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ABSTRACT

This study was undertaken to examine the status of computer-based instruction in Vancouver secondary schools which is categorized as computer-science courses or traditional courses which use the computer merely as a problem-solving and learning aid. Then schools participated in an examination of the computer-science courses. This aspect of the study consisted of five parts: a questionnaire to teachers, a questionnaire to students, a set of problems for students to measure their problem-solving ability, observation of three computer science classes in progress, and administration of the Computer Programmer Aptitude Battery to one computer class. This study summarized the findings of the teacher and student questionnaires regarding computer based instruction. Observation of three computer science classes generally supported the results of these questionnaires. The performance of the students on the programming problems indicated that they were capable of at least fundamental programming. Examination of one class' performance on the Computer Programmer Aptitude Battery illustrated that the computer science course had helped to improve the students' reasoning ability. Included in the appendices are the student and teacher questionnaires, problem sets, computer games and examples of computer programs written by students. For related documents, see TM003469 and 003476. (Author/RC)

RESEARCH REPORT

The Evaluation of Computer-Based Instruction in Vancouver Secondary Schools

July, 1973

M. Lynne Durward

Research Report 73-12

DEPARTMENT OF PLANNING AND EVALUATION
Board of School Trustees
1595 West 10th Avenue
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THE EVALUATION OF COMPUTER-BASED INSTRUCTION IN VANCOUVER SECONDARY SCHOOLS

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Abstract

This study was undertaken at the request of the Vancouver School Board's Education Department to examine the status of computer-based instruction in Vancouver secondary schools.

Computer-based instruction in Vancouver schools falls into two categories: computer-science courses and those traditional courses (Math, Commerce, Science, and Social Studies) which use the computer merely as a problem-solving and learning aid (as a calculator, simulator, graph plotter, etc.)

Ten schools participated in an examination of the computer-science courses. This aspect of the study consisted of five parts:

1) a questionnaire to teachers,
2) a questionnaire to students,
3) a set of problems for students to measure their problem-solving ability,
4) observation of three computer science classes in progress, and
5) administration of the Computer Programmer Aptitude Battery to one computer class.

In the questionnaire, teachers were asked to describe the objectives of their course, the use by their students of the various computer facilities, reference materials used, teaching qualifications, background experience, computer experience of their students, characteristics of their students, breakdown of teaching time, evaluation procedures, areas of application of the computer, class activities, strengths and weaknesses of the program, and suggestions for its improvement.

The responses of the teachers varied considerably among schools. Noteworthy among the findings were that:

1) students who enrolled in computer science courses were generally self-motivated and had above-average scholastic aptitude,
2) teachers of computer courses spent the largest part of their class time working with individual students rather than with groups of students,
3) in regard to the type of computer problems that students were given, the emphasis was upon mathematical, scientific and commercial applications, in that order.
4) the teachers felt that the course developed responsible and independent students who worked at their own rate,
5) the mixture of students from different grade levels and with different amounts of experience with computers was cited as a weakness of the program, and

6) the teachers felt that the program could be improved if more hands-on computer time were provided for the students.

The questionnaire distributed to students was aimed at determining their attitude toward the computer course. Again, reactions varied considerably amongst computer courses. Significant findings were:

1) teachers were rated as the most important source of help in the course; however, as the students became more adept at programming, the teacher rated behind "other students" and "reference material";
2) programming knowledge was willingly applied in their other subjects (Math, Science, etc.): half of the students wrote programs for other courses on their own initiative;
3) students wanted more hands-on time--the proposed ideal was that each school would have its own computer;
4) a third of the students were concerned that the increasing use of computers would lead to further unemployment; and
5) the academic standing of the students in their computer course was "B".

Observation of three computer science classes generally supported the findings of the questionnaires.

The performance of the students on the programming problems indicated that they were capable of at least fundamental programming. The success of the students was in line with their reported letter grades. Invalidity of the logic in their programming statements was the students' most frequent source of error in their attempts to create a computer program which would work.

Examination of one class' performance on the Computer Programmer Aptitude Battery indicated that the computer science course had helped to improve the students' reasoning ability.

Statistics from the computer consultant's annual survey of teachers revealed that student usage of computer facilities had increased substantially in the last few years and would continue to do so.

THE EVALUATION OF COMPUTER-BASED INSTRUCTION IN VANCOUVER SECONDARY SCHOOLS

I. INTRODUCTION

Few Canadians are aware of the pervasive influence of computers. Computers are used to control the timing of traffic lights in Toronto, to dispatch taxicabs to riders in Montreal, to check income tax returns in Ottawa and to confirm airplane reservations across Canada.

