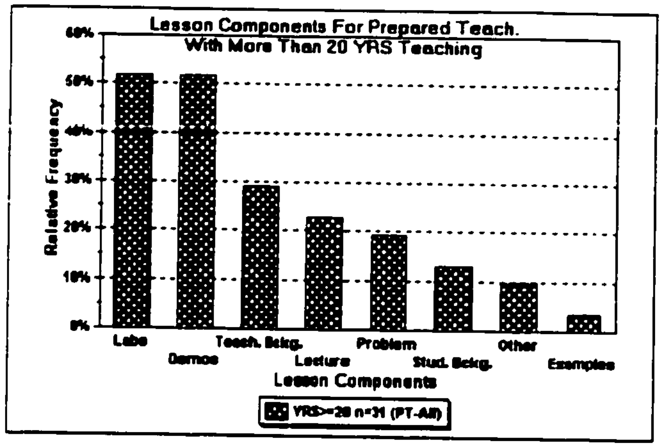
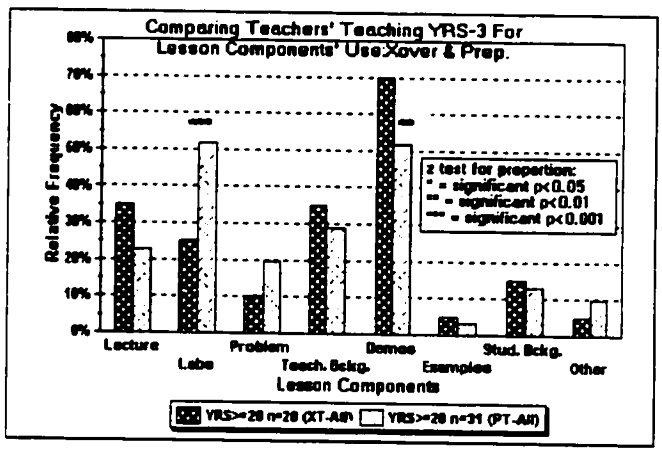


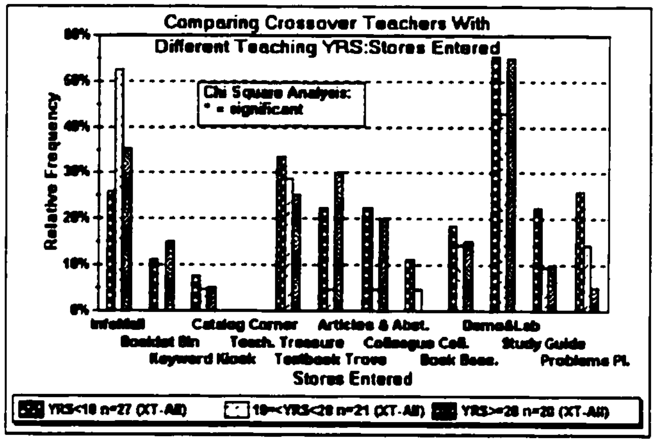
Fig 22c
Effect of specialization and experience: A plot of relative frequency as a function of lesson components for crossover and prepared teachers with greater than twenty years experience.



4.4.2 Stores Entered

Stores that teachers entered were highly dependent on which lesson components were chosen for their lesson plan. We performed a Chi Square analysis on each store that was entered by the YR-1, YR-2 and YR-3 groups for both the crossover and prepared teachers. Since both crossover and prepared teachers chose Demonstration and Laboratory as highly selected components, the Demos and Lab Shop should reflect a high proportion. Both figures 23a and 23b, exhibited the high proportion in that store and hence, confirm the high correlation that we had anticipated.

Fig 23a
Effect of specialization and experience: A plot of relative frequency as a function of stores entered for crossover teachers with different experiences.



In both the crossover and the prepared teachers, we did not see significant differences to indicate any effect of teaching experience on the choice for entering the Demo and Lab Shop store. Recall that when comparison was made within a group of teachers, we observed significant differences in the Laboratory component for the crossover teachers and in the Demonstration component for prepared teachers. These differences were not reflected in the Demo and Lab shop. In fact, the only store that was found to have significant difference was the Problem Place for the prepared teachers (see table 10). The YR-2 group had a significantly higher proportion than the other groups. This was consistent with the results we found for the choice of lesson components.

Fig 23b
Effect of specialization and experience: A plot of relative frequency as a function of stores entered for prepared teachers with different experiences.

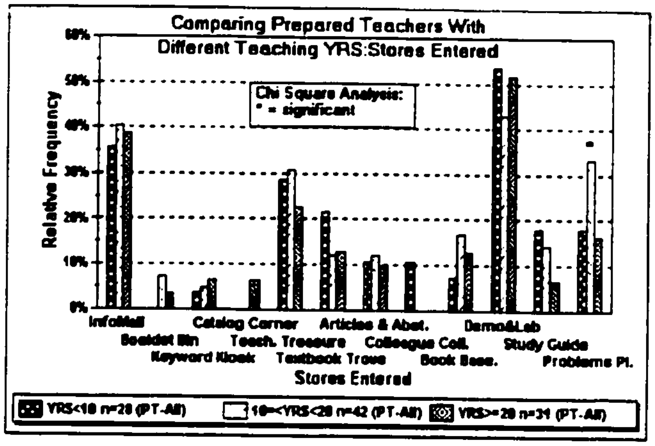


TABLE 10

EFFECT OF SPECIALIZATION AND EXPERIENCE: CHI SQUARE VALUES FOR STORES ENTERED

Stores Entered	Crossover Physics Teachers $\chi^2_{obt}(2)$, $\alpha < 0.05$ $[\chi^2_{crit}(2) = 5.99, \alpha < 0.05]$	Prepared Physics Teachers $\chi^2_{obt}(2)$ $\alpha < 0.05$ $[\chi^2_{crit}(2) = 5.99, \alpha < 0.05]$
Problems Place	Not Significant	6.99

For the YR-1 group, both crossover and prepared teachers entered Demo and Lab shop most frequently (see figure 24a and 24b). While crossover teachers in this group chose Teachers Treasure and the Entire InfoMall as the next two most frequent stores entered, prepared teachers chose otherwise. Problems Place was chosen as the fourth most frequent store for crossover teachers. On the other hand, prepared teachers elected to enter the Textbook Trove as the fourth most entered store. Again, this was consistent with what we observed in their choice of lesson components.

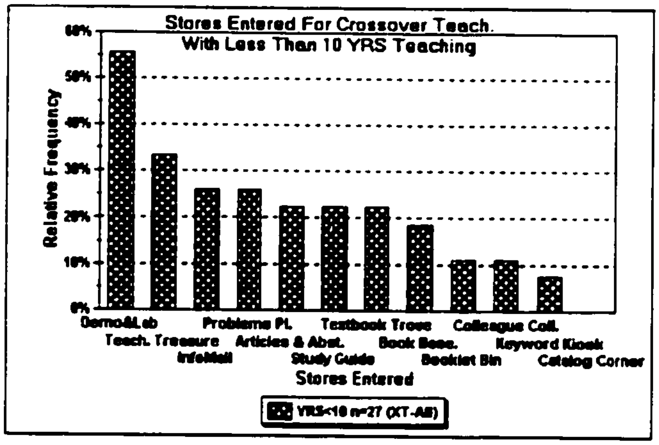


Fig 24a
Effect of specialization and experience: A plot of relative frequency as a function of stores entered for crossover teachers with less than ten years experience.

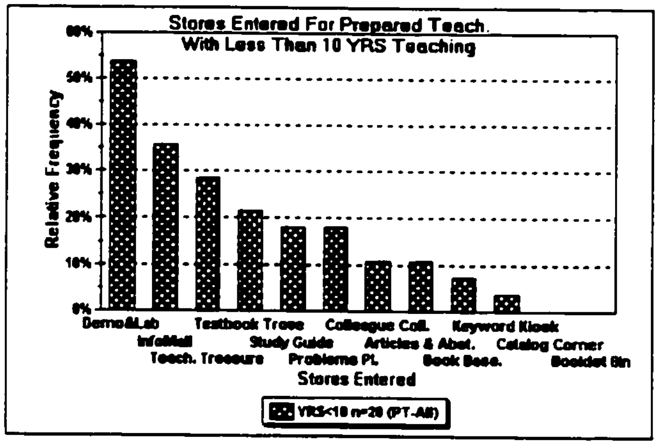


Fig 24b
Effect of specialization and experience: A plot of relative frequency as a function of stores entered for prepared teachers with less than ten years teaching experience.

We performed a z-test for proportion on each store between the crossover and prepared teachers and did not find any significant difference (see figure 24c). We infer that neither the crossover nor the prepared in the YR-2 group differed in their proportion for the stores that were entered for lesson planning using the Physics InfoMall.

Fig 24c
Effect of specialization and experience: A plot of relative frequency as a function of stores entered for crossover and prepared teachers with less than ten years teaching experience.

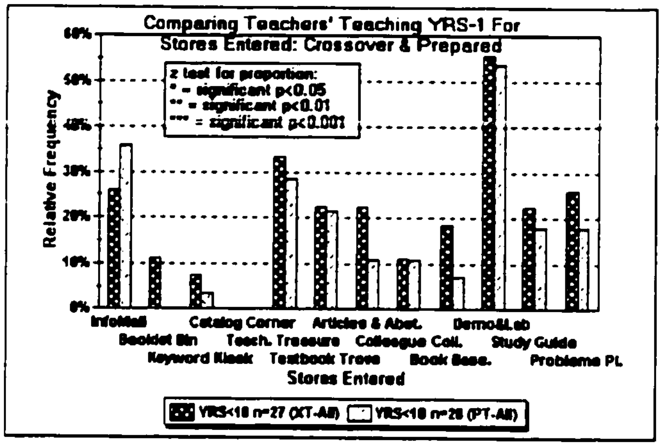
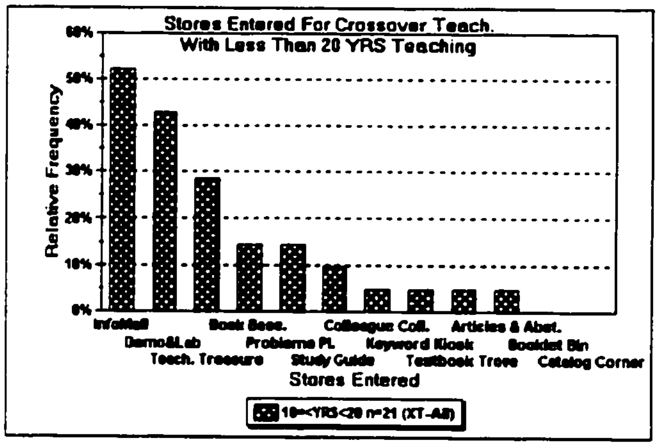


Fig 25a
Effect of specialization and experience: A plot of relative frequency as a function of stores entered for crossover teachers with greater than or equal to ten but less than twenty years experience.



The crossover YR-2 group indicated Entire InfoMall, Demo and Lab shop and Teachers Treasure as the most entered stores (see figures 25a and 25b). On the contrary, the prepared YR-2 group chose to enter Demo and Lab shop, Entire InfoMall and Problem Place more frequently than the other stores. Amazingly enough, Textbook Trove was entered least by both the crossover and prepared teachers in this group.

A z-test for proportion on the YR-2 group revealed a significantly high percentage of prepared teachers chose to enter the Problems Place (see figure 25c and Table 11) even though the difference for Problems component was not significant. Another remarkable feature was the absence of any significant differences for the Entire InfoMall and the Textbook Trove. Results in choices of lesson components indicated that crossover teachers chose Lecture and Teacher Background Reading components significantly more frequent than do prepared teachers. We were puzzled by the lack of correlation regarding this result and we felt an extended study for the YR-2 group should be done. Further, narrowing the topics to two rather than six or more, could help eliminate some uncertainties.

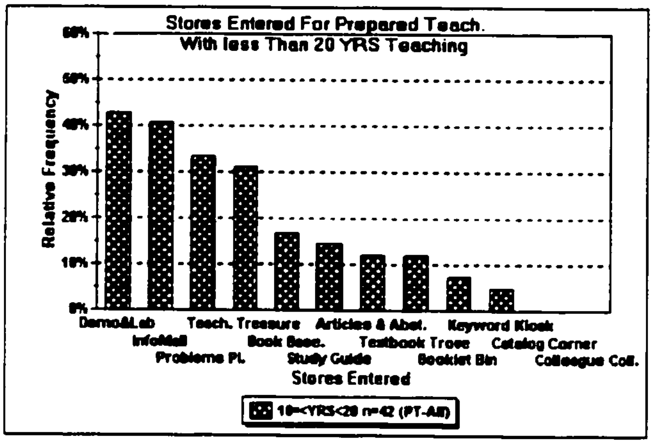


Fig 25b
Effect of specialization and experience: A plot of relative frequency as a function of stores entered for prepared teachers with greater than or equal to ten but less than twenty years experience.

Fig 25c
Effect of specialization and experience: A plot of relative frequency as a function of stores entered for crossover and prepared teachers with greater than or equal to ten but less than twenty years experience.

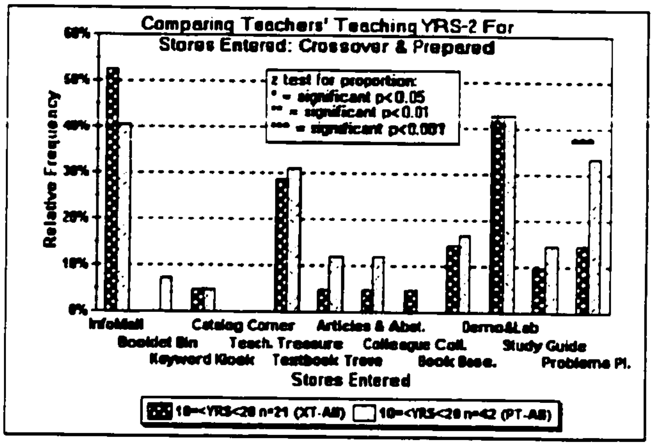


TABLE 11

EFFECT OF SPECIALIZATION AND EXPERIENCE: z VALUES FOR STORES ENTERED

	Years Teaching
	z_{obt} [z_{crit} = 1.96, 2.58, 3.30; α = 0.05, 0.01, 0.001]
Stores Entered	10≤YRS<20
Problems Place	-3.41

Although both crossover and prepared teachers in the YR-3 group showed high proportion for the Demo and Lab shop and the Entire InfoMall, they differed in the third most entered store (see figure 26a and 26b). Textbook Trove which was the third most entered store for the crossover teachers, was the sixth most frequent store for prepared teachers. However, a z-test for proportion did not reveal the difference as statistically significant (see figure 26c).

