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ABSTRACT

The purposes of this study were to determine how experienced high school physics teachers were in using computers, how computers were being used for high school physics instruction, what the teachers perceived the use of computers in their physics classes should be, and what the enabling and constraining factors were in developing the use of computers. A total of 319 high school physics teachers who were members of the American Association of Physics Teachers responded to a survey mailed to 400 teachers for a return rate of 79.8 percent. Conclusions based on the results of the survey were: (1) the teachers averaged seven years computer experience but the quality was questionable; (2) the number of computer systems available was insufficient to support use and restricted the teachers' selection of applications for physics instruction; (3) the teachers wanted to use all of the computer applications more frequently; and (4) the enabling factors were quantity of computer systems, software, and preparation time and the constraining factors were lack of funds for purchasing, having time to prepare for use, and having computer systems available. The survey instrument is appended. (YP)

Computer Usage By Physics Teachers and Their Students

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A paper presented at the American Educational Research Association Annual Meeting, San Francisco, CA, March 27-31, 1989

Purposes of the Study

The purposes of this study were to determine how experienced high school physics teachers were in using computers; to ascertain to what extent and how computers were being used for high school physics instruction; to determine what high school physics teachers perceived the use of computers in their physics classes should be; and to determine what the enabling and constraining factors were in developing the use of computers for high school physics instruction. A survey instrument designed by the researcher was mailed to a sample of American high school physics teachers who were members of the American Association of Physics Teachers.

Methodology

The instrument included questions regarding the experience of the respondent and the availability of computer equipment; the current frequency of use of computers by the teacher and his/her students, and the ideal frequency of use of computers by the teacher and his/her students. Questions regarding the teachers' concerns were used to determine the teachers' Stages of Concern; and the respondents were asked to list factors which assisted or thwarted their efforts to use computers for physics instruction.

The validity and reliability of the survey instrument (Appendix A) were established by a review of the literature for computer applications used in physics instruction and Stages of Concern instruments developed by Hall and his associates; and by an evaluation of the survey instrument by a group of ten high school physics teachers and one university physics professor (Appendix B).

Of the four hundred teachers selected to participate 319 or 79.8 percent returned their surveys. Perhaps this high rate of return may be attributed to some or all of the following factors:

- The sample was chosen from members of the American Association of Physics Teachers, a professional organization.
- The inclusion of a diskette of public domain software.
- The cover letter used a personalized greeting instead of "Dear Colleague."
- The survey was conducted by a fellow physics teacher rather than a professional researcher or an institution.

Findings

The high school physics teachers responding to the survey averaged 18 years of teaching experience (Figure 1) and 14 years of physics teaching experience (Figure 2). Over 30% of the respondents reported having physics as their undergraduate major. With the exception of biology (6.25%) all the majors with a frequency of 1% or greater were in the physical sciences. Eighty-two percent of the respondents have earned advanced degrees. The predominate majors for advanced degrees were in the physical sciences or education.