The influence of the computer is not restricted to the adult population. In Vancouver, for instance, secondary school students are now receiving computer-produced individualized timetables and report cards, and selected elementary school children are receiving computer-assisted instruction.

With the use of computers becoming so widespread, educators throughout the world have become aware of the need for computer-based instruction. In the United States, the Conference Board of Mathematical Science's Committee on Computer Education concluded:

> It is therefore essential that our educational system be modified in such a way that every student (i.e., every prospective citizen) become acquainted with the nature of computers and the current and potential roles which they play in our society. It is probably too late to do much about adults, but it would be disastrous to neglect the next generation. [1]

The next generation is not being neglected in Vancouver schools. Eleven secondary schools are currently offering computer science courses which acquaint students with the nature of computers, teach them elementary programming, and examine the social implications of the machines. A total of 5100 Vancouver students used the computer during 1972-73, either in the special computer courses, in their regular subject areas, or in extracurricular computer clubs. (This represented more than a 600% increase from the number of students who used the computer during the 1970-71 school year). In addition, 220 students from eight elementary schools used the computer facilities this past year.

The present study, requested by the Vancouver School Board Education Department, examines computer-based instruction in Vancouver secondary schools, with particular emphasis on the computer science courses currently being offered.

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[1] Committee on Computer Education, Conference Board of the Mathematical Sciences, "Recommendations Regarding Computers in High School Education", p. 3.

II. RESEARCH ON COMPUTER-BASED INSTRUCTION

A. Survey of the Literature

Among the recommendations emerging from the recent World Conference on Computers in Education was that an introduction to computers be part of a general education for all students. The literature points to the need for such courses: Wolfe (17) reported on the fallacious computer concepts possessed by seventh grade children, and Charp, (3) in a study on computer programming courses in secondary schools, observed that an unwarranted fear of computers resulted from such misconceptions. Tillet noted the importance of including a consideration of the social implications of computers in computer courses:

> ...if the content of typical courses is examined, a consideration of the social implications of computers is conspicuous by its absence, even for courses which are devoted to computer science, as distinct from mathematics courses with a computer orientation. The emergence of data banks, the invasion of the privacy of the individual, and the development of artificial intelligence, which are some of the real points at issue, are a far cry from the binary number system, which is much more frequently treated in these courses. Indeed, we will be doing our students a disservice if we embroil them in the intricacies of programming to the extent that broader issues are obscured or if we give them a one-sided impression of the computer as a 'number-cruncher' without any awareness of its ability to process information of the most general kind. [2]

At the secondary school level, computers have been most widely used in the area of mathematics. According to Tillet, the greatest value of the computer orientation of instruction in mathematics is its "potential for giving life and meaning to the formal abstractions of a subject which many students find dull and vague." [3] An increase in motivation on the part of students involved in computer-oriented mathematics has been noted by several researchers. Lerner (9) attributes the increase to the novelty value of computers and the building up of students' self-esteem through a sense of mastery over a complex machine, Johnson and Rising (8) to the elimination of drudgery of computation, and Post (13) to the rapid feedback and reinforcement possible with certain equipment configurations and the privacy of communication and impersonality of the machine.

However, researchers noted occasional cases of student frustration and lack of interest in computer-oriented mathematics courses, especially among less able students and in schools where frequent equipment malfunctions, long delays in turn-around and inadequate preparation of teachers were a problem.

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[2] Tillet, Peter, "Computer Orientation in Secondary School Mathematics", The Journal for the Association for Educational Data Systems (AEDS Journal), Spring, 1973, pp. 80-81.

[3] Ibid., p. 81.

Darby et al (in 16, p. 82) warned that, once the novelty effect of the computer had worn off, even a negative response to exposure to computers may occur. On the other hand, it was noted that some highly enthusiastic students become so obsessed with the computer, that a disproportionate amount of their out-of-school time is spent on computer assignments, and their other studies suffer as a result.

The teacher's role may change dramatically in a computer-oriented teaching situation. Students can progress quite adequately in such courses with little teacher assistance--the computer output provides the feedback they need. Thus, the students may advance at their own rates (given that the instructional situation allows them to undertake assignments of their own choosing) and may actually surpass their teachers in programming knowledge. Some teachers, according to Post (13), find this situation threatening. Nevertheless, the possibility of individual rates of progression is a definite advantage of computer-based instruction.