Fig 26a

Effect of specialization and experience: A plot of relative frequency as a function of stores entered for crossover teachers with greater than twenty years experience.

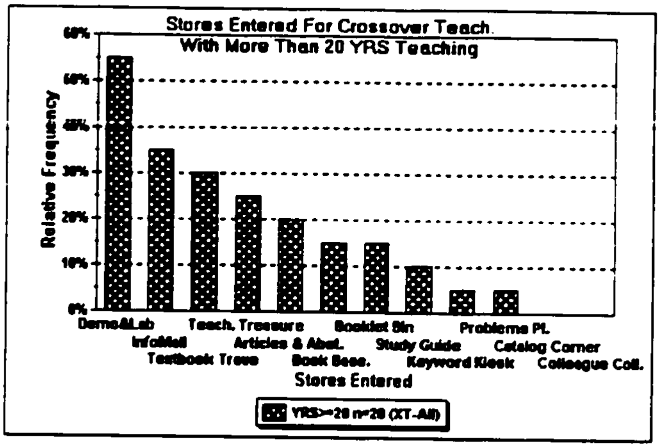


Fig 26b

Effect of specialization and experience: A plot of relative frequency as a function of stores entered for prepared teachers with greater than twenty years experience.

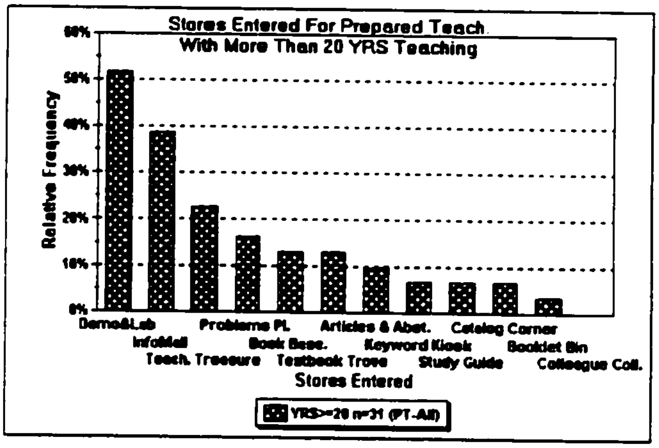
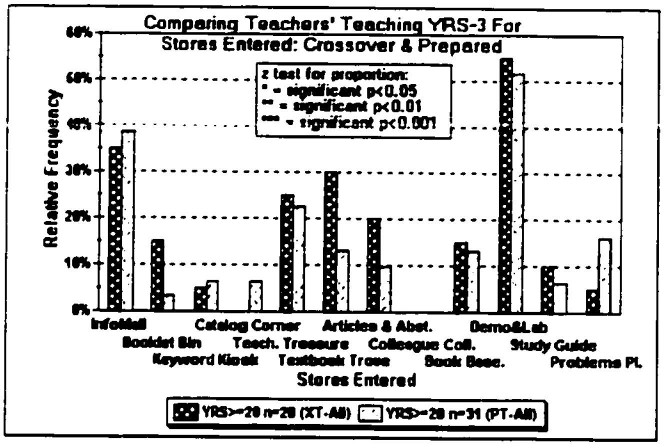


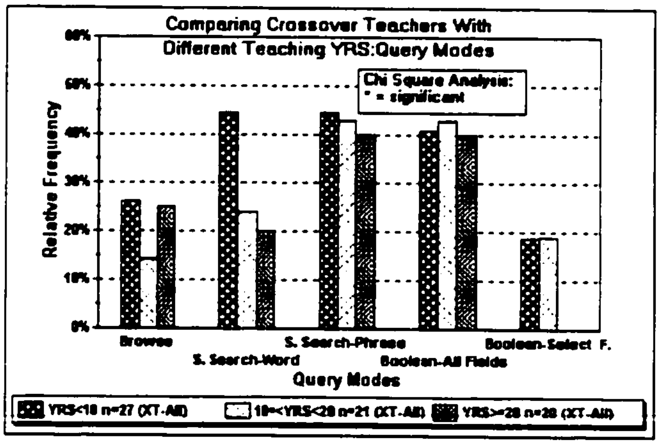
Fig 26c
Effect of specialization and experience: A plot of relative frequency as a function of stores entered for crossover and prepared physics teachers with greater than twenty years experience.



4.4.3 Query Modes

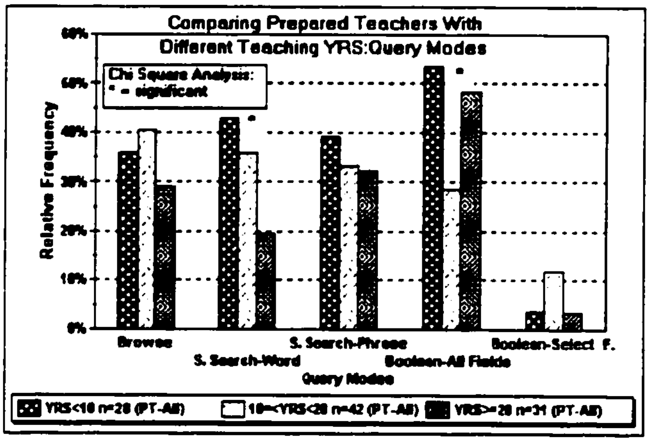
Querying for information should not be a function of what lesson components or which stores were entered by the different groups of teachers. In fact, we categorized the information querying modes into five categories without regard to the above-mentioned facts. The reason was obvious; there were too many topics, too many components and too many stores entered.

Fig 27a
Effect of specialization and experience: A plot of relative frequency as a function of query modes for crossover teachers with different experiences.



Overall, Boolean Searching-All Fields of documents was the most frequent query mode for all the three groups of crossover and prepared teachers (see figures 27a and 27b). Simple Search-Words exhibited differences between the groups but was only significant for prepared teachers when a Chi Square analysis was performed. In addition, only prepared teachers showed a significantly higher proportion of Boolean Search-All Fields for the YR-1 and the YR-3 groups as compared to the YR-2 group (see figures 27b and table 12). For both crossover and prepared teachers, Boolean Search-Selected Fields was the least chosen query mode. This could be attributed to the lack of experience using the *Physics InfoMall* and opportunities in doing online library searches.

Fig 27b
Effect of specialization and experience: A plot of relative frequency as a function of query modes for prepared teachers with different experiences.



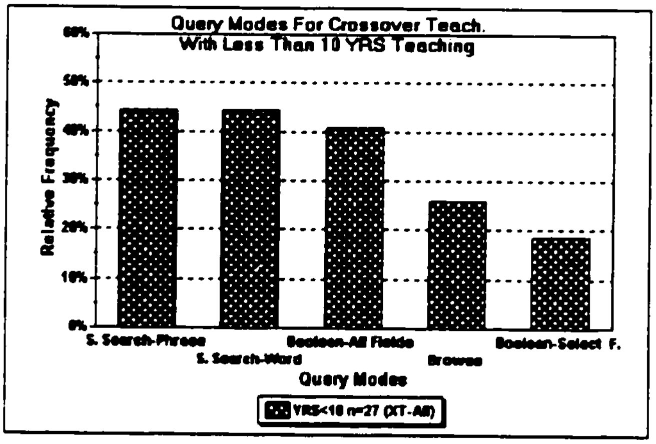
Crossover teachers for the YR-1 group chose to retrieve information mostly using simple searches by phrase and word, followed by Boolean searches in all fields of documents (see figure 28a). Prepared teachers in the same group, preferred to retrieve materials for lesson planning mostly through Boolean searches in all fields of documents (see figure 28b).

TABLE 12

EFFECT OF SPECIALIZATION AND EXPERIENCE: CHI SQUARE VALUES FOR QUERY MODES

Query Modes	Crossover Physics Teachers $\chi^2_{obt}(2)$, $\alpha < 0.05$ [$\chi^2_{crit}(2) = 5.99$, $\alpha < 0.05$]	Prepared Physics Teachers $\chi^2_{obt}(2)$ $\alpha < 0.05$ [$\chi^2_{crit}(2) = 5.99$, $\alpha < 0.05$]
Simple Search-Word	Not Significant	8.08
Boolean-All Fields	Not Significant	6.56

Fig 28a
Effect of specialization and experience: A plot of relative frequency as a function of query modes for crossover teachers with less than ten years experience.



The next two dominant query modes were simple searching by word and simple searching by phrase. Prepared teachers showed higher proportions for both browsing and Boolean searching in all fields of document while crossover teachers showed higher proportion for Boolean searching in selected fields of documents. However, a z-test for proportion to check if differences for each query mode between crossover and prepared teachers were significant, turned out negative (see figure 28c).

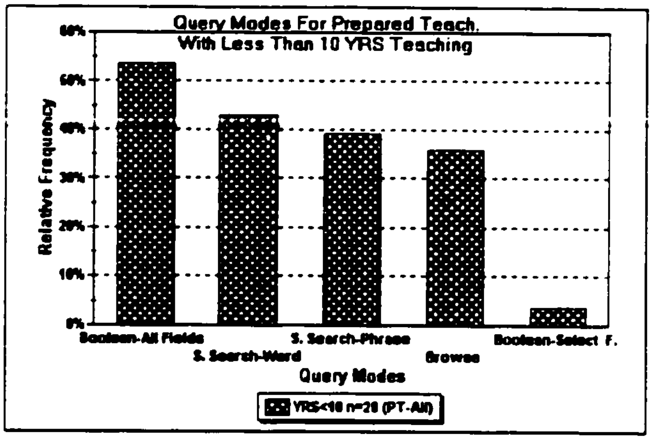


Fig 28b

Effect of specialization and experience: A plot of relative frequency as a function of query modes for prepared teachers with less than ten years experiences.

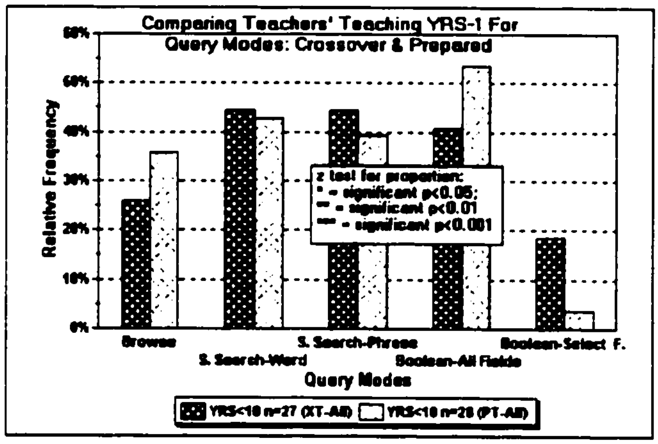


Fig 28c

Effect of specialization and experience: A plot of relative frequency as a function of query modes for crossover and prepared teachers with less than ten years experience.

The results for teachers in YR-2 group were different than that for YR-1. Crossover teachers in the former group queried mostly using simple searching by phrase and Boolean searching in all fields of documents. Browsing was the least method of information seeking (see figure 29a). On the other hand, prepared teachers in the YR-2 group used browsing as the primary method of querying (see figure 29b). Boolean searching in all fields and Boolean searching in selected fields of documents were the least used method of querying by prepared teachers in this group.

Fig 29a
Effect of specialization and experience: A plot of relative frequency as a function of query modes for crossover teachers with greater than or equal to ten but less than twenty years experience.

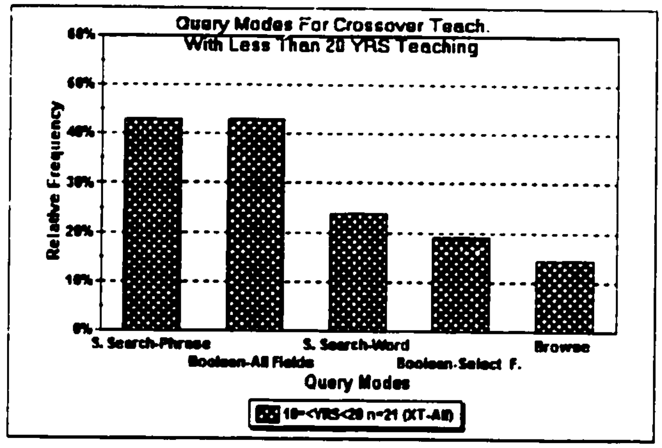
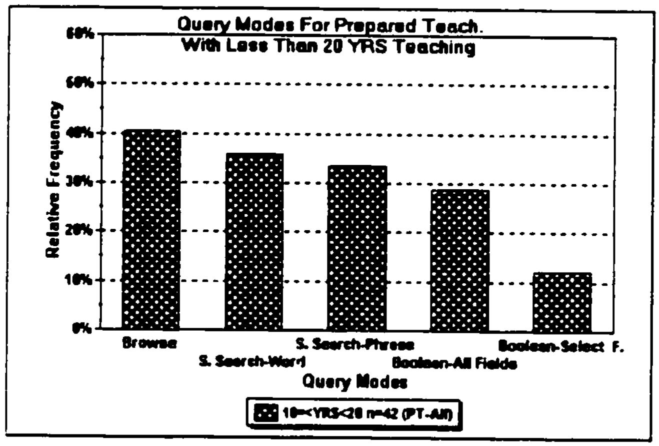


Fig 29b
Effect of specialization and experience: A plot of relative frequency as a function of query modes for prepared teachers with greater than or equal to ten but less than twenty years experience.



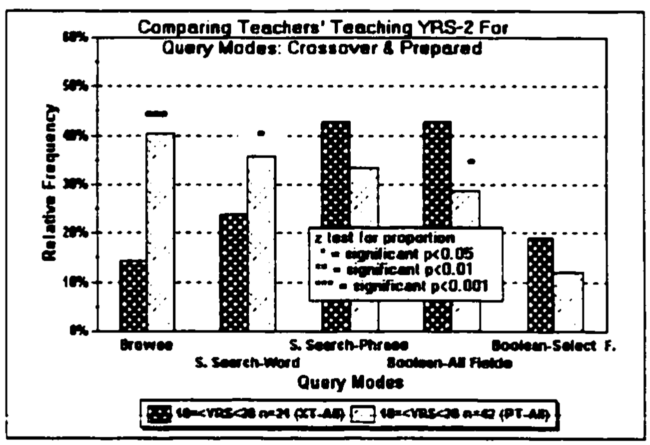
When a z-test for proportion was performed to see if differences for each query mode was significant between crossover and prepared teachers, we found some interesting results (see figure 29c and table 13). Prepared teachers significantly used browsing and simple searching by word to retrieve information. On the contrary, crossover teachers significantly queried for information via Boolean searching in all fields of documents. Due to the lack of other studies, we were unable to compare our results. The differences that we observed could not be explained without doing further studies with a larger sample.