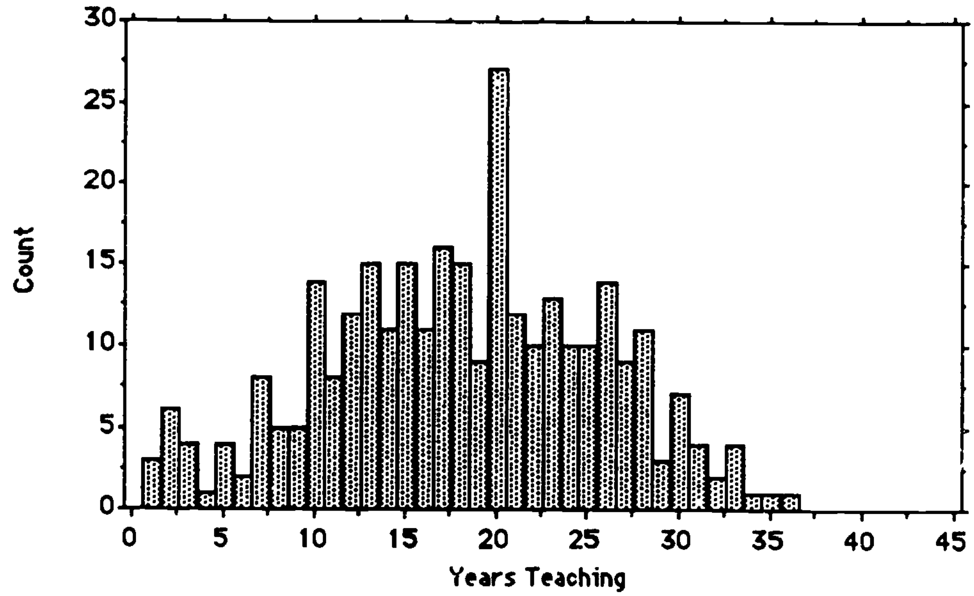

Figure 1. Respondents' Years of Teaching Experience

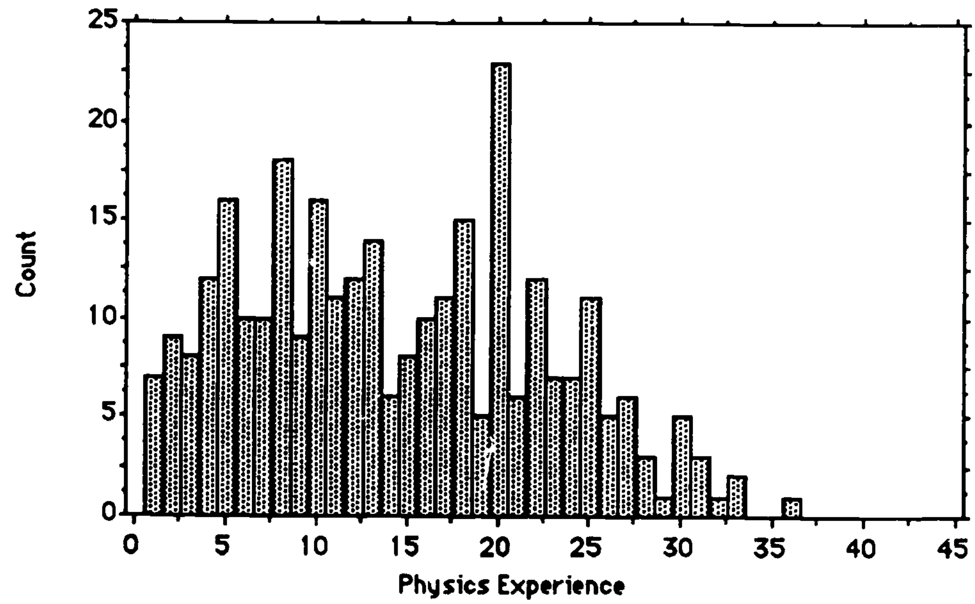

Figure 2. Respondents' Years of Experience Teaching Physics

Ninety-five percent of the physics teachers responding have had experience using computers (Figure 3). The average number of years experience was 6.97 with a mode of three years. The average number of computer stations available was 6.7; however, the mode was only one. These would include computers which must be shared with other classes during the school day. Furthermore, the average number of computer stations available on a daily basis was only 2.5, with a mode of zero.

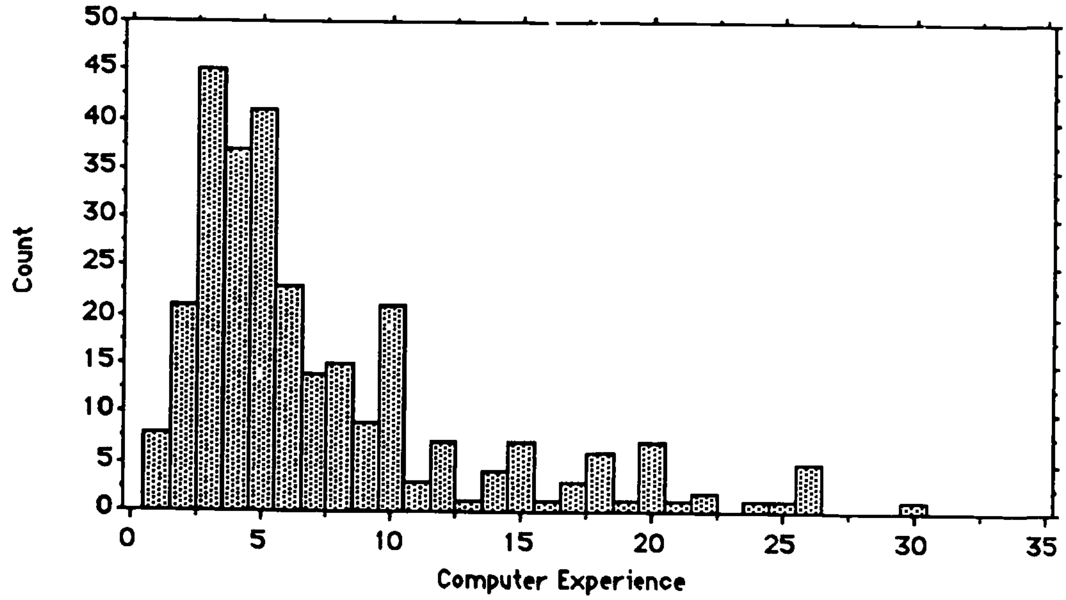

Figure 3. Respondents' Years of Experience Using Computers

The computer applications used by the greatest number respondents were word processing (teacher use), demonstration, and grade book programs. Each was reported used at least once during the school year by more than 50% of the respondents. Word processing and grade book programs were used on a weekly basis, while demonstration programs were used 2 to 5 times during the school year.

Between 40% and 50% of the respondents reported using laboratory simulations, laboratory tool (teacher use), drill and practice, tutorials, data plotter (teacher), word processing (student use), and educational game programs. The laboratory simulations, drill and practice, tutorial, and word processing programs were used by students. The modal frequency of use of each of these applications was two to five times during the school year. Data plotter programs were reported used by less than 40% of the respondents' students.

Most of the teachers believed that word processing, demonstrations, grade book, test generators and drill and practice should be used weekly. Laboratory tools, laboratory simulations, data plotters, tutorials, educational games, authoring and spreadsheets (teacher use) should be used monthly.

The most frequently cited enabling factors were having adequate numbers of computer stations (24.3%), appropriate software (15.2%) and adequate preparation time (13.2%). The most frequently cited constraining factors were inadequate funding (18.4%), inadequate preparation time (17.8%) and an inadequate number of computer stations (15.9%).

Statistically significant differences were found between the current frequency of teacher use and the ideal frequency of teacher use of authoring, demonstration, grade book, test generator, communications, data plotter, spreadsheet, information services, laboratory tool, and word processing applications software. Statistically significant differences were also found between the current frequency of student use and the ideal frequency of student use of drill and practice, educational games, laboratory simulation, programming, tutorial, communications, data plotter, spreadsheet, information services, laboratory tool, and word processing applications software.

A statistically significant difference was found among the respondents' placement into Stages of Concern (SOC) categories (Figure 4). This distribution was bimodal with the greatest number of respondents being placed into Stage of Concern one and many respondents being placed at or near Stage of Concern four.