Many researchers claim that computer courses improve students' ability to "think logically". Students must, as Tillet (in 16, p.83) points out, be able to develop a precise and logically exact approach to the solution of problems to be able to write computer programs. According to Bates (in 16, p. 83) students encountered most of their difficulties while trying to conceive algorithms (i. e., develop a logical approach) when writing computer programs; the problems encountered with the computer language itself were minimal in comparison.

B. A Previous Study of Computer-Based Instruction in Vancouver Secondary Schools

In 1970, "An Evaluation of Student Experience with Computers in the Instructional Program of Two Secondary Schools of Vancouver, 1969-70" (11) was carried out. In that study, the recommendations of the teachers for expanding and improving the computer program were that:

1) computer courses be offered for credit on an elective basis to students in Grades 9 - 12,
2) Grade 8 students be introduced to computer programming in their regular school subjects,
3) terminals be installed in schools which do not have a computer,
4) batch-processing of computer programs be accelerated,
5) student aides be paid for delivering programs for computer processing,
6) afternoon and evening sessions be expanded for teachers and students who want to use the computer,
7) in-service meetings on computer programming be instituted for teachers,
8) a teacher-expert be appointed to coordinate computer instruction in Vancouver schools,
9) all future computer equipment purchased or leased be able to accept the BASIC language, and
10) long-range policy be formulated in regard to the organization of administrative and educational computer facilities.

As of June, 1973, recommendations (1) and (2) had been implemented in five Vancouver schools. Although no permanent terminals have been installed (item 3, above), a portable terminal is being used by schools on a rotational basis. High speed batch-processing computer facilities (items 4, 5 above) now provide twice daily return of programs, and two drivers have been hired to provide a pickup and delivery service. Afternoon and evening sessions (item 6, above) have been expanded to be available to all secondary schools, in-service training for teachers (item 7, above) has been instituted, and Mr. Wayne Dodds has been appointed (item 8, above) as Computer Consultant for the Vancouver School Board. Recommendations (9, and (10) have also been put into effect.

III. OUTLINE OF THE STUDY

1. A questionnaire was sent to teachers of computer science courses in ten secondary schools (see Appendix A). Among the items of information sought by the questionnaire were teacher background and experience, student computer experience, course content, method of instruction, use of computer facilities, use of reference material, enrichment activities, and teacher evaluation of the program. Section IV presents the results of the teacher questionnaire.

2. The attitudes of students enrolled in computer science classes towards the courses were examined by means of a questionnaire (see Appendix B). The students were encouraged to state what they saw as the strengths and/or weaknesses of the program and to offer suggestions for its improvement. The results of the student questionnaire are presented in Section V.

3. Students were asked to complete a computer-programming problem (chosen from two problem sets--see Appendices C and D), and to keep a record of the errors made and the number of runs required to complete the assignment correctly. Section VI presents a summary of the results.

4. An independent observer was asked to visit a few of the computer science classes to observe the interaction among the students and between the students and the teacher, take note of the activities of the students, and interview a few students to verify and extend the impressions obtained from the analysis of responses to the student questionnaire (see section VII).

5. The Computer Programmer Aptitude Battery[4] was administered to a computer science class of fifteen students as a pre-test at the beginning of the course and as a post-test at its completion. The performance of the students on the Battery is summarized in section VIII.

6. The results of the annual survey of student usage of the Hewlett-Packard Computers, conducted by Mr. Wayne Dodds, are presented in section IX.

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[4]The Computer Programmer Aptitude Battery. Developed by Jean Maier Palormo, Science Research Associates, Inc.

IV. SUMMARY OF RESPONSES TO A QUESTIONNAIRE FOR TEACHERS ABOUT COMPUTER-BASED INSTRUCTION

Teachers of computer science courses in eleven schools were asked to complete one questionnaire (see Appendix A) for each course taught. Returns were received from ten teachers who taught a total of 15 computer science courses. This represented an 83.3% return.

The responses to each item of the questionnaire will be dealt with in turn.

1. The ultimate goal of the course

In general, the ultimate goal of the computer course, according to teachers, was to provide students with a general knowledge of computers and to introduce elementary programming techniques. One teacher emphasized the business applications of computers (her course was originally intended for both academic and non-academic students); other teachers, whose students had more than one year of computer experience, included in their course goals the students' learning of high level languages such as FORTRAN.

2. The topics covered and the specific objectives of each one

The topics covered varied slightly among schools. One commercial-oriented class concentrated on computer hardware, flowcharting and programming, but did not cover the social implications of the computer; another stressed BASIC, FORTRAN and more sophisticated programming techniques. In general, however, teachers cited four main topic areas:

Topics	Objectives
a) Introduction to computers	- to teach students what a computer is, how it works and what its applications are
b) Flowcharting and problem solving techniques	- to show students how to use flowcharts to analyze and solve problems
c) Programming in BASIC language	- to teach students how to use BASIC language to solve problems by computer
d) Social implications of computers	- to show how some areas of society may benefit or suffer from the use of the computer.