TABLE 13

EFFECT OF SPECIALIZATION AND EXPERIENCE: z VALUES FOR QUERY MODES

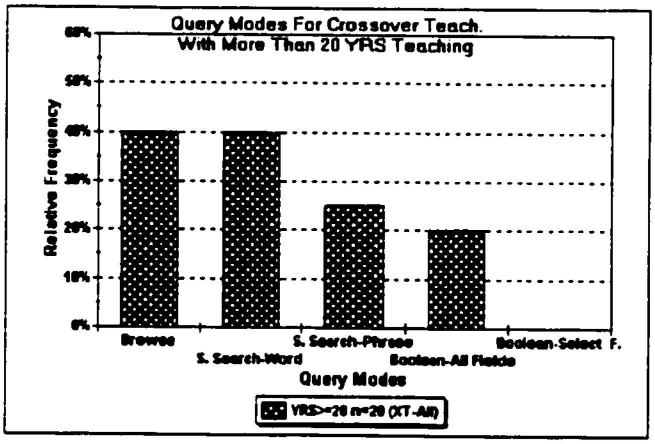
	Years Teaching
	[z_{crit} = 1.96, 2.58, 3.30; α = 0.05, 0.01, 0.001]
	z_{obt}
Query Modes	10≤YRS<20
Browse	-4.47
S. Search-Word	-2.03, α = 0.04
Boolean-All Fields	2.41, α = 0.016

Fig 29c
Effect of specialization and experience: A plot of relative frequency as a function of query modes for crossover and prepared teachers with greater than or equal to ten but less than twenty years experience.



With the exception of Boolean searching in selected fields of a document, the trend of information seeking for crossover teachers in the YR-3 group (see figure 30a) was almost exactly the same as querying methods for prepared teachers in the YR-2 group (see figure 29b). This trend was not observed for prepared teachers in the YR-3 group (see figure 30b). Instead, Boolean searching in all fields of documents was the dominant query mode while Boolean searching in selected fields of documents was the least used technique by the prepared teachers in this group.

Fig 30a
Effect of specialization and experience: A plot of relative frequency as a function of query modes for crossover teachers with greater than twenty years experience.



For the YR-3 group, we found browsing and simple searching by word were frequent choices by crossover teachers as opposed to Boolean searching in all fields of documents by prepared teachers. However, the differences for each query mode between crossover and prepared teachers were found to be statistically insignificant when we performed the z-test for proportion (see figure 30c).

Fig 30b
Effect of specialization and experience: A plot of relative frequency as a function of query modes for prepared teachers with greater than twenty years experiences.

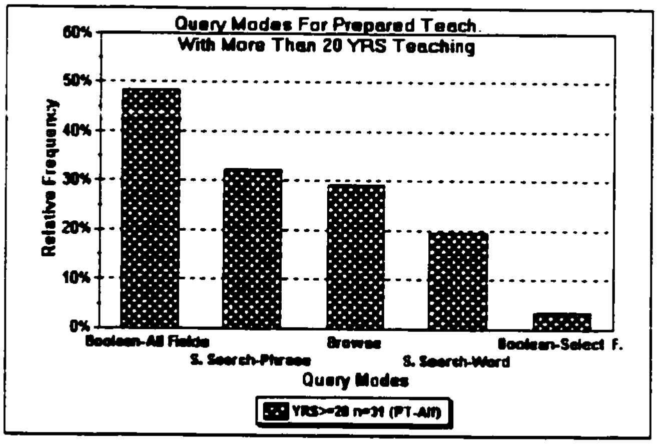
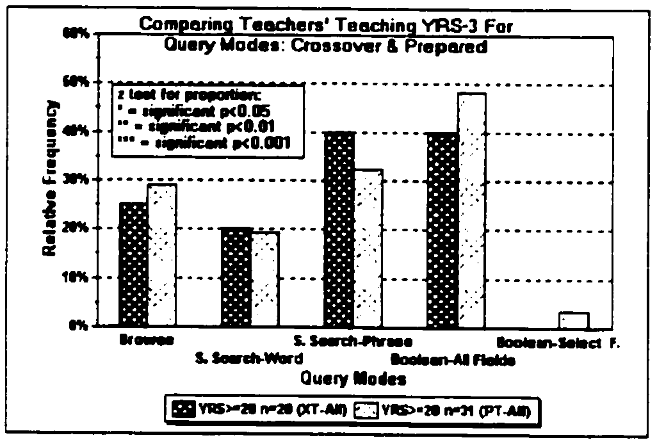


Fig 30c
Effect of specialization and experience: A plot of relative frequency as a function of query modes for crossover and prepared teachers with greater than twenty years experience.



4.4.4 Mean Values for Information Seeking Categories

On average, crossover teachers with less than ten years experience went through more iterations in completing an observation compared to crossover teachers in the other two groups (see figure 31a). But the difference was not statistically significant when tested using ANOVA. The same can be said about the amount of time teachers spent to complete an observation. Even though we saw differences between the three groups' mean values, the differences were not statistically significant.

Fig 31a

Effect of specialization and experience: A plot of mean values as a function of information seeking categories for crossover teachers with different experience.

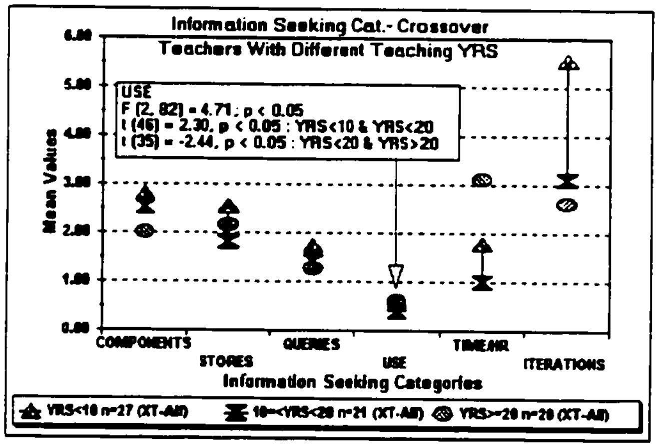
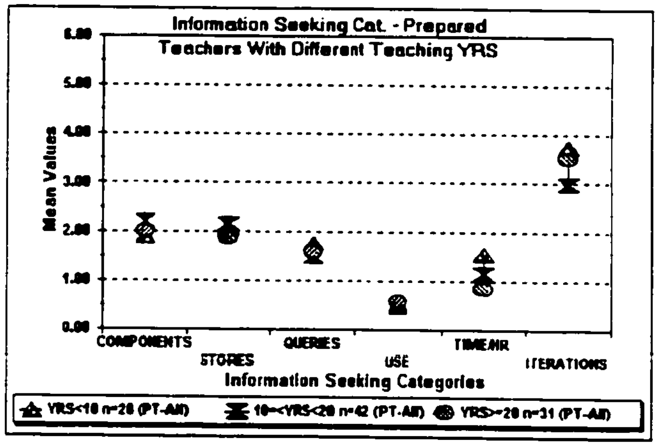


Fig 31b

Effect of specialization and experience: A plot of mean values as a function of information seeking categories for prepared physics teachers with different experience.



We found that the only variable showing significant difference was the amount of information used relative to information retrieved (see table 14). On average, crossover teachers with less than ten years experience and with more than twenty years experience used 60% of the information retrieved as compared to only 39% for crossover teachers with experience between ten and twenty years. We did not see any significant differences for any of the variables for prepared teachers (see figure 31b). From this, we inferred that teaching experience did not affect the mean values per observation for any of the variables except the amount of information used to the information retrieved by crossover teachers.

TABLE 14

EFFECT OF SPECIALIZATION AND EXPERIENCE: ANOVA, t AND MEAN VALUES FOR INFORMATION SEEKING CATEGORIES

	Crossover Physics Teacher		
Information Seeking Category (ISC)	USE		
Years Teaching	YRS<10	10≤YRS<20	YRS≥20
Mean Values	0.57	0.39	0.60
F_{obt} [F_{crit} = 3.14, α<0.05]		4.71	
Actual α value		0.012	
Bartlett's sample homogeneity value		0.98	
t_{obt} (46), [t_{crit} =2.01, α < 0.05]	2.30		NA
t_{obt} (35), [t_{crit} =2.03, α < 0.05]	NA	-2.44	

TABLE 15

EFFECT OF SPECIALIZATION AND EXPERIENCE: YR-1 GROUP'S t AND MEAN VALUES FOR INFORMATION SEEKING CATEGORIES

	Crossover (XT) & Prepared (PT) Teachers
Years Teaching	10<YRS
Mean Values	XT=2.81, PT=1.89
Information Seeking Categories	COMPONENTS
t values	t_{obt} (46) = 2.34 [t_{crit} =2.01, $\alpha<0.05$]

Crossover teachers with less than ten years experience chose to do, on average, 2.8 lesson components for each observation as opposed to only 1.9 for prepared teachers with the same experience (see figure 32a). The mean values were found to be significantly different when a t-test for independent samples was performed (see table 15). Mean values for iterations, even though showing higher for crossover teachers, were not found to be statistically significant.

Fig 32a
Effect of specialization and experience: A plot of relative frequency as a function of information seeking categories for crossover and prepared teachers with less than ten years experience.

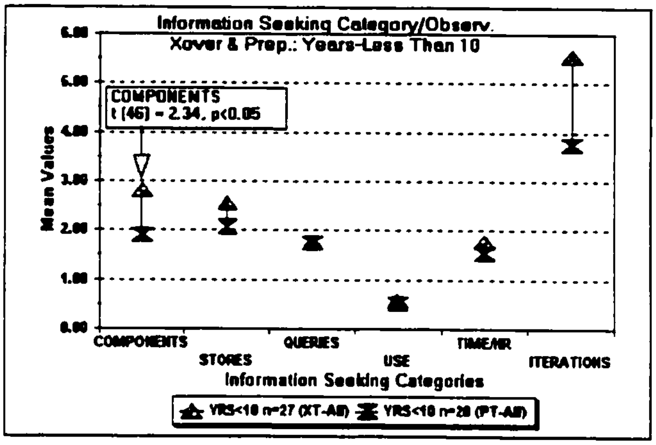
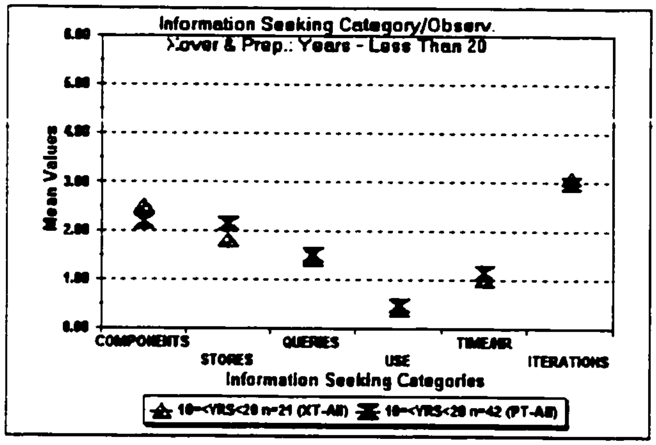


Fig 32b
Effect of specialization and experience: A plot of relative frequency as a function of information seeking categories for crossover and prepared teachers between ten and twenty years experience.



The only other variable we found that had a significant difference was the amount of time crossover teachers with more than twenty years experience spent in completing an observation (see figure 32b and 32c). On average, crossover teachers spent 3.11 hours while prepared teachers with the same experience spent only 0.83 hours (see table 16).

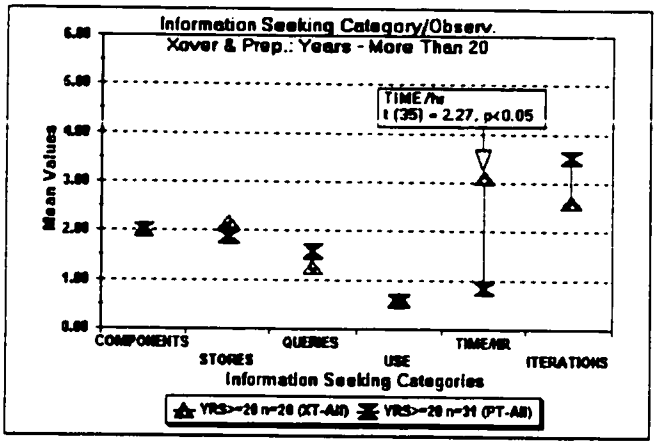
TABLE 16

EFFECT OF SPECIALIZATION AND EXPERIENCE: YR-3 GROUP'S t AND MEAN VALUES FOR INFORMATION SEEKING CATEGORIES

	Crossover (XT) & Prepared (PT) Teachers
Years Teaching	YRS>20
Mean Values	XT=3.11, PT=0.83
Information Seeking Categories	TIME/hr
t values	$t_{obt}(35) = 2.27$ [$t_{crit} = 2.03$, $\alpha < 0.05$]

Fig 32*c*

Effect of specialization and experience: A plot of relative frequency as a function of information seeking categories for crossover and prepared teachers with more than twenty years teaching experience.



Chapter 5
Conclusion

In this study, we presented results of information exploration and how it was similar or different among diverse specialization and teaching experiences of physics teachers. With specialization such as Vocational Education, Biology and Physics, and with teaching experiences ranging from none to thirty-one years, we looked at how these factors influenced lesson planning using the *Physics InfoMall*.

5.1 Overall Result

Teachers used the *Physics InfoMall* mostly to prepare for demonstrations, laboratories, lectures and to obtain background information. Hence, they would naturally enter the Demo and Lab shop, the Entire InfoMall and the Teachers Treasure. Textbook Trove was not entered as much even though Lecture and Teacher Background Reading were the third and fourth most chosen components by teachers. We suggest that teachers entered the Entire InfoMall to find materials for lecture and background reading rather than entering the Textbook Trove.

