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Introduction

Many high schools have access to computer terminals. Such terminals are of limited value if the computer library is not stocked with programs that are integrated into the educational program of the school. There is a need for the evaluation of computer programs with respect to their applicability to various levels of instruction.

In this paper, a method of evaluating computer programs for high school physics is outlined. The computer programs involved were evaluated as to their appropriateness for use in a high school physics course that uses the text, *Physics Fundamentals and Frontiers* (19). The study was limited to programs that use an interactive computer with hard copy output. The study was also limited to those programs available on the campus of the University of Northern Iowa at the time of the study. Sources of programs are included at the end of the article.

Procedures

1. Programs were identified by code in BASIC computer language and were used to retrieve programs in taped storage systems such as the Hewlett-Packard 2000 System. Table 1 indicates the programs evaluated.

2. Programs were evaluated as to type, using the following classification:
   a. Remedial programs (R) are programs designed to provide background knowledge or skills which students would be expected to master before taking high school physics.
   b. Core programs (C) are programs which present the basic content of high school physics.
   c. Supplementary programs (S) are programs which present content areas not normally covered in basic physics courses.
3. Programs were evaluated as to instructional modes by using the following definitions of computer-assisted instruction as outlined by the Iowa Department of Public Instruction (18):
   a. Tutorial (T): The tutorial mode is programmed instruction of text materials. The student interacts directly with the computer as the computer presents information and asks questions in a programmed format.
   b. Problem Solving (PS): In this mode, the student uses the computer to assist in problem solving, particularly problems that

involve mathematical manipulation of data. In some cases, students will use prewritten programs while in other cases, it is appropriate for students to write their own programs.

c. Simulation (SI): In this mode, the computer simulates real situations and students learn principles and concepts through interaction with computer simulations.

Table 1

Computer Programs

Code	Topic	Source
MKS1	*Weight, mass and velocity conversions*	(16)
MKS2	*Weight, mass and velocity conversions*	(16)
METRIC	*General conversions*	(?)
BOUNCE	*Elasticity of matter*	(17)
PRJTL	*Projectile motion*	(6)
PRJTLQ	*Projectile motion*	(6)
KINERV	*Kinematics*	(10)
SPACE	*Orbital motion*	(20)
CALORI	*Calorimetry*	(2)
CONVRT	*Temperature conversions*	(?)
EFIELD	*Electric fields*	(7)
BFIELD	*Magnetic fields*	(1)
SLITS	*Wave diffraction*	(4)
WAVES	*Wave interaction*	(8)
PHOTEL	*Photoelectric effect*	(3)
CHARG	*Electron charge*	(5)

4. Programs were evaluated for running time and assigned to one of the following three categories:
   a. Short programs (SP) have a running time of less than 10 minutes.
   b. Medium programs (MP) have a running time of 10 to 30 minutes.
   c. Long programs (LP) run over 30 minutes.
5. Programs were evaluated for the level of mathematical understanding required to understand the program as follows:
   a. Arithmetic (AR) involve mathematical concepts using only positive real numbers.
   b. Algebra (AL) involve only algebraic calculations.
   c. Geometry (G) involve geometric concepts.
   d. Trigonometry (T) involve trigonometric concepts.
   e. Calculus (C) involve concepts covered in advanced mathematics.

6. Subjective evaluations were made on seven basic criteria as follows:
   a. Is the content adequate and clearly presented?
   b. Does the program accommodate poor or incomplete student input by providing adequate prompts?
   c. Could a student run the program with a minimum of supervision?
   d. Is the program flexible enough to allow changes in input, especially in simulation programs?
   e. Is the program interactive?
   f. Does the program provide easily interpreted graphic output?
   g. Does the program utilize computer time efficiently?

Evaluation Results

Table 2 summarizes the evaluations of the previously mentioned programs with respect to Program Type (PT), Program Mode (PM), Run Time (RT) and Mathematics Level (ML). Table 3 summarizes the subjective evaluation of seven basic criteria.