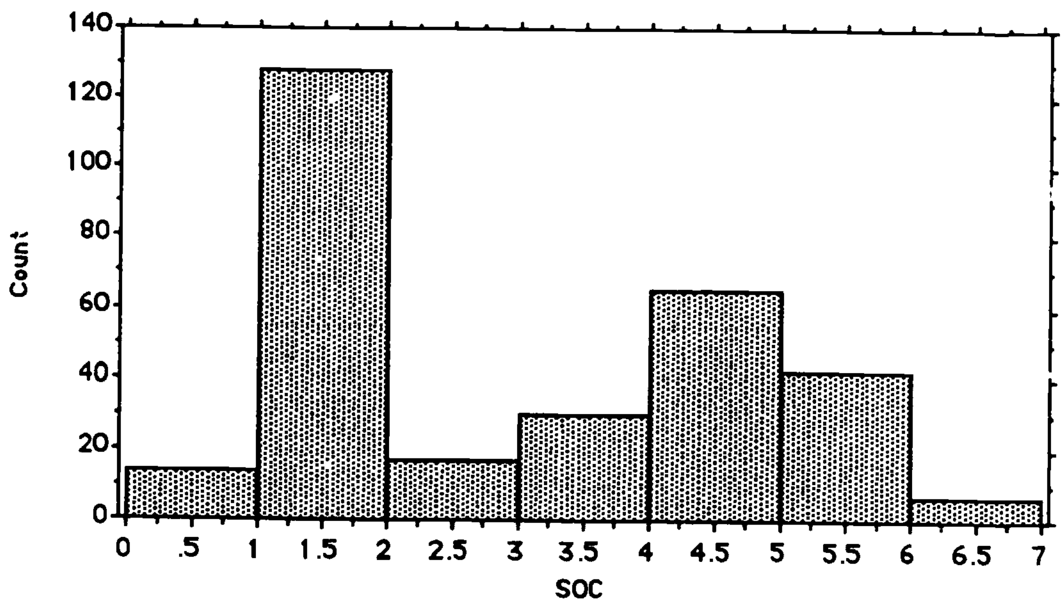

Figure 4. Respondents' Placement Into Stage of Concern Categories

No statistically significant differences were found among the respondents' mean number of years of teaching experience, mean number of years of experience teaching physics, mean number of computers available for physics instruction or mean number of computers available for physics instruction on a daily basis when grouped by the respondents' Stage of Concern (SOC). However, a statistically significant difference was found among the respondents' mean number of years of experience using computers when grouped by the respondents' Stage of Concern.

This difference may be explained by Hall's concerns based adoption model. Those who had been given early opportunities to use computers progressed through the sequence of concern stages while others did not. These teachers may have been among the first users of personal computers and thus had gained more years of computer experience and greater Stages of Concern.

Significant differences were found between the current frequency of use for all computer applications investigated except authoring, communications, information services and test generators when grouped by the respondents' Stage of Concern. This difference may also be explained by Hall's concerns based model of innovation in that individuals must progress through the sequence of concerns regarding an innovation before accepting and using it. However, the Concerns Model would predict that the all applications should be used more frequently by teachers at the greater Stages of Concern. Thus, it is important to note that the four applications in which no significant differences were found were among those least used (see Table 9). The question raised by this situation is, why don't the teachers at the greater Stages of Concern use these applications? Some possible answers include the following:

- The teachers at the greater Stages of Concern are unfamiliar with these applications.
- The teachers at the greater Stages of Concern have not considered the usefulness of these applications.
- The teachers at the greater Stages of Concern have decided that these applications have limited usefulness.
- The teachers at the greater Stages of Concern do not have these applications available.

Significant differences were also found between the respondents' perceptions of the ideal frequency of use for all computer applications investigated except test generators, tutorials, and word processing (ISU) when grouped by the respondents' Stage of Concern. The Concerns Model would predict that teachers at the greater Stages of Concern should perceive a greater ideal frequency of use than teachers at the lesser Stages of Concern, for all applications investigated. No explanation is apparent to explain the agreement among teachers at all Stages of Concern regarding the ideal frequency of use of test generators, tutorials, and word processing (ISU).

Resolution of the Hypotheses

It was hypothesized that there would be no statistically significant difference between the respondents' or their students' current frequencies of use and the respondents' perceptions of the ideal frequencies of use for authoring programs, demonstration programs, grade book programs, test generators, drill-and-practice, educational games, laboratory simulation programs, programming as a learning tool, tutorials, communications, data plotter programs, electronic spread sheets, information services, laboratory tool and word processing programs. Every computer application investigated yielded a statistically significant difference, at alpha = .05, between the reported current frequency of use and the respondents' perceptions of the ideal frequency of use. Therefore, the hypothesis that there is no difference between the respondents' or their students' current frequencies of use and the respondents' perceptions of the ideal frequencies of use is rejected for all computer applications investigated.

It was hypothesized that there would be no statistically significant difference between the physics teachers' placement into Stages of Concern categories. However, at alpha = .05, a statistically significant difference was observed. Therefore, the null hypothesis is rejected and it is concluded that there was a difference in the placement of physics teachers into Stages of Concern categories.

Conclusions

Physics Teachers Experience

The first purpose of this study was to determine how experienced high school physics teachers were in using computers. From the findings it may be concluded that high school physics teachers are experienced using computers and should be sufficiently prepared to successfully use them for physics instruction.

Considering that the teachers averaged seven years computer experience, the high frequency of respondents determined to be at Hall's Stages of Concern one (SOC 1) was unexpected. Several factors may help explain this apparent inconsistency. First, this study made no distinction between microcomputer, minicomputer, and main frame computer systems and many of the respondents may have included experiences from undergraduate or graduate courses using main frame or minicomputers years ago. This is most certainly true of respondents reporting more than ten years computer experience as the history of personal computers is only ten years old.

Also, many or most respondents may have included all the time since their last computer experience rather than estimating the time spent actively using computers. Thus, a hypothetical teacher who had completed a six week computer literacy class three years ago, and had not used a computer since, may have reported three years of experience rather than six weeks.

Finally, the general use of computers in education and the use of computers for physics instruction may be regarded as separate innovations and thus could explain the observed bimodal distribution of Stages of Concern. It appears plausible that many respondents may have progressed through several Stages of Concern regarding the general use of computers in schools several years ago. At some time in the past they may have been primed and ready to participate in using the innovation.

However, only selected individuals were given the opportunity to participate initially. These were most likely mathematics, science or business education teachers who were interested in teaching programming, business applications or computer literacy classes. Many of the physics teachers responding may have become involved with computers in this manner and may account for the relatively high frequency of distribution of respondents about SOC 4. In fact, several respondents did report that they were also their school's computer teacher.

Those who did not become involved immediately may have been given little opportunity to participate in using the innovation and thus did not progress along the sequence of stages as described by Hall. These individuals may have accepted the innovation as it exists elsewhere in the curriculum, or as it pertains to personal use such as word processing or maintaining grades, without seriously considering its role within the physics curriculum. Such individuals may very well account for the large number of respondents at Stages of Concern one. These individuals may not be interested in learning more about computers but more about how computers can be used in their physics classes.