Information that teachers retrieved from the *Physics InfoMall* was queried by using combinations of Boolean searching and simple words and simple phrase searching. Boolean searching in all fields of documents was the most chosen query mode followed by simple searching, browsing and finally, Boolean searching in selected fields of documents. We assume that teachers used both, Boolean searching and simple searching due to the ease of retrieving relevant documents even though these methods of querying usually returned large number of documents. On the other hand, browsing would not return enough relevant documents for comparison purposes. We suspect that teachers were more than satisfied to browse through goods in each store since the number of goods were small. For example, Textbook Trove and Demo and Lab shop had only four books in each store. Hence, browsing through the documents was not as time consuming as it would with stores that had ten documents. The small number of goods could also contribute to the small proportion of teachers using Boolean searching in selected fields of documents. This hypothesis can be tested with Third Field Test Version of the InfoMall which will have four times more information in the database. The lack of experience with shopping in the *Physics InfoMall* and experiences using online searching in libraries would also contribute to high browsing proportion, high proportion for simple searching and Boolean searching in all fields, and small proportion in Boolean searching in selected fields.

We found that the March instrument did a better job in refining the variables we were measuring. In the three highly chosen lesson components, the proportion using the March instrument was consistently higher than exhibited by the October instrument. We pointed out in earlier chapters that teachers were lumping a number of lesson components on one sheet. Hence, it was not possible to keep track of our measurements for each component. In addition, the March instrument also revealed higher proportions in stores most entered and query modes most used by teachers confirming further that the March instrument kept track of measurements better than the October instrument.

5.2 Effect of Specialization

While crossover teachers chose to query materials for lecture significantly more than prepared teachers, we did not observe any significant differences for any other components. In addition, results in this study led us to conclude that being a crossover or prepared teacher did not influence information seeking strategies. However, crossover teachers showed higher mean values for the number of components per observation and the amount of time per observation. Even though the difference in mean values were small, the differences were statistically significant. We believed the higher mean value of components per observation for crossover teachers was due to the lack of physics training and the lack of accessible resources for lesson planning. Hence, they were motivated to peruse the vast resources offered by the InfoMall more than the prepared teachers. This led to higher mean values for components chosen per observation and thus, increasing the amount of time per observation.

5.3 Effect of Teaching Experience

Teachers with more than ten years experience chose demonstrations as the primary component when planning their lessons using the *Physics InfoMall*. On the other hand, teachers with less than ten years experience concentrated on combinations of laboratories, lectures and demonstrations. Because of this inexperience, teachers with less than ten years experience were preparing themselves for all facets of teaching - academically and administratively. The more experienced teachers concentrated on spicing up interest in the classroom rather than preparing lecture contents. We failed to find significant differences between the different teaching experience in all variables that we measured. Hence, we were led to believe that teaching experiences did not influence the choice of lesson components, stores entered, query modes and information seeking categories for lesson planning using the *Physics InfoMall*.

5.4 Effect of Specialization and Teaching Experience

Crossover teachers with less than ten years experience queried materials for laboratories and examples more than crossover teachers with more than ten years experience. For the prepared teachers, those with more than twenty years experience had the smallest proportion in finding materials for lecture compared to those with less than twenty years experience. In addition, both prepared teachers with less than ten years and more than twenty years experience chose Teacher Background Reading component significantly more than teachers between ten and twenty years experience. We also found that prepared teachers with teaching experience between ten and twenty years chose Problem and Demonstration components more than the other two groups.

Crossover teachers with less than ten years experience exhibited higher proportion than prepared teachers with similar experience for Lecture, Laboratory, Problem and Demonstration components. In contrast, crossover teachers with experience between ten and twenty years showed higher percentage only for Lecture and Teacher Background Reading. Crossover teachers with more than twenty years experience showed high proportion for Demonstration but low for Laboratory component. The trend seemed to indicate that crossover teachers gained more confidence in terms of content and focused more on presenting concepts visually as their teaching experiences increased. In this sense, they tend to become specialists the longer they teach, in agreement with Neuschatz and Alpert's findings.

Differences found in the method of information seeking among crossover teachers with different teaching experiences were found to be not significant statistically. On the other hand, prepared teachers with less than ten years experience showed higher proportion in Simple Search - Word while teachers with experience between ten and twenty years showed low percentage on Boolean Search - All Fields.

We compared query modes between crossover and prepared teachers and found that prepared teachers with experiences between ten and twenty years queried information by browsing and doing Simple Search - Word more than crossover teachers with the same experience. But, they used fewer Boolean Search - All Fields than crossover teachers. Comparisons in the other two groups exhibited no differences between crossover and prepared teachers for all of the query modes. We did believe that specialization or experiences did not have any influence on choice of query modes and results for most of our observations confirmed this belief. We can not offer any explanations as to the differences for some of the query modes observed for the group between ten and twenty years experience.

On average, crossover teachers with experience between ten and twenty years used less of the retrieved information compared to the other two groups, We found that crossover teachers with less than ten years experience, on average, chose to do more components per observation than prepared teachers with similar experience. In addition, we observed that crossover teachers with more than twenty years experience spent more time per observation than prepared teachers in the same experience group. Owing to the absence of any other studies, no comparisons can be made.

5.5 Further Studies

Many of the observations that we made could not be confirmed or rejected based on other studies. Since *Physics InfoMall* was the first CD-ROM database containing a wide range of teaching resources, and this study was a pioneer study in learning teachers' exploration strategies when preparing lesson plans using an electronic database, the results we obtained were not comparable to other studies. Thus, further investigation needs to be done. Specifically, we suggest further observations for the following patterns that were observed in this study when physics teachers use the *Physics InfoMall* for lesson planning:

1. Crossover teachers (little or no physics background) tend to find materials for lecture more frequently than the prepared teachers (significant physics background.)
2. Teachers' teaching experiences (number of teaching years) do not affect the frequency for choice of lesson components, stores entered, query modes, average time spent for completing a lesson plan and the average number of iterations per lesson plan.
3. Crossover teachers with less than 10 years experience look for laboratories more frequently than those with more than 20 years experience.
4. Prepared teachers with more than 20 years experience look for materials for lecture less frequently than those with less than 20 years experience.
5. Prepared teachers with experience between 10 and 20 years choose materials for background reading less frequently than those teachers with less than 10 years experience and the teachers with more than 20 years experience.
6. Prepared teachers with experience between 10 and 20 years choose materials for problems and demonstrations more frequently than those teachers with less than 10 years experience and the teachers with more than 20 years experience.

7. Crossover teachers with less then ten years experience look for materials for lecture, laboratory demonstrations and problems more frequently than prepared teachers with similar experience.

8. Crossover teachers with experience between 10 and 20 years query for materials for lecture and teaching background more frequently than prepared teachers with similar experience.

9. Crossover teachers with 20 years experience seek materials for demonstration more frequently but seek for materials for laboratory less frequently than prepared teachers with similar experience.

10. On average, crossover teachers with less than 10 years experience choose to do more lesson components per lesson planning compared to prepared teachers with similar experience.

11. On average, crossover teachers with more than 20 years experience spend more time to complete a lesson plan compared to prepared teachers with similar experience.

Since our study used volunteers, the findings are limited. In order to extend the results to a wider population of teachers belonging to the different groups that we had identified, we must be assured of a representative sample. Hence, we need to reexamine the patterns that emerged from this study and work with groups that are more randomly selected and work with a larger pool of teachers in all the groups. Furthermore, our target group, the crossover teachers were significantly smaller in numbers than the prepared teachers. Hence, we need to ensure the numbers represented in each group be large enough so as to increase the statistical power and that the numbers in each group are not too different.

All of our analysis was based on the total number of lesson plans rather than the number of teachers in each group. As such, we propose a study that will allow analysis of two separate classes; information exploration based on the frequency of lesson plans and based on the frequency of use by teachers and group the data into the two major categories. The information obtained from the latter will best explain the true effect of areas of specialization and teaching experiences on information seeking by physics teachers. The information obtained from the former is best used to support results obtained based on the frequency of use by teachers.

The results reported in this manuscript were mostly quantitative but there is much more to be learned regarding the effect of specialization and experiences on lesson planning. Specifics such as the actual document chosen for each lesson component and for a particular topic, why the choice of those documents, how the documents will be used in the classroom and how these differ according to specialization and experience, can be done qualitatively. We suggest that these specifics be investigated by restricting the number of topics assigned for teachers to report. For example, choose one topic out of the six assigned topics where teachers will report on the documents that they seriously examine and choose to incorporate into their lessons. In order for this to be done, the evaluation form will require some changes. In fact, all that is required is to merge the latter portion of the instrument for the October evaluation form with the March evaluation form. This part of the study will lead to information on how novices differ from the experts in terms of what documents they consider more useful and interesting and the approaches they would use in teaching the same subject; qualitative (conceptual), quantitative (mathematical rigor) or the combination of both. Of course, for the analysis to make any sense, it must be correlated with the courses that they teach (conceptual, algebra-based or calculus-based). This proposed study is best done with *Field Test Version Three of the Physics InfoMall* since most of the restructuring in this version incorporates findings from our study. Furthermore, the database size has been increased to more than 400 megabytes, almost four times the size of *Field Test Version Two*.

The present study sets up a groundwork for information exploration among physics teachers with diverse qualification and teaching experience. Knowing the patterns will help physics educators working in electronic database development focus on the kinds of documents to place in the database and the most effective means of information retrieval. The proposed further study will test patterns that were observed in the present study and streamline those patterns to fit the needs of physics researchers, educators and database developers to provide the best possible physics database which will serve as a powerful tool for physics teaching. In addition, we hope that our findings will influence and convince others in the science community to venture into electronic database in providing teachers in their field a comprehensive resource which is rich and diverse, easily retrievable documents and state-of-the-art teaching tool.

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Appendix A
Effects of Instruments Revisited

In section 4.2 and 4.3, we presented results on the differences between crossover teachers and prepared teachers and teachers with different experiences regarding their information exploration strategies when preparing for lesson plans using the *Physics InfoMall*. We discussed the effects of measuring instruments on our investigations in section 4.1 and concluded that the March instrument was better for the kind of data that we wanted. Further, the March instrument allowed detailed analysis to be done on information exploration, qualitatively and quantitatively. This appendix presents comparisons within instruments (October versus October and March versus March) and between instruments (October versus March) for all of the variables that have been discussed in the manuscript. Results of statistical tests that were significant are tabulated and indicated in the graphs associated with the comparisons made.

A.1 Areas of Specialization

A.1.1 Lesson Components

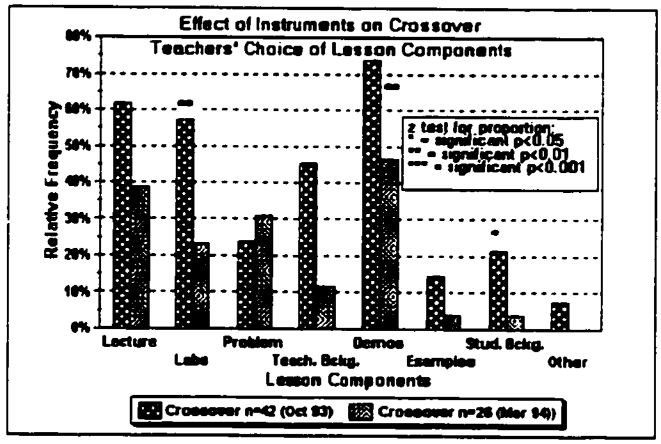


Fig 33*a*
A plot of relative frequency as a function of lesson components for crossover physics teachers' October and March data.

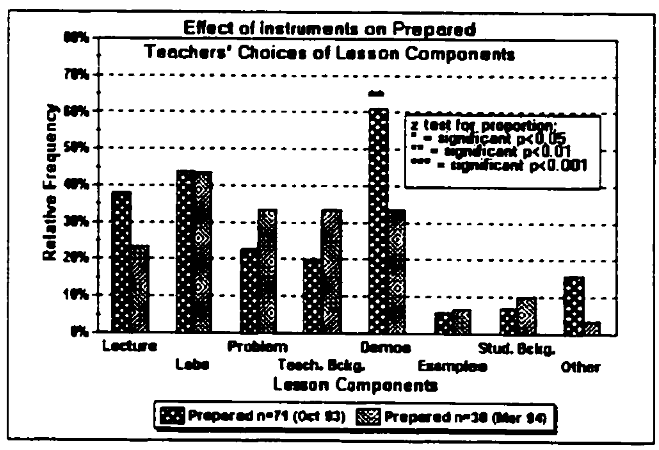


Fig 33b
A plot of relative frequency as a function of lesson components for prepared physics teachers' October and March data.

TABLE 17

EFFECT OF SPECIALIZATION USING DIFFERENT INSTRUMENTS: z VALUES FOR LESSON COMPONENTS

Lesson Components	Crossover Teachers z_{obt} [z_{crit} = 1.96, 2.58, 3.30; α = 0.05, 0.01, 0.001]	Prepared Teachers z_{obt} [z_{crit} = 1.96, 2.58, 3.30; α = 0.05, 0.01, 0.001]
Labs	2.75, $\alpha = 0.006$	Not significant
Demos	2.30, $\alpha = 0.021$	2.54, $\alpha = 0.011$
Stud. Bckg.	1.99, $\alpha = 0.046$	Not significant

Fig 34a
A plot of relative frequency as a function of lesson components for crossover and prepared physics teachers' October data.

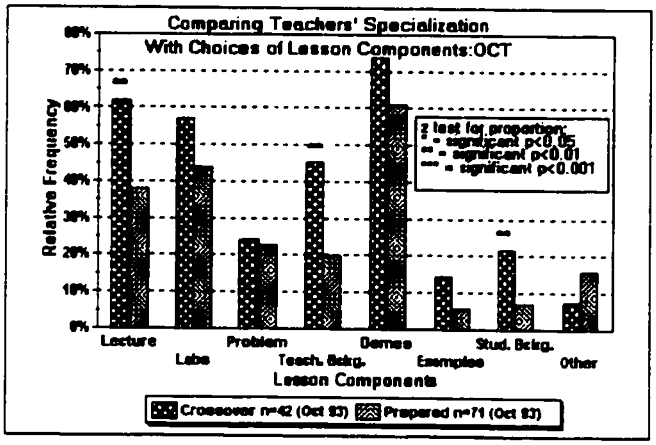


Fig 34b
A plot of relative frequency as a function of lesson components for crossover and prepared physics teachers' March data.