Table 2

Program Evaluation

Program Code	PT	PM	RT	ML
MKS1	*R*	–	*MP*	*Al*
MKS2	*R*	–	*MP*	*Al*
METRIC	*R*	–	*SP*	*Ar*
BOUNCE	*S*	*SI*	*MP*	*Ar*
PRJTL	*C*	*SI*	*SP*	*Al*
PRJTLQ	*C*	–	*SP*	*G&T*
KINERV	*C*	–	*MP*	*Al*
SPACE	*S*	*SI*	*MP*	*G*
CALORI	*C*	–	*SP*	*Al*
CONVRT	*R*	–	*SP*	*Ar*
EFIELD	*S*	*SI*	*MP*	*Al*
BFIELD	*S*	*SI*	*MP*	*Al*
SLITS	*S*	*SI*	*MP*	*T*
WAVES	*C*	*SI*	*MP*	*Al*
PHOTEL	*C*	*SI*	*MP*	*Al*
CHARG	*S*	*SI*	*MP*	*Al*

Summary

The computer program evaluation method outlined can facilitate the integration of computer instruction into a physics curriculum. In addition to the data published, notes were recorded concerning pre-run

instructions which would provide information concerning the background and equipment necessary for optimal instructional efficiency. Post-run notes were also recorded which summarized the skills and concepts gained from the programs and outlined suggestions for appropriate follow-up activities.

Table 3

Program Evaluation of Basic Criteria*

	a	b	c	d	e	f	g
MKS1	*S*	*S*	*S*	*S*	*S*	*A*	*S*
MKS2	*S*	*S*	*S*	*S*	*S*	*A*	*S*
METRIC	*S*	*S*	*S*	*S*	*S*	*A*	*U*
BOUNCE	*S*	*U*	*S*	*S*	*S*	*S*	*U*
PRJTL	*S*	*S*	*S*	*S*	*S*	*A*	*S*
PRJTLQ	*S*	*S*	*S*	*A*	*U*	*A*	*S*
KINERV	*S*	*S*	*S*	*A*	*S*	*A*	*S*
SPACE	*S*	*S*	*S*	*S*	*S*	*A*	*S*
CALORI	*S*	*S*	*S*	*S*	*S*	*A*	*S*
CONVRT	*S*	*S*	*S*	*S*	*S*	*A*	*S*
EFIELD	*S*	*S*	*S*	*S*	*S*	*S*	*U*
BFIELD	*S*	*S*	*S*	*S*	*S*	*S*	*U*
SLITS	*S*	*S*	*S*	*S*	*S*	*S*	*S*
WAVES	*S*	*S*	*S*	*S*	*S*	*S*	*S*
PHOTEL	*S*	*S*	*S*	*S*	*S*	*A*	*S*
CHARG	*S*	*S*	*S*	*S*	*U*	*A*	*S*

**S=satisfactory, U=unsatisfactory; A=absent*

Sixteen programs were evaluated with respect to their suitability for high school physics. Many more programs are available for evaluation. Some programs are integrated as sets of progressive materials that would require more extensive hardware than is available in most high schools. A multitude of program sets are available in the *Hewlett-Packard Computer Curriculum Series* (11) (12) (13) (14). Such programs would function well in programmed learning situations if enough terminal facilities were accessible. Other programs of the drill and practice mode, such as those of PHYSCHEM (15), are more easily integrated into the school curriculum. These programs are relatively inexpensive.

Computer texts designed to augment undergraduate physics courses are a source of additional programs. *Using Computers in Physics* (9) has a number of programs designed for a non-calculus approach suitable for high school physics. Students should be encouraged to develop programs of their own which can be used by others. By evaluating, purchasing and producing a few programs each year, a school can eventually compile a computer library that will add a new dimension to physics instruction.

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Thomas Edison

Thomas Edison was taken out of school because it was thought that he couldn't learn at all. His spelling and grammar were very poor.

Purpose in Nature

"God does not throw dice."
Albert Einstein

"It is not our business to prescribe to God how He should run the world."
Nils Bohr