The difference found between the respondents' Stages of Concern and their years of computer experience may also be explained by the notion that those who had been given early opportunities to use computers progressed through the sequence of stages while the others did not. The mean years of computer experience of teachers at SOC 5 was 10 years, nearly twice that of teachers at SOC 1. These teachers must have been among the first users of personal computers and thus were probably very interested in the innovation as it relates to physics from the outset.

An apparent discrepancy regarding the years of computer experience and the Stages of Concern exists when considering the twelve individuals at SOC 0. Their mean years computer experience was 9.4 years, close to the respondents at SOC 5. However, some of these individuals claimed over 20 years experience, wrote negative notations on their questionnaires, and seemed to be hostile to the innovation, the survey, and the researcher.

Perhaps the mean years of computer experience for SOC 0 should be discounted. These respondents most likely used main frame computers in the past and may be attempting to use this experience to defend their resistance to accepting the use of personal computers in the physics curriculum. This possibility may also help explain the unexpected high level of computer experience for the respondents at SOC 1.

Current Use of Computer Applications

The second purpose of this study was to ascertain to what extent and how computers were being used for high school physics instruction. It may concluded that the number of computer systems available was insufficient to support extensive use and restricted the teachers' selection of applications that would be appropriate for physics instruction. Although the teachers had computers available on a shared basis they did not have equipment available daily. Thus computers could not be used as part of an experiment unless the setup was to be broken down on a daily basis. Also, unless the school had a computer laboratory which could accommodate an entire class, computer equipment would have to be transported and set up in the physics classroom or laboratory. This would have made it difficult for students to use the computers because most applications require individual or laboratory team use (usually two students). The teachers seemed to have enough equipment to utilize all of the applications themselves and to provide occasional demonstrations for their students.

Word processing for teacher use and grade book programs were used on a weekly basis, while demonstration programs were used 2 to 5 times during the school year. The fact that the each of these applications require only one computer system supports the conclusion that there is insufficient equipment to provide for student computer experiences.

Between 40% and 50% of the respondents reported using laboratory simulations, laboratory tool (teacher use), drill and practice, tutorials, data plotter (teacher), word processing (student use), and educational game programs. The laboratory simulations, drill and practice, tutorial, and word processing programs were used by students. The modal frequency of use of each of these applications was two to five times during the school year. Except word processing, each of these applications can be used with a single computer as a learning center by rotating students through the experience on different days. These applications seem to be the most readily available and it is not surprising that they are the ones most frequently used by students.

It was surprising to learn that data plotter programs were reported being used by less than 40% of the respondents' students. This should be one of the most useful computer applications for physics considering the number of experiments which require graphing of numerical data. However, data plotter programs have limited usefulness if a printer is not available. Perhaps it may not be convenient or impossible for students to print out graphs for their reports.

The data permits the conclusion that the respondents at the greater Stages of Concern have greater current frequencies of computer use than those respondents at the lesser Stages of Concern for all applications except authoring, communications, information services and test generators. This conclusion simply reflects Hall's concerns based model of innovation in that individuals must progress through a sequence of concerns regarding an innovation before accepting and using it. The four applications in which no significant differences were found were among those least used (see Table 9).

Shavelson's research (1984) found that the most successful users of computer-based instruction varied their patterns of use. He also found that teachers with extensive undergraduate work in science tended fall into the adjunct instruction and drill and practice modes of computer-based instruction. The limited patterns of use reported by the physics teachers and the large number of respondents at the Awareness (0) and Information (1) Stages of Concern seems to support Shavelson's suggestion that "science teachers may not be the ones to lead the technology revolution in education (1984, p. 71)."

Ideal Use of Computer Applications

The third purpose of this study was to determine what high school physics teachers perceived the use of computers in their physics classes should be. The data collected clearly supports the conclusion that physics teachers perceived that they should be using all of the computer applications investigated more frequently than they are currently using them.

The data also permits the conclusion that the respondents at the greater Stages of Concerns perceive greater ideal frequencies of computer use than those respondents at the lesser Stages of Concern for all applications except test generators, tutorials, and word processing for student use. This conclusion is also predicted by Hall's concerns based model of innovation.

Cognitive dissonance, as described in Chapter 2, may also explain the respondents' perceptions of the ideal frequency of use of computer applications. It may be that the teachers were troubled by the possibility that they were not doing something that other teachers were; and thus, as described by Festinger (p. 667), "selectively perceived" higher ideal frequencies of use "in an effort to reduce this 'dissonance.'" In fact, when considered collectively, it may be impossible to use all the applications at the ideal frequencies perceived.

Enabling and Constraining Factors

The fourth purpose of this study was to determine what the enabling and constraining factors were in developing the use of computers for high school physics instruction. It has been concluded that physics teachers perceived that having an adequate quantity of computer systems available was the most important enabling factor in using computers for physics instruction. The second most important enabling factor was having appropriate software. Having adequate preparation time for their use was the third most important enabling factor.

It has been concluded that physics teachers perceived that having adequate funds to purchase computer systems and to provide for adequate preparation for their their use was the most important constraining factor. The logic is obvious, if having adequate numbers of computer systems is the most important enabling factor then the lack of funds for their purchase should be the most important constraining factor. Also, assuming an adequate quantity of computer systems are available, then funds must also be provided for preparing teachers how to use them. The second most important constraining factor was having time to prepare to use the computers. Having computer systems available was the third most important constraining factor.

Most of the respondents did not differentiate between enabling or constraining factors. The constraining factors were simply negative assertions of the enabling factors. If, for example, a respondent claimed that supportive administration was an enabling factor, he or she would most likely state that non-supportive administration was a constraining factor. However, it is interesting to note that, as a group, the teachers perceived that the greatest enabling factor was to have computer systems while the greatest constraining factor was the lack of funds to pay for them.

Although many different factors were given, many appear to be synonymous or closely related. For instance, many respondents simply stated that time was a factor. Were they referring to time to learn how to use computer hardware and software, time to prepare lessons, time to fit "computer physics" into the crowded curriculum, or simply time to let the "dust settle" and see where we are headed? Many of those who claimed time as an enabling or constraining factor may be describing the same factor that others called training.