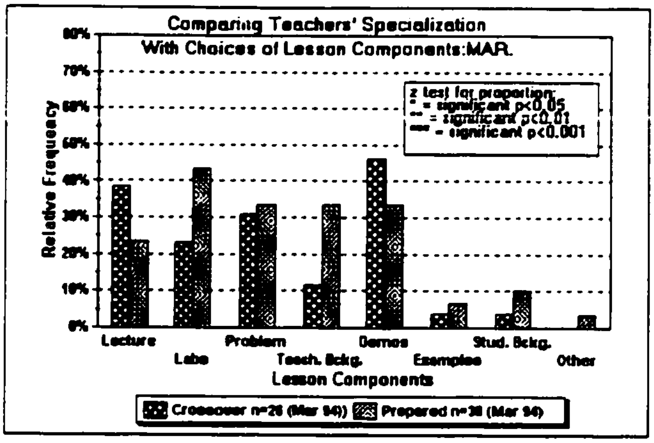


TABLE 18

EFFECT OF INSTRUMENTS AND SPECIALIZATION: z VALUES FOR LESSON COMPONENTS

Lesson Components	October z_{obt} [z_{crit} = 1.96, 2.58, 3.30; α = 0.05, 0.01, 0.001]	March z_{obt} [z_{crit} = 1.96, 2.58, 3.30; α = 0.05, 0.01, 0.001]
Lecture	2.46, α = 0.014	Not significant
Teacher Bckg.	2.88, α = 0.004	Not significant
Stud. Bckg.	2.24, α = 0.025	Not significant

A.1.2 Stores Entered

Fig 35a

A plot of relative frequency as a function of stores entered for crossover physics teachers' October and March data.

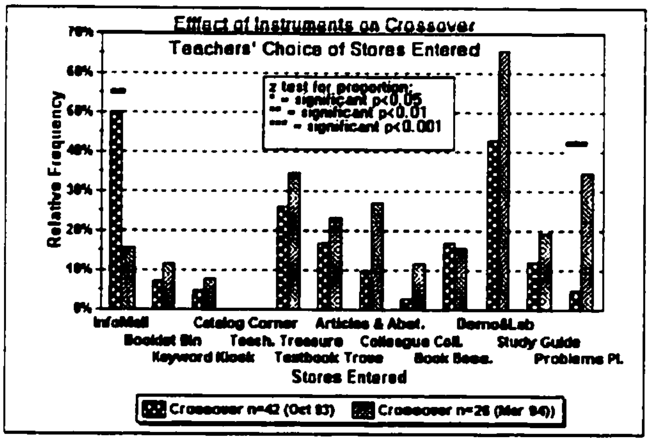


Fig 35b

A plot of relative frequency as a function of stores entered for the prepared physics teachers' October and March data.

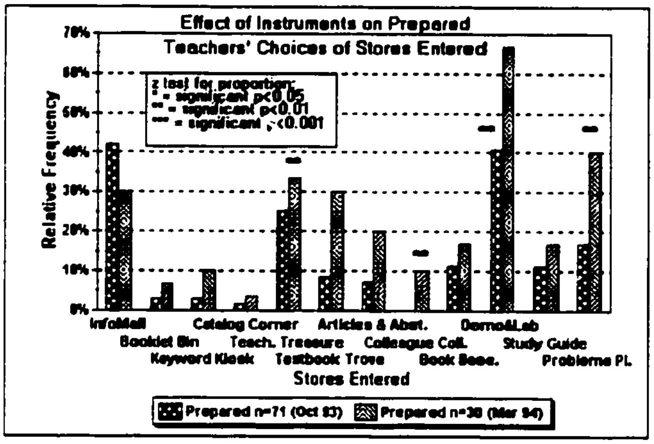


TABLE 19

EFFECT OF SPECIALIZATION USING DIFFERENT INSTRUMENTS: z VALUES FOR STORES ENTERED

	Crossover Teachers	Prepared Teachers
Stores Entered	z_{obt} [z_{crit} = 1.96, 2.58, 3.30; α = 0.05, 0.01, 0.001]	z_{obt} [z_{crit} = 1.96, 2.58, 3.30; α = 0.05, 0.01, 0.001]
InfoMall	2.88, α = 0.004	Not significant
Textbook Trove	Not significant	-2.78, α = 0.0054
Colleague Collection	Not significant	-2.71, α = 0.0068
Demo & Lab	Not significant	-2.37, α = 0.0178
Problems Place	-3.25, α = 0.0012	-2.49, α = 0.0128

Fig 36*a*
A plot of relative frequency as a function of stores entered for crossover and prepared physics teachers' October data.

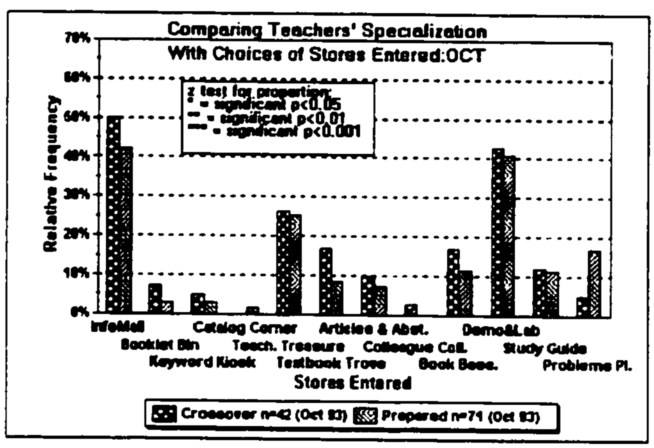
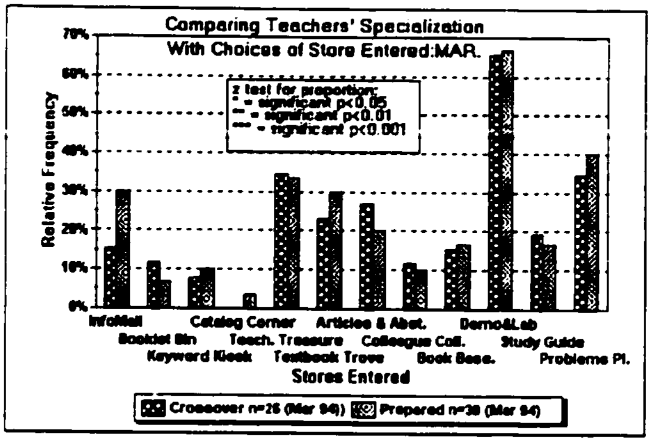


Fig 36b
A plot of relative frequency as a function of stores entered for crossover and prepared physics teachers' March data.



A.1.3 Query Modes

Fig 37a
A plot of relative frequency as a function of query modes for crossover physics teachers' October and March data.

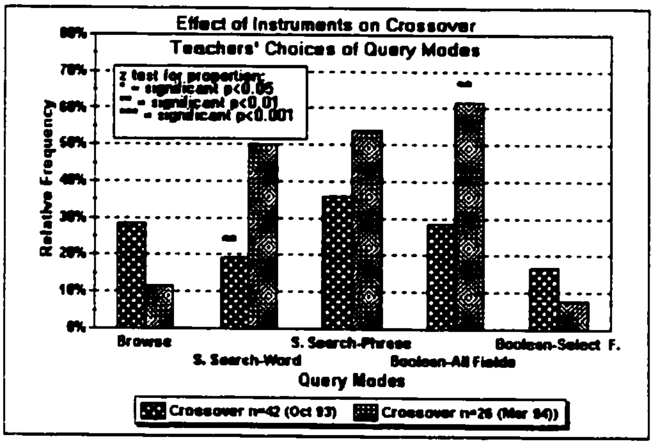


Fig 37b
A plot of relative frequency as a function of query modes for prepared physics teachers' October and March data.

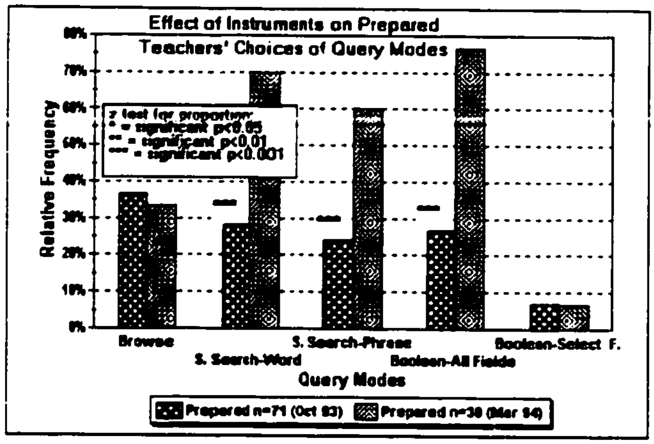


TABLE 20

EFFECT OF SPECIALIZATION USING DIFFERENT INSTRUMENTS: z VALUES FOR QUERY MODES

Query Modes	Crossover Teachers z_{obt} [z_{crit} = 1.96, 2.58, 3.30; α = 0.05, 0.01, 0.001]	Prepared Teachers z_{obt} [z_{crit} = 1.96, 2.58, 3.30; α = 0.05, 0.01, 0.001]
S. Search-Word	-2.68, α = 0.0074	-3.91
S. Search-Phrase	Not significant	-3.48
Boolean-All Fields	-2.68, α = 0.0074	-4.65

Fig 38a

A plot of relative frequency as a function of query modes for crossover and prepared physics teachers' October data.

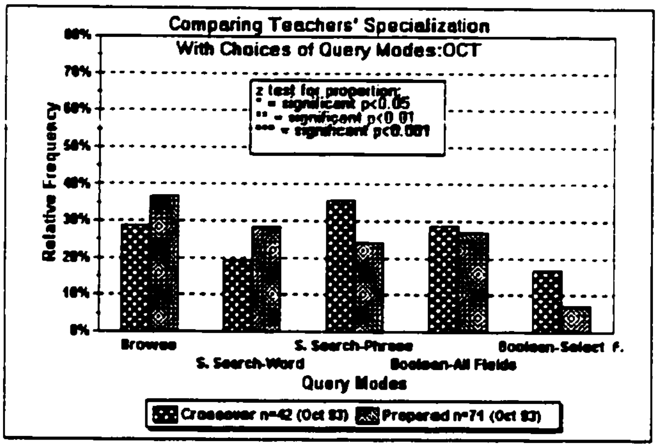
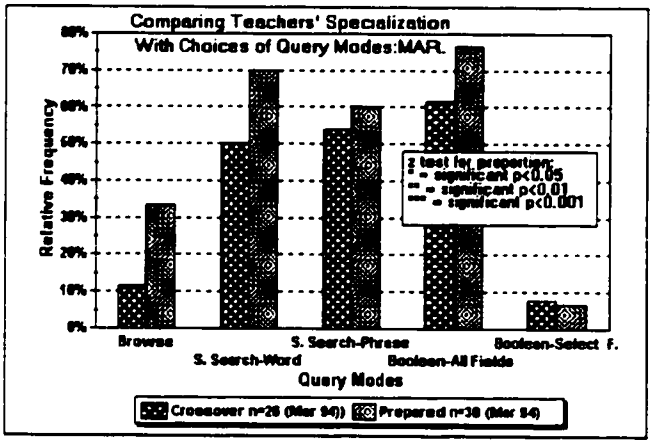


Fig 38b

A plot of relative frequency as a function of query modes for crossover and prepared physics teachers' March data.



A.1.4 Mean Values for Information Seeking Categories

Fig 39a

A plot of mean values as a function of information seeking categories for crossover physics teachers' October and March data.

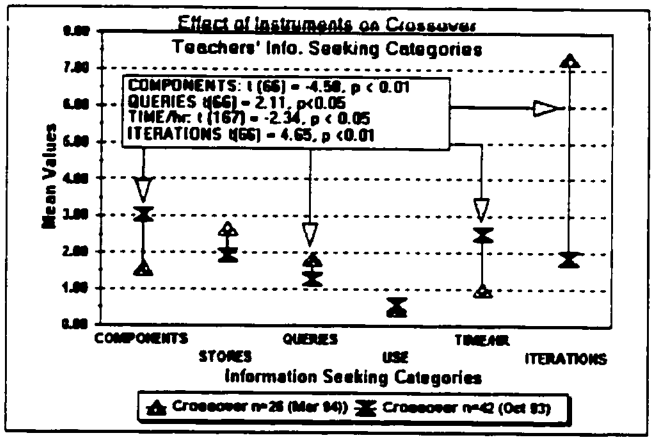


TABLE 21

EFFECT OF SPECIALIZATION USING DIFFERENT INSTRUMENTS: t VALUES FOR INFORMATION SEEKING CATEGORIES (CROSSOVER)

Crossover (XT) Teachers-October & March		
Information Seeking Categories	Mean Values	t values
COMPONENTS	Oct = 3.05	t_{obt} (66) = -4.58
	Mar = 1.58	[t_{crit} =2.00, α<0.05]
QUERIES	Oct = 1.29	t_{obt} (66) = 2.11
	Mar = 1.85	[t_{crit} =2.00, α<0.05]
TIME/hr	Oct = 2.52	t_{obt} (66) = -2.34
	Mar = 1.00	[t_{crit} =2.00, α<0.05]
ITERATIONS	Oct = 1.85	t_{obt} (66) = 4.65
	Mar = 7.31	[t_{crit} =2.00, α<0.05]

Fig 39b
A plot of mean values as a function of information seeking categories for prepared physics teachers' October and March data.

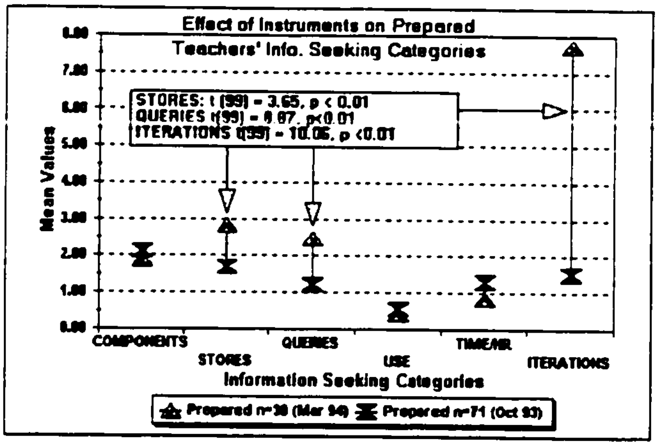


TABLE 22

EFFECT OF SPECIALIZATION USING DIFFERENT INSTRUMENTS: t VALUES FOR INFORMATION SEEKING CATEGORIES (PREPARED)

Prepared (PT) Teachers-October & March		
Information Seeking Categories	Mean Values	t values
STORES	Oct=1.70, Mar=2.63	t_{obt} (99) = 3.65 [t_{crit} =2.00, α<0.05]
QUERIES	Oct=1.22, Mar=2.47	t_{obt} (99) = 8.87 [t_{crit} =2.00, α<0.05]
ITERATIONS	Oct=1.51, Mar=7.73	t_{obt} (99) = 10.06 [t_{crit} =2.00, α<0.05]

Fig 40a
A plot of mean values as a function of information seeking categories for crossover and prepared physics teachers' October data.

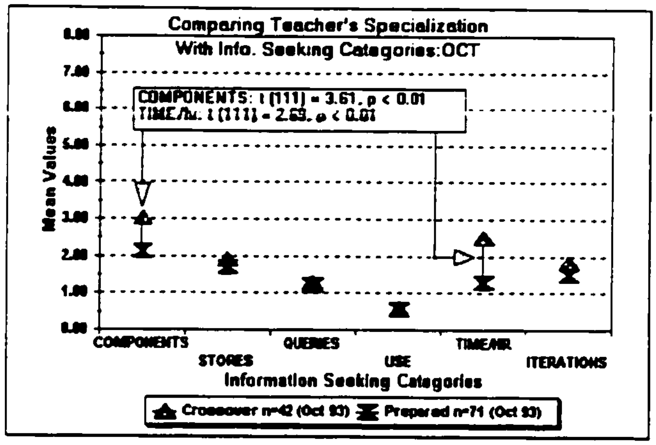


TABLE 23

EFFECT OF SPECIALIZATION USING DIFFERENT INSTRUMENTS: t VALUES FOR INFORMATION SEEKING CATEGORIES (OCTOBER)

Crossover (XT) and Prepared (PT) Teachers-October		
Information Seeking Categories	Mean Values	t values
COMPONENTS	XT=3.05, PT=2.13	t_{obt} (111) = 3.61 [t_{crit} =1.98, α<0.05]
TIME/hr	XT=2.52, PT=1.30	t_{obt} (111) = 2.69 [t_{crit} =1.98, α<0.05]

Fig 40b
A plot of mean values as a function of information seeking categories for crossover and prepared physics teachers' March data.

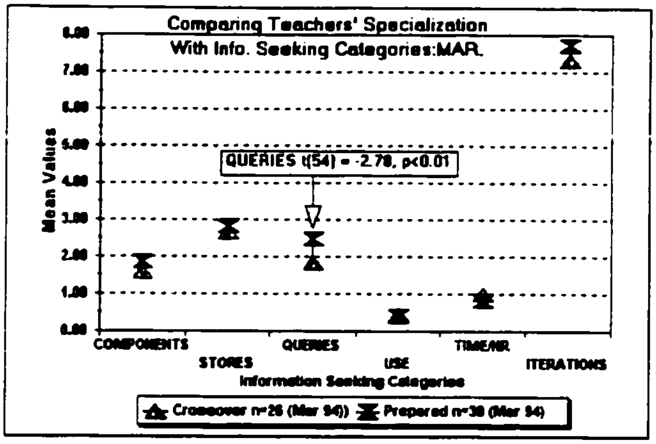


TABLE 24

EFFECT OF SPECIALIZATION USING DIFFERENT INSTRUMENTS: t VALUES FOR INFORMATION SEEKING CATEGORIES (MARCH)

Crossover (XT) and Prepared (PT) Teachers-October		
Information Seeking Categories	Mean Values	t values
QUERIES	XT=1.85, PT=2.47	t_{obt} (54) = -2.78 [t_{crit} =2.00, α<0.05]

A.2 Teaching Experience

A.2.1 Lesson Components

Fig 41a
October data: A plot of relative frequency as a function of lesson components for different teaching experiences.

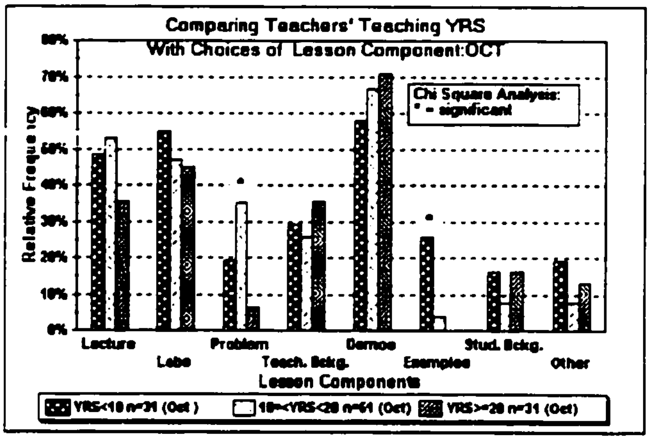


Fig 41b
March data: A plot of relative frequency as a function of lesson components for different teaching experiences.

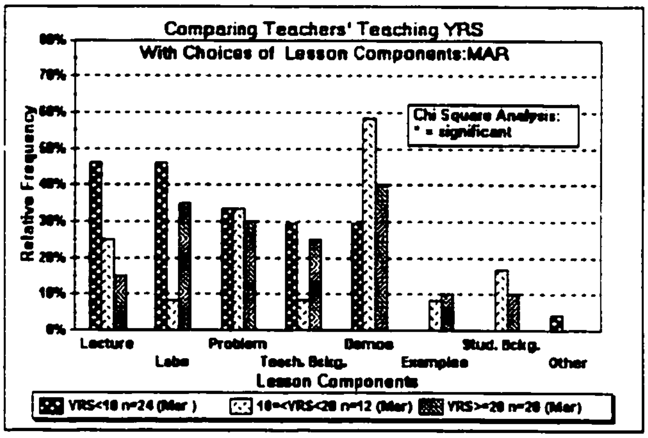


TABLE 25

EFFECT OF EXPERIENCE USING DIFFERENT INSTRUMENTS: CHI SQUARE VALUES FOR LESSON COMPONENTS

Lesson Components	October $\chi^2_{obt}(2)$, $\alpha < 0.05$ [$\chi^2_{crit}(2) = 5.99$, $\alpha < 0.05$]	March $\chi^2_{obt}(2)$ $\alpha < 0.05$ [$\chi^2_{crit}(2) = 5.99$, $\alpha < 0.05$]
Problem	9.38	Not significant
Examples	15.60	Not significant

Fig 42a

October and March data: A plot of relative frequency as a function of lesson components for teaching experience less than ten.

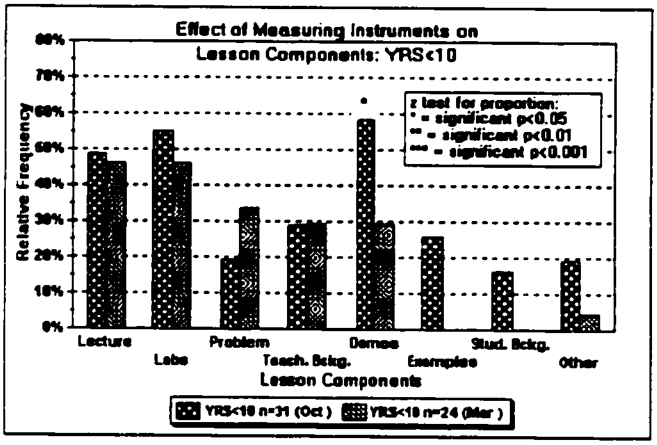


Fig 42b

October and March data: A plot of relative frequency as a function of lesson components for teaching experience equal to or greater than ten but less than twenty.

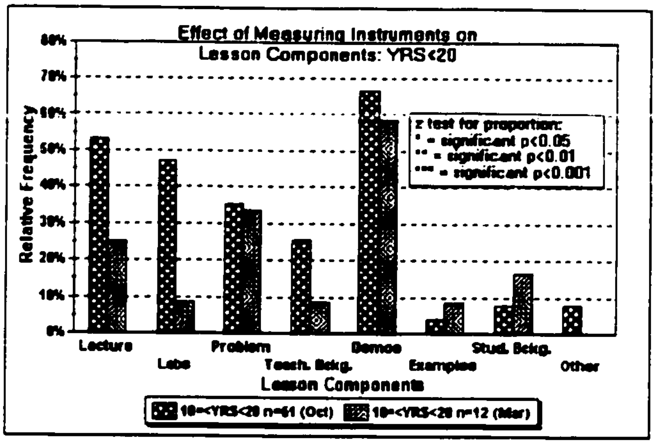


Fig 42c

October and March data: A plot of relative frequency as a function of lesson components for teaching experience greater than twenty.

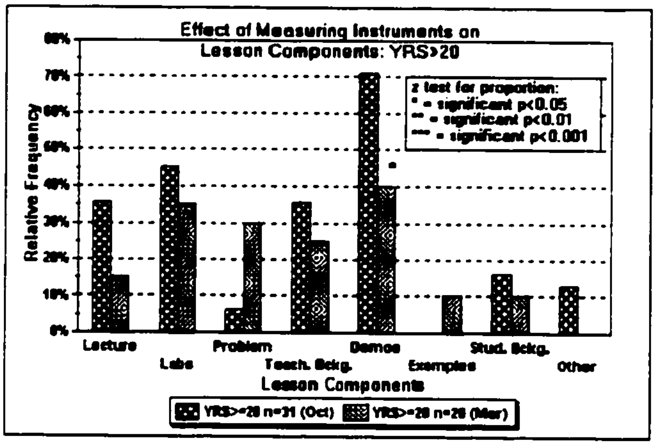


TABLE 26

EFFECT OF EXPERIENCE AND INSTRUMENTS: z VALUES FOR LESSON COMPONENTS

	Years Teaching		
	z_{obt} [z_{crit} = 1.96, 2.58, 3.30; α = 0.05, 0.01, 0.001]		
Lesson Components	10<YRS	10≤YRS<20	YRS≥20
Demos	2.13, α = 0.033	Not significant	2.19, α = 0.0286

A.2.2 Stores Entered

Fig 43a
October data: A plot of relative frequency as a function of stores entered for different teaching experiences.

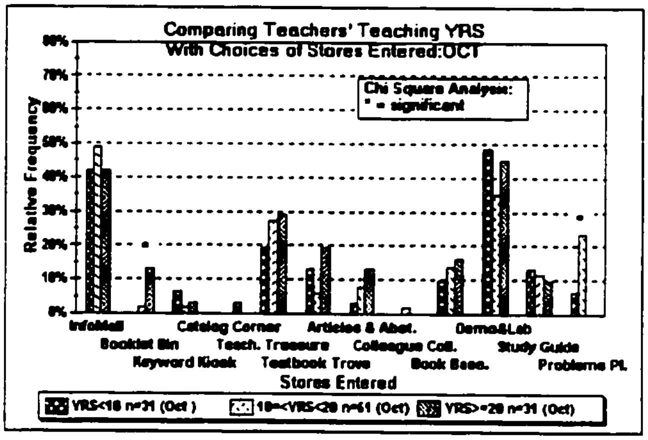


Fig 43b
March data: A plot of relative frequency as a function of stores entered for different teaching experiences.

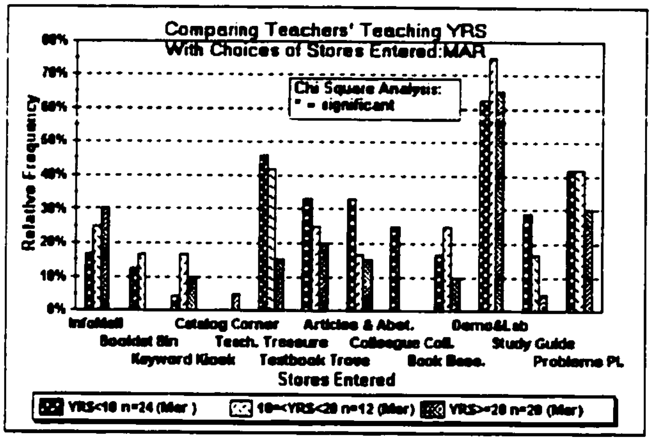


TABLE 27

EFFECT OF EXPERIENCE USING DIFFERENT INSTRUMENTS: CHI SQUARE VALUES FOR STORES ENTERED

	October	March
Stores Entered	$\chi^2_{obt}(2), \alpha < 0.05$ [$\chi^2_{crit}(2) = 5.99, \alpha < 0.05$]	$\chi^2_{obt}(2)\ \alpha < 0.05$ [$\chi^2_{crit}(2) = 5.99, \alpha < 0.05$]
Booklet Bin	7.44	Not significant
Problem Place	11.22	Not significant

Fig 44a

October and March data: A plot of relative frequency as a function of stores entered for teaching experience less than ten.

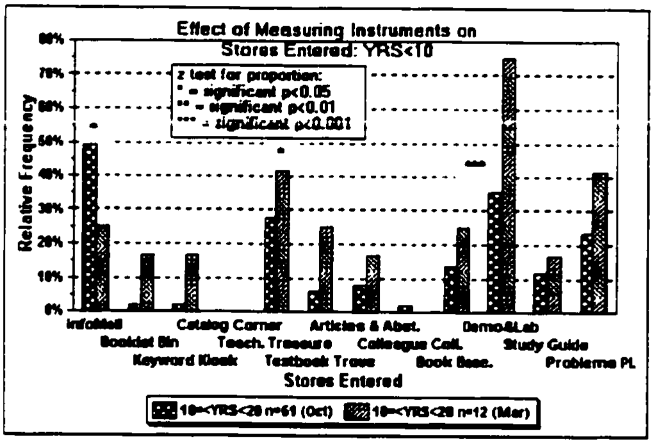


Fig 44b

October and March data: A plot of relative frequency as a function of stores entered for teaching experience equal to or greater than ten but less than twenty.