Coburn (pp. 170-171) cited essentially the same constraints in explaining why computer assisted instruction "did not become a significant ongoing part of many school programs in the sixties or even the early seventies." Most notably, Coburn concluded that "the cost of the hardware needed to reach the masses of students and the cost of developing quality educational software were much to high." Although these costs have dropped dramatically, funding for the use of computers in assisting physics instruction has remained inadequate. The constraining factors which existed 25 years ago still exist today, and Coburn's observation that schools are fundamentally conservative social systems remains true.

Recommendations

Graef (p 431) and Becker (p 4) have previously recommended that science educators needed to determine what computer applications were useful and what could be done to make computers more useful in the future. This study has come to several conclusions which support these recommendations.

The leading constraint to using computers in the physics curriculum is the lack of funds to purchase equipment, software, and training for the teachers. While it is beyond the scope of this project to make recommendations regarding the financing of educational innovation it is important to note that it cannot take place without it. However, simply providing adequate quantities of computer equipment and training on how to operate it will not insure its successful integration into the physics curriculum. Physics teachers also need help in knowing what computer applications are appropriate to the curriculum; and where, when, and how they should be used.

It is recommended that the writers, publishers, manufacturers and distributors of physics curricula materials revise their products to include appropriate computer activities. These revisions should completely integrate the computer based activities into the curriculum rather than simply supplement the current or past curriculum. The leading physics curriculum projects, such as Project Physics and PSSC physics, should make major revisions to provide teachers with a precise guide to follow when using computers with their particular approach to teaching physics.

It is recommended that professional organizations, such as the American Association of Physics Teachers, continue their efforts to identify exemplary uses of computer technology in physics teaching. They should also continue to provide workshops and training for physics teachers and science curriculum coordinators.

It is recommended that major colleges and universities, throughout the United States provide courses for high school physics teachers on how to use computers in their classes.

Suggestions for Further Research

Several questions arose during the analysis phase of this project which could not be answered from the data collected. Therefore, similar research projects should consider including items in the survey instrument which address the following questions:

- How recent was the teacher's computer experience?
- Was the computer experience with main frame computer, minicomputer, or microcomputer systems?

- How recent was any computer training?

- Was the training related to using computers for physics instruction?

- What other classes did the respondent teach?

- Did the respondent teach computer classes?

- Did the school have a computer laboratory?

- Which of the computer applications investigated were available at the respondent's school?

- How many printers were available for the computers used in physics instruction?

- Were computers available for student use outside of class time?

This research project has addressed teachers perceptions of uses of computers in the science curriculum. It has been concluded that physics teachers believe that they should be using computers more frequently than they are currently being used. To facilitate that goal, it has been recommended that new physics curriculum materials be developed which explicitly guide the teacher in choosing and delivering appropriate computer based learning experiences.

Considering that teachers do not have time nor resources to create computer based learning experiences publishers should develop software that corresponds with new or existing physics textbooks. This software should include appropriate demonstration, tutorial, laboratory simulation and test generating materials with instructions for their use. Furthermore, learning experiences involving the use of word processing, data plotter, laboratory tool or other applications software should be provided. The instructions for using these learning experiences should focus upon how to best integrate applications software into the physics curriculum.

A major step in developing such a curriculum would be to determine the appropriate uses of computers and where and how they should be written into the curriculum. Therefore, it is suggested that an investigation of successful physics teachers who use computers in their curriculum be conducted.

SURVEY OF PHYSICS TEACHERS' PERCEPTIONS OF THE USE OF COMPUTERS IN THE PHYSICS CURRICULUM

GENERAL INFORMATION

Please answer the following questions by writing your response in the space provided.

1. What was your undergraduate major? ____________________
2. What was your undergraduate minor? ____________________
3. Do you have a Master degree? ________ Doctorate degree? ________
4. If you have an advanced degree, what was your major(s)?

   a) ____________________________ b) ____________________________

5. How many years have you taught? ________ physics? ________
6. Do you have experience using computers (for any purpose)? ________
7. If you have experience, how long have you been using computers? ________
8. Please mark the box corresponding to your age category:

   20-29 ☐ 30-39 ☐ 40-49 ☐ 50-59 ☐ above 60 ☐

9. How many physics classes do you teach? ______
10. How many computer stations are available for your physics classes? _____
11. Do your physics classes have to share computer stations or computer time with non-physics classes? _____
12. How many of the computer stations mentioned above are available daily for physics classes? _____

USING COMPUTERS FOR PHYSICS INSTRUCTION

This part of the survey requests information about how frequently you use computer applications in your physics classes now, and what you believe the ideal frequency of using computer applications should be.

The frequency of use categories are based upon a ten month school year.
The categories are daily, monthly, weekly, 2 to 5 times during the year, only once during the year, and never.

Section 1: Computer Applications Involving Teacher Use Only

Each computer application will be defined. You will be asked to respond with your current frequency of use for that application. You will then be asked to respond with what you believe the ideal frequency of your use should be for that application.

13. Authoring programs. Computer programs which facilitate the development of computer based lessons. Super Pilot is an example of an authoring program.

A. Mark the box which best describes your current frequency of use of authoring programs for physics instruction:

CURRENT TEACHER USE	Never	Once	2 to 5	Monthly	Weekly	Daily
	☐	☐	☐	☐	☐	☐

B. Mark the box which best describes what you believe the ideal frequency of your use of authoring programs for physics instruction should be:

IDEAL TEACHER USE	Never	Once	2 to 5	Monthly	Weekly	Daily
	☐	☐	☐	☐	☐	☐

14. Demonstration programs. These programs are used in the same way as blackboards and films are used, to illustrate a concept for an entire class. Ray Tracer is a program that displays the head-to-tail addition of vectors.