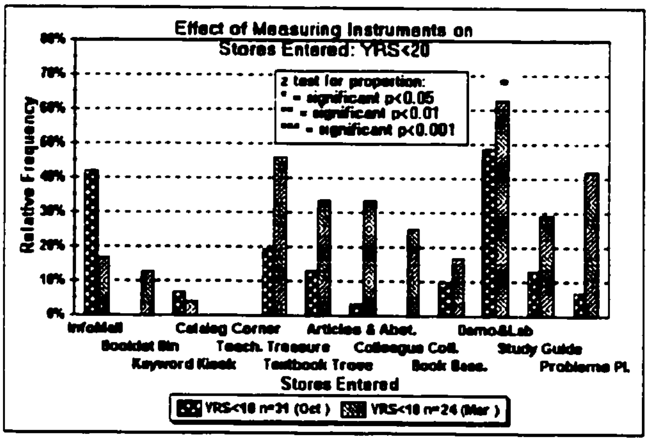


Fig 44c

October and March data: A plot of relative frequency as a function of stores entered for teaching experience greater than twenty.

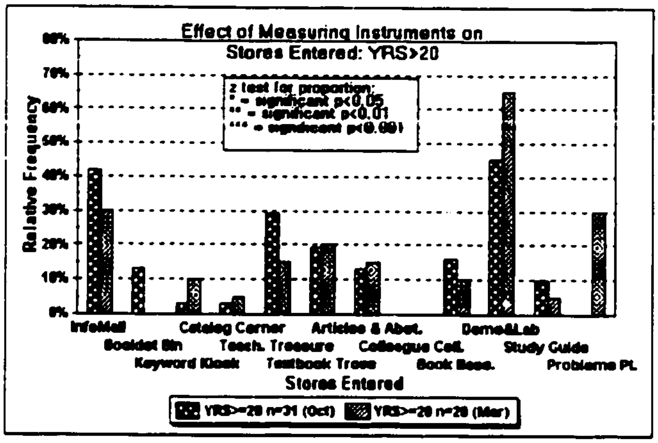


TABLE 28

EFFECT OF EXPERIENCE AND INSTRUMENTS: z VALUES FOR STORES ENTERED

	Years Teaching		
	z_{obt} [z_{crit} = 1.96, 2.58, 3.30; α = 0.05, 0.01, 0.001]		
Stores Entered	10<YRS	10≤YRS<20	YRS≥20
InfoMall	2.01 $\alpha = 0.044$	Not significant	Not significant
Teachers Treasure	-2.11, $\alpha = 0.035$	Not significant	Not significant
Demo & Lab	-3.54	2.50, $\alpha = 0.012$	Not significant

A.2.3 Query Modes

Fig 45a

October data: A plot of relative frequency as a function of query modes for different teaching experiences.

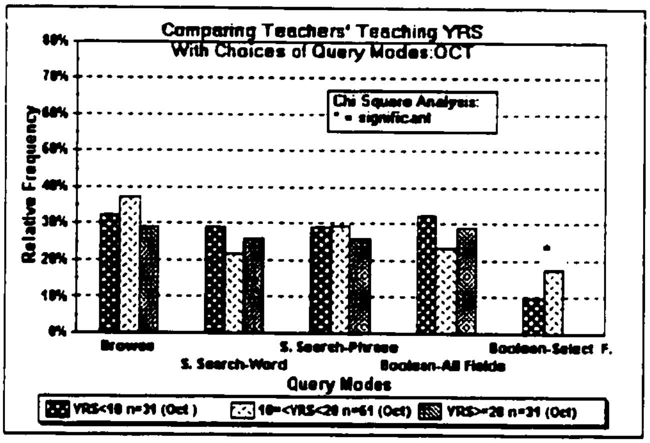


Fig 45b

March data: A plot of relative frequency as a function of query modes for different teaching experiences.

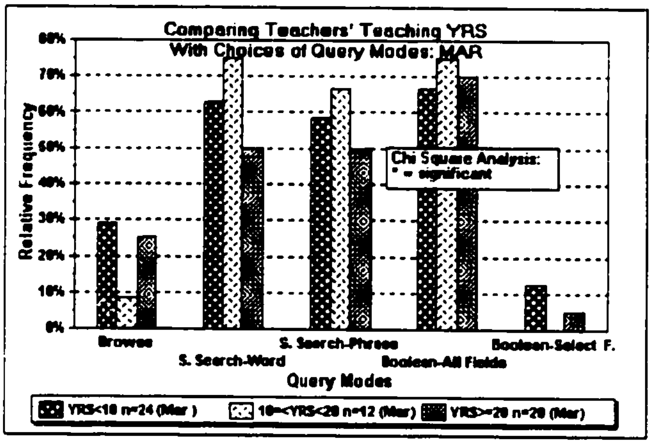


TABLE 29

EFFECT OF EXPERIENCE USING DIFFERENT INSTRUMENTS· CHI SQUARE VALUES FOR STORES ENTERED

Query Modes	October $\chi^2_{obt}(2)$, $\alpha < 0.05$ [$\chi^2_{crit}(2) = 5.99$, $\alpha < 0.05$]	March $\chi^2_{obt}(2)$ $\alpha < 0.05$ [$\chi^2_{crit}(2) = 5.99$, $\alpha < 0.05$]
Boolean Select F.	6.37	Not significant

Fig 46a

October and March data: A plot of relative frequency as a function of query modes for teaching experience less than ten.

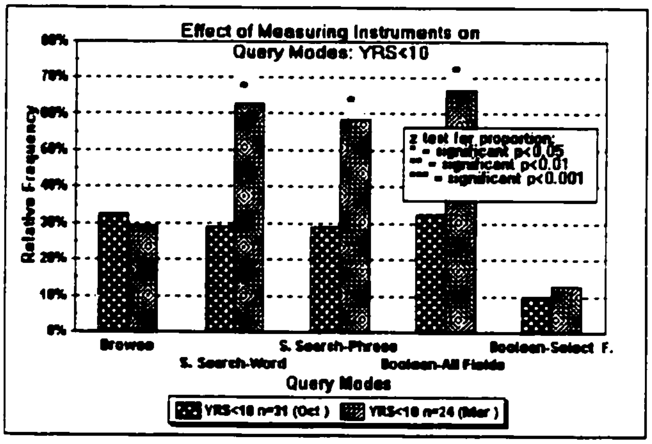


Fig 46b

October and March data: A plot of relative frequency as a function of query modes for teaching experience equal to or greater than ten but less than twenty.

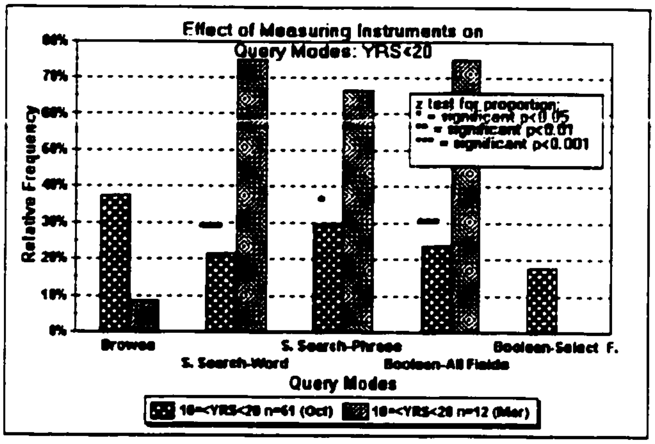


Fig 46c

October and March data: A plot of relative frequency as a function of query modes for teaching experience greater than twenty.

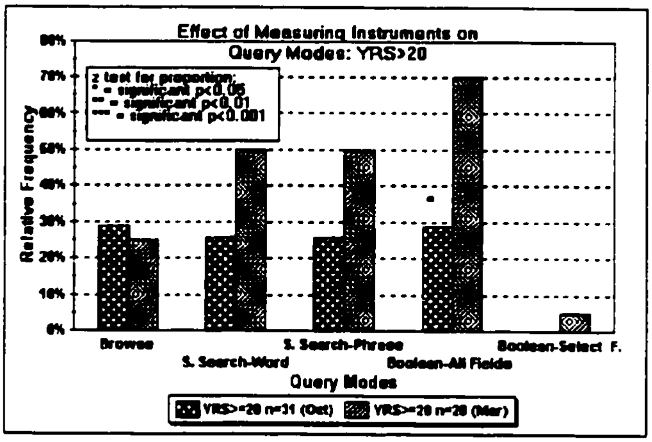


TABLE 30

EFFECT OF EXPERIENCE AND INSTRUMENTS: z VALUES FOR QUERY MODES

	Physics Teachers Teaching Years z_{obt} [z_{crit} = 1.96, 2.58, 3.30; α = 0.05, 0.01, 0.001]		
Query Modes	10<YRS	10≤YRS<20	YRS≥20
S. Search-Word	-2.48 α = 0.013	-3.58 α = 0.0002	Not significant
S. Search-Phrase	-2.18, α = 0.029	-2.41, α = 0.016	Not significant
Boolean-All Fields	-2.53 α = 0.011	-3.40 α = 0.0006	-2.87 α = 0.0042

A.2.4 Mean Values for Information Seeking Categories

Fig 47a
October data: A plot of mean values as a function of information seeking categories for different teaching experiences.

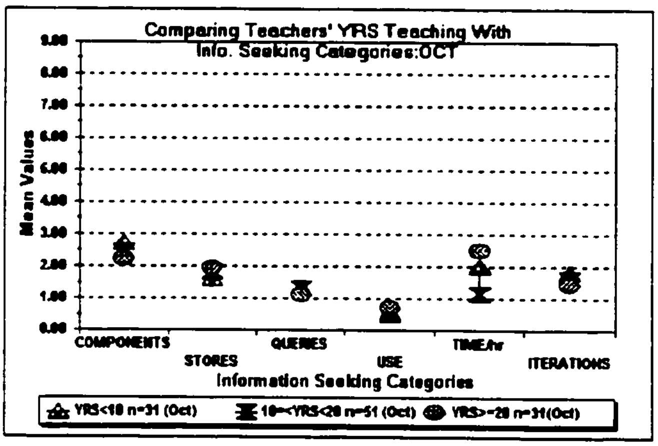


Fig47b
March data: A plot of mean values as a function of information seeking categories for different teaching experiences.

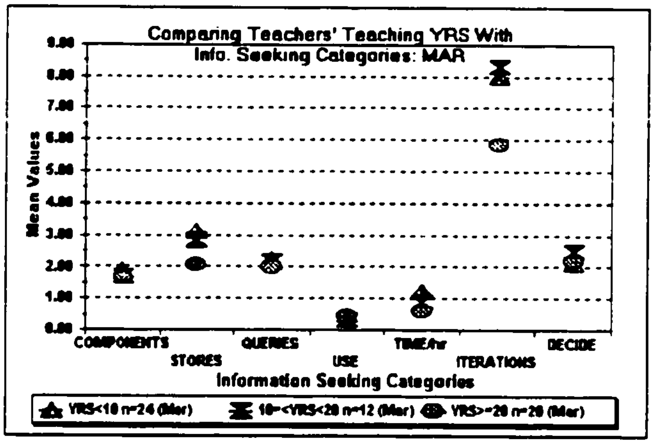


Fig 48a
October and March data: A plot of mean values as a function of information seeking categories for teaching experience less than ten.

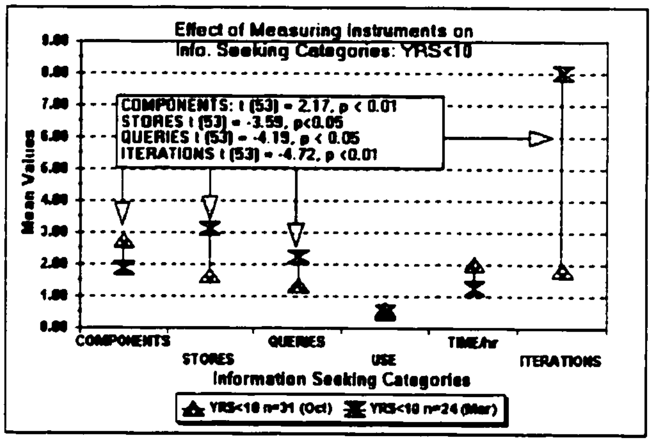


TABLE 31

EFFECT OF SPECIALIZATION USING DIFFERENT INSTRUMENTS: t VALUES FOR INFORMATION SEEKING CATEGORIES (UNDER TEN YEARS)

	Physics Teaching Years YRS < 10	
Information Seeking Categories (ISC)	Mean Values	t values
COMPONENTS	Oct = 2.73	t_{obt} (53) = 2.17
	Mar = 1.88	[t_{crit} =2.01, α<0.05]
STORES	Oct = 1.63	t_{obt} (53) = -3.59
	Mar = 3.12	[t_{crit} =2.01, α<0.05]
QUERIES	Oct = 1.33	t_{obt} (53) = -4.19
	Mar = 2.24	[t_{crit} =2.01, α<0.05]
ITERATIONS	Oct = 1.83	t_{obt} (53) = -4.72
	Mar = 8.00	[t_{crit} =2.01, α<0.05]

Fig 48b

October and March data: A plot of mean values as a function of information seeking categories for teaching experience equal to or greater than ten but less than twenty.

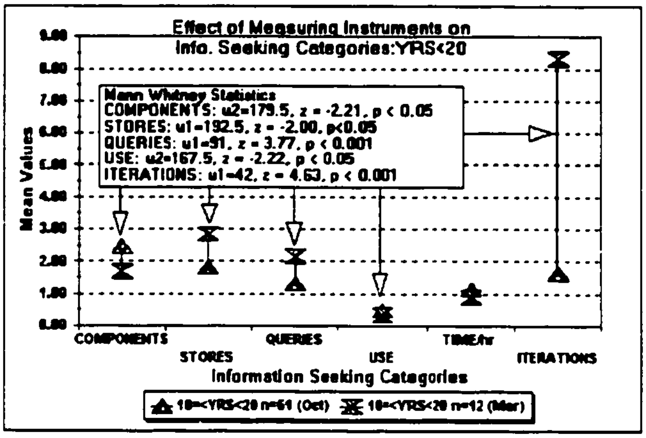


TABLE 32

EFFECT OF SPECIALIZATION USING DIFFERENT INSTRUMENTS: t VALUES FOR INFORMATION SEEKING CATEGORIES

(BETWEEN TEN AND TWENTY YEARS)

	Physics Teaching Years 10 ≤YRS <20	
Information Seeking Categories (ISC)	Mean Values	U values
COMPONENTS	Oct = 2.48	u2 = 179.5
	Mar = 1.69	[z = -2.21, α = 0.027]
STORES	Oct = 1.82	u1 = 192.5
	Mar= 2.85	[z = -2.00, α = 0.048]
QUERIES	Oct = 1.30	u1 = 91
	Mar = 2.15	[z = 3.77, α = 0.000]
USE	Oct = 0.48	u2 = 167.5
	Mar = 0.33	[z = -2.22, α = 0.026]
ITERATIONS	Oct = 1.64	u1 = 42
	Mar = 8.31	[z = 4.63, α = 0.000]

Fig 48c
October and March data: A plot of mean values as a function of information seeking categories for teaching experience greater than twenty.