A. Mark the box which best describes your current frequency of use of demonstration programs for physics instruction:

CURRENT TEACHER USE	Never	Once	2 to 5	Monthly	Weekly	Daily
	☐	☐	☐	☐	☐	☐

B. Mark the box which best describes what you believe the ideal frequency of your use of demonstration programs for physics instruction should be:

IDEAL TEACHER USE	Never	Once	2 to 5	Monthly	Weekly	Daily
	☐	☐	☐	☐	☐	☐

15. Gradebook programs. These computer programs are designed to handle information related to student grades. The user can establish a class roster, enter scores, calculate grades and statistics, and print detailed reports. Grade Master is an example of a commercially available gradebook program.

A. Mark the box which best describes your current frequency of use of gradebook programs for physics instruction:

CURRENT TEACHER USE	Never	Once	2 to 5	Monthly	Weekly	Daily
	☐	☐	☐	☐	☐	☐

B. Mark the box which best describes what you believe the ideal frequency of your use of gradebook programs for physics instruction should be:

IDEAL TEACHER USE	Never	Once	2 to 5	Monthly	Weekly	Daily
	☐	☐	☐	☐	☐	☐

16. Test generators. These programs allow the user to create tests quickly from questions previously stored on diskette. Test generators usually provide question banks on disk while also allowing users to create their own. Create-A-Test is an example of a test generator that has test banks available for physics.

A. Mark the box which best describes your current frequency of use of test generator programs for physics instruction:

CURRENT TEACHER USE	Never	Once	2 to 5	Monthly	Weekly	Daily
	☐	☐	☐	☐	☐	☐

B. Mark the box which best describes what you believe the ideal frequency of your use of test generator programs for physics instruction should be:

IDEAL TEACHER USE	Never	Once	2 to 5	Monthly	Weekly	Daily
	☐	☐	☐	☐	☐	☐

Section 2: Computer Applications Involving Student Use Only

Each computer application will be defined. You will be asked to respond with your students' current frequency of use for that application. You will then be asked to respond with what you believe the ideal frequency of your students' use should be for that application.

17. **Drill-and-practice**. The use of computer programs to memorize facts, such as formulas . Basic Electricity is a program that gives practice in applying Ohm's and Kirchoff's Laws to simple DC circuits .

A. Mark the box which best describes your students' current frequency of use of drill-and-practice programs for physics instruction:

CURRENT STUDENT USE	Never	Once	2 to 5	Monthly	Weekly	Daily
	☐	☐	☐	☐	☐	☐

B. Mark the box which best describes what you believe the ideal frequency of your students' use of drill-and-practice programs for physics instruction should be:

IDEAL STUDENT USE	Never	Once	2 to 5	Monthly	Weekly	Daily
	☐	☐	☐	☐	☐	☐

18. **Educational games**. Computer programs designed to be entertaining yet having educational value. Artillery type games may have some educational value in developing an understanding ballistics.

A. Mark the box which best describes your students' current frequency of use of educational games programs for physics instruction:

CURRENT STUDENT USE	Never	Once	2 to 5	Monthly	Weekly	Daily
	☐	☐	☐	☐	☐	☐

B. Mark the box which best describes what you believe the ideal frequency of your students' use of educational games programs for physics instruction should be:

IDEAL STUDENT USE	Never	Once	2 to 5	Monthly	Weekly	Daily
	☐	☐	☐	☐	☐	☐

19. Laboratory simulation programs. These programs simulate laboratory experiments on a computer system. These might be called "pseudo-experiments." Scatter is a simulation of the work Rutherford and present day elementary particle research.

A. Mark the box which best describes your students' current frequency of use of laboratory simulation programs for physics instruction:

	Never	Once	2 to 5	Monthly	Weekly	Daily
CURRENT STUDENT USE						

B. Mark the box which best describes what you believe the ideal frequency of your students' use of laboratory simulation programs for physics instruction should be:

	Never	Once	2 to 5	Monthly	Weekly	Daily
IDEAL STUDENT USE						

20. Programming as a learning tool. Assigning students to write a computer program to solve a scientific problem with the objective of learning the physics concepts involved thoroughly. For example, a student may be assigned to write a program that will graphically display the addition of any number of vectors.

A. Mark the box which best describes your students' current frequency of use of programming as a learning tool for physics instruction:

	Never	Once	2 to 5	Monthly	Weekly	Daily
CURRENT STUDENT USE						

B. Mark the box which best describes what you believe the ideal frequency of your students' use of programming as a learning tool for physics instruction should be:

	Never	Once	2 to 5	Monthly	Weekly	Daily
IDEAL STUDENT USE						

21. __Tutorials__. These programs provide explicit content instruction to students. __Light Waves__ is a tutorial program that provides instruction on the wave theory of light.

A. Mark the box which best describes __your students' current frequency of use__ of tutorial programs for physics instruction:

CURRENT STUDENT USE	Never	Once	2 to 5	Monthly	Weekly	Daily
	☐	☐	☐	☐	☐	☐

B. Mark the box which best describes what you believe __the ideal frequency of your students' use__ of tutorial programs for physics instruction should be:

IDEAL STUDENT USE	Never	Once	2 to 5	Monthly	Weekly	Daily
	☐	☐	☐	☐	☐	☐

__Section 3: Computer Applications Involving Either Teacher Use or Student Use__

Each computer application will be defined. You will be asked to respond with __your__ current frequency of use for that application and with what you believe the ideal frequency of __your__ use should be for that application.

You will then be asked to respond with __your students'__ current frequency of use for that application and what you believe the ideal frequency of __your students'__ use should be for that application.

22. __Communications__. Programs and equipment which allow a computer or terminal to communicate with a host computer, usually over phone lines. Physics teachers and students may use communications equipment to access __SPACE__ , an electronic bulletin board with the latest information on the Voyager and Space Shuttle programs from JPL and NASA.

A. Mark the box which best describes __your current frequency of use__ of communications programs for physics instruction:

CURRENT TEACHER USE	Never	Once	2 to 5	Monthly	Weekly	Daily
	☐	☐	☐	☐	☐	☐

B. Mark the box which best describes what you believe __the ideal frequency of your use__ of communications programs for physics instruction should be:

IDEAL TEACHER USE	Never	Once	2 to 5	Monthly	Weekly	Daily
	☐	☐	☐	☐	☐	☐

C. Mark the box which best describes your students' current frequency of use of communications programs for physics instruction:

CURRENT STUDENT USE	Never	Once	2 to 5	Monthly	Weekly	Daily
	☐	☐	☐	☐	☐	☐

D. Mark the box which best describes what you believe the ideal frequency of your students' use of communications programs for physics instruction should be:

IDEAL STUDENT USE	Never	Once	2 to 5	Monthly	Weekly	Daily
	☐	☐	☐	☐	☐	☐

23. **Data plotter programs**. These programs are used to plot and print graphs from data inputed. Graphical Analysis is a data plotter program for the Apple II computer which includes semi-log and log-log graphing capabilities.

A. Mark the box which best describes your current frequency of use of data plotter programs for physics instruction:

CURRENT TEACHER USE	Never	Once	2 to 5	Monthly	Weekly	Daily
	☐	☐	☐	☐	☐	☐

B. Mark the box which best describes what you believe the ideal frequency of your use of data plotter programs for physics instruction should be:

IDEAL TEACHER USE	Never	Once	2 to 5	Monthly	Weekly	Daily
	☐	☐	☐	☐	☐	☐

C. Mark the box which best describes your students' current frequency of use of data plotter programs for physics instruction:

CURRENT STUDENT USE	Never	Once	2 to 5	Monthly	Weekly	Daily
	☐	☐	☐	☐	☐	☐

D. Mark the box which best describes what you believe the ideal frequency of your students' use of data plotter programs for physics instruction should be:

IDEAL STUDENT USE	Never	Once	2 to 5	Monthly	Weekly	Daily
	☐	☐	☐	☐	☐	☐

24. __Electronic spreadsheet programs__. A software development tool which allows the user to develop a spreadsheet that contains both data and formulas. In the classroom spreadsheets may be used to calculate grades, analyze experimental data, or keep inventory of equipment and materials.

A. Mark the box which best describes __your current frequency of use__ of electronic spreadsheet programs for physics instruction:

CURRENT TEACHER USE	Never	Once	2 to 5	Monthly	Weekly	Daily
	☐	☐	☐	☐	☐	☐

B. Mark the box which best describes what you believe __the ideal frequency of your use__ of electronic spreadsheet programs for physics instruction should be:

IDEAL TEACHER USE	Never	Once	2 to 5	Monthly	Weekly	Daily
	☐	☐	☐	☐	☐	☐

C. Mark the box which best describes __your students' current frequency of use__ of electronic spreadsheet programs for physics instruction:

CURRENT STUDENT USE	Never	Once	2 to 5	Monthly	Weekly	Daily
	☐	☐	☐	☐	☐	☐

D. Mark the box which best describes what you believe __the ideal frequency of your students' use__ of electronic spreadsheet programs for physics instruction should be:

IDEAL STUDENT USE	Never	Once	2 to 5	Monthly	Weekly	Daily
	☐	☐	☐	☐	☐	☐

25. __Information services__. Large computer systems containing many data bases and communications services. Individuals may access an information service with a computer and have access to the largest information storehouses available. CompuServe's Consumer Information Service is one example.

A. Mark the box which best describes __your current frequency of use__ of information services for physics instruction:

CURRENT TEACHER USE	Never	Once	2 to 5	Monthly	Weekly	Daily
	☐	☐	☐	☐	☐	☐

B. Mark the box which best describes what you believe the ideal frequency of your use of information services for physics instruction should be:

IDEAL TEACHER USE	Never	Once	2 to 5	Monthly	Weekly	Daily
	☐	☐	☐	☐	☐	☐

C. Mark the box which best describes your students' current frequency of use of information services for physics instruction:

CURRENT STUDENT USE	Never	Once	2 to 5	Monthly	Weekly	Daily
	☐	☐	☐	☐	☐	☐

D. Mark the box which best describes what you believe the ideal frequency of your students' use of electronic information services for physics instruction should be:

IDEAL STUDENT USE	Never	Once	2 to 5	Monthly	Weekly	Daily
	☐	☐	☐	☐	☐	☐

26. Laboratory tool. The use of computers, along with additional interfaces, to capture, store, analyze and display experimental data. The VELA-plus is a laboratory microcomputer specifically designed to capture experimental data (CENCO).

A. Mark the box which best describes your current frequency of use of computers as a laboratory tool for physics instruction:

CURRENT TEACHER USE	Never	Once	2 to 5	Monthly	Weekly	Daily
	☐	☐	☐	☐	☐	☐

B. Mark the box which best describes what you believe the ideal frequency of your use of computers as a laboratory tool for physics instruction should be:

IDEAL TEACHER USE	Never	Once	2 to 5	Monthly	Weekly	Daily
	☐	☐	☐	☐	☐	☐

C. Mark the box which best describes your students' current frequency of use of computers as a laboratory tool for physics instruction:

	Never	Once	2 to 5	Monthly	Weekly	Daily
CURRENT STUDENT USE	☐	☐	☐	☐	☐	☐

D. Mark the box which best describes what you believe the ideal frequency of your students' use of computers as a laboratory tool for physics instruction should be:

	Never	Once	2 to 5	Monthly	Weekly	Daily
IDEAL STUDENT USE	☐	☐	☐	☐	☐	☐

27. **Word processing programs**. These programs facilitate the rapid production of typed documents. Some also allow graphics to be included within the text. In the classroom they may be used to produce lab reports, term papers, handouts, memos, letters and overlays.