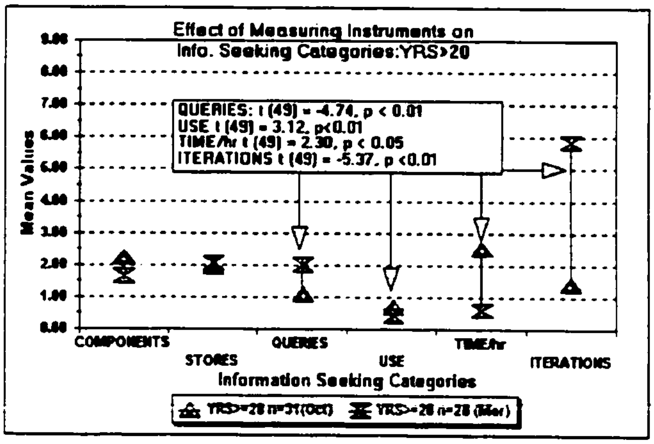


TABLE 33

EFFECT OF SPECIALIZATION USING DIFFERENT INSTRUMENTS: t VALUES FOR INFORMATION SEEKING CATEGORIES (MORE THAN TWENTY YEARS)

Information Seeking Categories (ISC)	Physics Teaching Years ≥ 20	
	Mean Values	t values
QUERIES	Oct = 1.10	t_{obt} (49) = -4.74
	Mar = 2.00	[t_{crit} =2.01, $\alpha<0.05$]
USE	Oct = 0.68	t_{obt} (49) = -3.12
	Mar = 0.42	[t_{crit} =2.01, $\alpha<0.05$]
TIME/hr	Oct = 2.51	t_{obt} (49) = 2.30
	Ma r= 0.60	[t_{crit} =2.01, $\alpha<0.05$]
ITERATIONS	Oct = 1.42	t_{obt} (49) = -5.37
	Mar = 5.85	[t_{crit} =2.01, $\alpha<0.05$]

Appendix B
Letter to Field tester

KSU KANSAS STATE UNIVERSITY

Department of Physics
116 Cardwell Hall
Manhattan, Kansas 66506-2601
913-532-6786
FAX: 913-532-6806

March 11, 1994

Dear Colleague:

Your application to be a field tester for the third field test version of the Physics InfoMall has been accepted. We have run into a delay with field test version 3 and do not expect to have it ready for release until August. In the meantime, we are sending you a copy of field test version 2.

Enclosed you should find:

- the CD-ROM
- User's guides (both Mac and Windows versions)
- Mac User's warning
- Initial Impressions Survey
- log sheets to be used in providing feedback

We are anxious to get feedback on how effectively the disk supports lesson planning. Please choose from one of the six topics listed below that we would like you to provide feedback on.

Electrostatics
Energy Conservation.
Momentum
Projectile Motion
Quantum Physics
Waves

Using the enclosed log sheets, track the strategy you use to locate the information and the time involved in planning for the week. A sample log sheet is enclosed. Those returning log sheets for any of these topics will receive the next release of Physics InfoMall at no cost. Please return your log sheets in the enclosed postage paid, self-addressed envelope to us along with the coupon enclosed so that we may send you your free copy of Field Test Version 3 this fall.

If you have any questions, please do not hesitate to call the Physics InfoMall voice mail at 800-232-0133, ext. 7167, or send e-mail messages to infomall@phys.ksu.edu.

Finally, we apologize for the delay in sending these materials to you. We had anticipated that FTV3 would be ready for distribution in mid-April. We know this may have inconvenienced some of you, but we expect that the delay will result in a more useful InfoMall.

Sincerely,

Dean Zollman
Field Test Coordinator

Jacqueline D. Spears
InfoMall Evaluator

Appendix C
Samples of Evaluation Forms

Evaluation Form - October, 1993

Physics InfoMall Survey - 13   Return to: Physics InfoMall, Dept. of Physics, KSU, 116 Cardwell Hall, Manhattan, KS 66506-2601

Name: Judy Ng   InfoMall Platform (circle one). Mac   Windows

Topic: Momentum and Impulse   Start time: End time: Date:

1. Which of the following tasks are you completing?

- [ ] lecture materials
- [x] demonstrations
- [x] laboratory experiments
- [ ] worked examples
- [x] problems/test
- [ ] student reading materials
- [ ] teacher background reading materials
- [ ] other (please specify)

2. Which of the following stores did you enter (check one)?

- [x] Entire InfoMall
- [x] Teachers Treasures
- [ ] Book basement
- [ ] Booklet Bin
- [ ] Textbook Trove
- [ ] Demo & Lab Shop
- [ ] Keyword Kiosk
- [ ] Articles & Abstracts
- [ ] Study Guide Store
- [ ] Catalog Corner
- [ ] Colleague Collection
- [ ] Problems Place

3a. While in the store, which mode did you use to access information?

- [ ] Browse → Go to 4
- [ ] Simple Search → Go to 3b
- [x] Compound Search → Go to 3c.

3b. Specify your search word/phrase.

3c. Specify your search queries (words/phrases), your search field and where the words are to be found.

momentum	and	Impulse	and	~~collision~~ Elastic collision	and	
	or		or		or	Inelastic collision
	not		not		not	

- [ ] All Fields
- [ ] Article Heading
- [ ] Section Heading
- [ ] Sub-sec Heading
- [ ] Table (Literal)
- [ ] Citations
- [ ] Keywords
- [ ] Text
- [ ] Within Paragraph
- [ ] Within Article

4a. Name ten of the documents you examined and indicate which ones you incorporated into your teaching by placing a check mark in the last column.

Document title	Section Heading	Sub-section Heading	Use
clothespin snap lab (snap open the clothespin)			✓
Amusement park physics (bungee jump) sample [illegible]			✓
momentum problem [illegible]			✓
momentum labs			

4b. Briefly explain why you chose the documents that you did to incorporate into your teaching.

The amusement park physics - bungee jump is of great interest to students.
The clothespin lab is easy to prepare. materials are readily available. discussion questions are included

4c. Do you have enough materials to complete your task?

☑ Yes → Go to 5. ☐ No → Go back to 1.

5. How much time did you spend to complete this task?

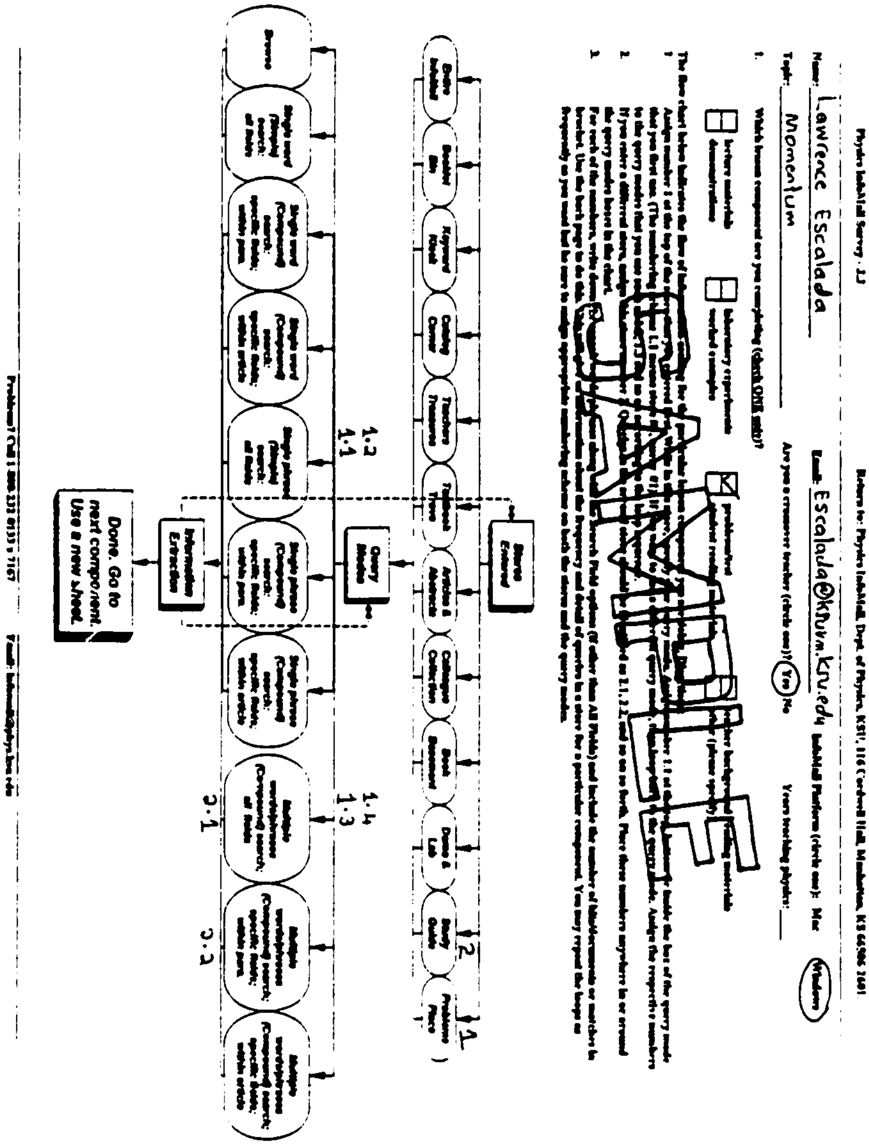
Two periods

6. Were you limited in the amount of time to complete this task? Explain.

No

7. Please add any additional comments regarding this evaluation specifically and the Physics InfoMall in general.

Evaluation for March, 1994



Name: Lawrence Escalada

Email: Escalada@KSUVM.KSU.EDU

Topic: Momentum

Done. Go to next component. Use a new sheet.

Search words/phrases, search field options and amount of hits/documents or matches

1.1: Linear* momentum* ; [1/1]
1.2: Conservation* of momentum* ; [11/6]
1.3: momentum* AND collisions* ; [29/4]
1.4: momentum* AND elastic* AND collisions* ; [17/2]
2.1: momentum* AND elastic* AND collisions* ; [28/2]
2.2: momentum* AND impulse* ; keywords ; [18/3]

2. What percentage of the numbers that you listed above was integrated into your lesson for this component (circle ONE only)?
10 20 30 40 50 60 70 (80) 90 100

3. How difficult was it to decide which of the retrieved documents you wanted to use for teaching?
Very Difficult 5 4 OK 3 2 Very Easy (1)

Briefly explain the factors in your decision.
The problems that I found would be used in a way or another as worked examples, problems on homework assignments, worksheets and tests. They were simple to use and easy to understand.

4. How much time did you spend seeking relevant materials for this component?
10-15 minutes

5. General comments.
Copying text one paragraph at a time is very inefficient. Otherwise the InfoMall is a fantastic physics resource.

Appendix D
Application Form

Physics InfoMall CD-ROM
Information Sheet for Field Test Version Three

Name: **School Name:**

Home Address: **School Address:**

Home Telephone: **School Telephone:**

FAX:

e-mail:

Physics in Your School
How many students enroll annually in: Physical Science___ Introductory Physics___
Advancement Placement Physics______

Give approximate *percentages* below for a typical academic year.

	Male	Female	White	Afro-American	Hispanic	Native American	Other
Physical Science							
Introductory Physics							
Advanced Placement							

How many teachers teach physics in your school?____________

Your School Profile
Grade Levels in the School ☐ 9 ☐ 10 ☐ 11 ☐ 12 ☐ Other___
Total number of students in the school_____
Approximate *percentage* of males____ females____
Approximate *percentage* of White____ Afro-American____ Hispanic_____
Native American____ Other____
Size of community in which the school is located:__________
Approximate *percentage* of total student population which come from:
inner city____ suburban____ large town____ small town____
rural___ other____
Approximate percentage of students eligible for free or reduced-price lunch_____

Your Teaching Experience
Academic Degree(s) and Year(s)____
Additional Academic Training:

Content Areas of Endorsement/Certification

How many years have you taught physics? _____

What else have you taught?

What else are you teaching now?

Please complete the other side.

Why are you teaching physics?

Do you consider yourself a cross-over teacher (someone who started teaching other subjects then added or switched to physics)? ☐ Yes ☐ No

Your Computer Experience

Do you have a computer available

☐ at home? ☐ in your classroom? ☐ in your office? ☐ in a media center/library?
☐ in the teachers' lounge? ☐ in an administrator's office? ☐ computer lab ☐ other

What is your computer experience?

☐ a real hacker ☐ heavy user ☐ moderate user ☐ light user
☐ I turned one on once! ☐ What's a computer?

If you use computers, what is your primary use?

How frequently do you use CD-ROMs?

☐ every day ☐ at least once a week ☐ at least once a month
☐ occasionally ☐ once in a lifetime ☐ never

The Computer/CD-ROM System on which you will use the Physics InfoMall

Make and model of CD-ROM drive:____________________

☐ **IBM PC or compatible**

Make of Computer:________________________

Type of Processor	☐ 80286	☐ 80386	☐ 80486	☐ other______
Version of DOS	☐ 4.0	☐ 5.0	☐ 6.0	☐ other______
Version of Windows	☐ 3.0	☐ 3.1		

Random Access Memory (RAM) _____Megabytes

☐ **Macintosh**

Model:________________________

Random Access Memory (RAM)_____Megabytes

System ☐ 6.x ☐ 7.x

Where is this computer located?

☐ at home? ☐ in your classroom? ☐ in your office? ☐ in a media center/library?
☐ in the teachers' lounge? ☐ in an administrator's office? ☐ computer lab ☐ other

The commercial distribution contract for the InfoMall is now being negotiated. We anticipate that a discount will be available to everyone who has provided the project staff with useful feedback on their use of the InfoMall. We cannot state what the size of the discount will be, but it should be a significant fraction of the price that you pay for the field test version.

________________________ __________________

signature *date*

Return to: Physics InfoMall, Department of Physics, 116 Cardwell Hall, Kansas State University, Manhattan, KS 66506-2601; Voice/FAX: 1-800-232-0133 ext 7167; e-mail: Infomall@phys.ksu.edu

Please complete the other side.