A. Mark the box which best describes your current frequency of use of word processing programs for physics instruction:

	Never	Once	2 to 5	Monthly	Weekly	Daily
CURRENT TEACHER USE	☐	☐	☐	☐	☐	☐

B. Mark the box which best describes what you believe the ideal frequency of your use of word processing programs for physics instruction should be:

	Never	Once	2 to 5	Monthly	Weekly	Daily
IDEAL TEACHER USE	☐	☐	☐	☐	☐	☐

C. Mark the box which best describes your students' current frequency of use of word processing programs for physics instruction:

	Never	Once	2 to 5	Monthly	Weekly	Daily
CURRENT STUDENT USE	☐	☐	☐	☐	☐	☐

D. Mark the box which best describes what you believe the ideal frequency of your students' use of word processing programs for physics instruction should be:

	Never	Once	2 to 5	Monthly	Weekly	Daily
IDEAL STUDENT USE	☐	☐	☐	☐	☐	☐

YOUR CONCERNS
REGARDING THE USE OF COMPUTERS FOR PHYSICS INSTRUCTION

The purpose of this part of the questionnaire* is to determine what teachers who are using or thinking about using computers for physics instruction are concerned about at various times during the adoption process. The items were developed from typical responses of school and college teachers who ranged from no knowledge at all about various programs to many years experience in using them. Therefore, A GOOD PART OF THE ITEMS IN THIS SECTION MAY APPEAR TO BE OF LITTLE RELEVANCE OR IRRELEVANT TO YOU AT THIS TIME. For the completely irrelevant items, please circle "0" on the scale. Other items will represent those concerns you DO have, in varying degrees of intensity, and should be marked higher on the scale.

For example:

This statement is very true of me at this time.	0 1 2 3 4 5 6 (7)
This statement is somewhat true of me now.	0 1 2 3 (4) 5 6 7
This statement is not at all true of me at this time.	0 (1) 2 3 4 5 6 7
This statement seems irrelevant to me now.	(0) 1 2 3 4 5 6 7

Please respond to the items in terms of your present concerns, or how you feel about your involvement or potential involvement with the use of computers for physics instruction. We do not hold to any definition of this innovation, so please think of it in terms of YOUR OWN PERCEPTION of what it involves. Remember to respond to each item in terms of YOUR PRESENT CONCERNS about your involvement or potential involvement with computers for physics instruction.

0	1	2	3	4	5	6	7
Irrelevant	Not true of me now		Somewhat true of me now			Very true of me now	

28. I am concerned about students' attitudes toward using computers for physics instruction. 0 1 2 3 4 5 6 7

29. I now know some other approaches that might work better. 0 1 2 3 4 5 6 7

30. I don't even know what using computers for physics instruction means. 0 1 2 3 4 5 6 7

31. I am concerned about not having enough time to organize myself each day. 0 1 2 3 4 5 6 7

32. I would like to help other faculty in their using of computers for physics instruction. 0 1 2 3 4 5 6 7

33. I have very limited knowledge about using computers for for physics instruction. 0 1 2 3 4 5 6 7

34. I would like to know what effect using computers for physics instruction will have on my professional status. 0 1 2 3 4 5 6 7

35. I am concerned about conflict between my interests and my responsibilities. 0 1 2 3 4 5 6 7

36. I am concerned about revising my use of computers for physics instruction. 0 1 2 3 4 5 6 7

37. I would like to develop working relationships with both our faculty and outside faculty regarding the use of computers for physics instruction. 0 1 2 3 4 5 6 7

38. I am concerned about how using computers for physics instruction affects students. 0 1 2 3 4 5 6 7

3[illegible]. I am not concerned about using computers for physics instruction. 0 1 2 3 4 5 6 7

0	1	2	3	4	5	6	7
Irrelevant	Not true of me now		Somewhat true of me now			Very true of me now	

40. I would like to know who will make the decisions regarding using computers for physics instruction. 0 1 2 3 4 5 6 7

41. I would like to discuss the possibility of using computers for physics instuction. 0 1 2 3 4 5 6 7

42. I would like to know what resources are available if we decide to adopt the use of computers for physics instruction. 0 1 2 3 4 5 6 7

43. I am concerned about my inability to manage all that using computers for physics instruction requires. 0 1 2 3 4 5 6 7

44. I would like to know how my teaching or administration is supposed to change. 0 1 2 3 4 5 6 7

45. I would like to familiarize other departments or persons with the progress of using computers for physics instruction. 0 1 2 3 4 5 6 7

46. I am concerned about evaluating my impact on students. 0 1 2 3 4 5 6 7

47. I would like to revise the instructional approach of using computers for physics instruction 0 1 2 3 4 5 6 7

48. I am completely occupied with other things. 0 1 2 3 4 5 6 7

49. I would like to modify our use of computers for instruction based on the experiences of our students. 0 1 2 3 4 5 6 7

50. Although I don't know about using computers for physics instruction, I am concerned about things in the area. 0 1 2 3 4 5 6 7

0	1	2	3	4	5	6	7
Irrelevant	Not true of me now		Somewhat true of me now			Very true of me now	

51. I would like to excite my students about their part in using computers for physics instruction.	0 1 2 3 4 5 6 7
52. I am concerned about time spent working with nonacademic problems related to using computers for physics instruction.	0 1 2 3 4 5 6 7
53. I would like to know what the use of computers for physics instruction will require in the immediate future.	0 1 2 3 4 5 6 7
54. I would like to coordinate my effort with others to maximize the use of computers for physics instruction.	0 1 2 3 4 5 6 7
55. I would like to have more information on time and energy commitments required to use computers for physics instruction.	0 1 2 3 4 5 6 7
56. I would like to know what other faculty are doing regarding the use of computers for physics instruction.	0 1 2 3 4 5 6 7
57. At this time, I am not interested in learning about using computers for physics instruction.	0 1 2 3 4 5 6 7
58. I would like to determine how to supplement, enhance, or replace the use of computers for physics instruction.	0 1 2 3 4 5 6 7
59. I would like to use feedback from students to change the program.	0 1 2 3 4 5 6 7
60. I would like to know how my role will change when I am using computers for physics instruction.	0 1 2 3 4 5 6 7
61. Coordination of tasks and people is taking too much of my time.	0 1 2 3 4 5 6 7
62. I would like to know how using computers for physics instruction is better than what we have now.	0 1 2 3 4 5 6 7

ENABLING AND CONSTRAINING FACTORS

This part of the survey requests information about factors which either help or hinder your use of computers for instruction in your physics classes.

63. In the spaces provided list three things that could assist your efforts to use computers in your physics classes:

A. ______________________________

____

____

B. ______________________________

____

____

C. ______________________________

____

____

64. In the spaces provided list three things that could thwart your efforts to use computers in your physics classes:

A. ______________________________

____

____

B. ______________________________

____

____

C. ______________________________

____

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