3. Use of computer facilities

The Vancouver School Board owns two Hewlett-Packard digital computers which are used by students in computer science courses. The main input device to each computer is a mark sense card reader. Students write their programs in BASIC language on "mark sense" cards and submit their programs for "batch" processing. (A "batch" of computer programs refers to two or more students' programs being combined into one deck of cards and run through the computer consecutively by the computer operator). A pick-up/delivery service is provided to transmit the batches of programs from surrounding schools to the schools which house the computer facilities, (John Oliver Secondary and Point Grey Secondary). The results from the programs ("output") are printed by a high speed line printer and are returned to students in time for their next classroom session in that subject (usually returned by next day or same day).

A summary is presented in Table I of the number of students in computer science courses that use the pick-up/delivery service for "batch mode" BASIC and the frequency of use.

TABLE I: SUMMARY OF UTILIZATION OF THE PICK-UP/DELIVERY SERVICE FOR BATCH MODE BASIC

Course*	1	2	3	4	5a	5b	5c	6	7	8a	8b	9a	9b	9c	10	Total
No. of students in the course	26	35	16	6	69	20	6	15	N	17	9	12	12	9	34	286
No. of students who use the facility	26	35	16	6	69	20	6	15	N	17	9	12	12	9	25	277 (96.9%)
Frequency of use	D	D	D	D	D	D	D	D	N	F	F	D	D	D	D	

Legend: D - daily
F - five out of seven days
N - not included in this summary--the students do not need to use the pick-up/delivery service since the computer is in their school.

*For the purposes of this study, each teacher was assigned a number. Where a teacher taught more than one computer course, the courses were distinguished by letters (e.g. 5a, 5b, and 5c were three computer courses taught by the same teacher).

Almost all (96.9%) of the students used the pick-up/delivery service, and most of these use it on a daily basis. (Teacher number 7 does not need to use the pick-up/delivery service, since his school houses one of the computers.)

The disadvantage of using the pick-up/delivery service for batch mode BASIC is that students have to wait a day to get their programs back and correct errors. Thus, if a student has five errors in his program, it may take him a week before he has discovered and made all the corrections. By using "hands-on batch mode" BASIC in the evenings, students can overcome this problem. Evening time has been reserved on the two Hewlett-Packard computers so that students may come to the installations, submit their programs directly to the computer and receive their output almost instantaneously. Programs are usually submitted on optic mark sense cards (pencil marks are read by the computer's card reader) but occasionally are submitted on punched paper tape (which is read by a high-speed photo-electric paper tape reader).

The output from the computer is printed on a sheet of paper, or, in special circumstances, punched on paper tape.

Table II presents a summary of the use of the hands-on batch mode BASIC in evenings.

TABLE II: SUMMARY OF UTILIZATION OF HANDS-ON BATCH MODE BASIC IN EVENINGS

Course	1	2	3	4	5a	5b	5c	6	7	8a	8b	9a	9b	9c	10	Total
No. of students in course	26	35	16	6	69	20	6	15	30	17	9	12	12	9	34	316
No. using mark sense cards	26	35	10	6	69	20	6	2	30	-	-	5	5	2	35	251 (79.4%)
Frequency of use (no. of times per term)	1	20	20	10	5	20	20	20	D	-	-	20	20	20	20	
No. using paper tape	-	35	-	-	-	-	6	1	5	-	-	-	-	-	5	52 (16.5%)
Frequency of use (no. of times per term)	-	20	-	-	-	-	P	20	5	-	-	-	-	-	20	

Legend: D - daily
P - only for important, original programs

Approximately 80% of the students used the hands-on batch mode with mark sense cards; only 16.5% used paper tape programs.

Students may communicate directly with the computer via a portable terminal (manufactured by the Texas Instrument Company) which is used by the schools on a rotating basis. The advantage to this "hands-on interactive coding" is that a student can correct his errors while his program is in the memory of the computer. No cards or paper tapes are necessary--programs are typed in on the terminal keyboard. Six of the ten schools used the terminal; frequency of use varied among the schools from once per term to once every two weeks (see Table III).

Table IV summarizes the utilization of the portable terminal with demonstration and other centrally supplied BASIC programs. These supplied programs enable students to try to outwit the computer in a number of educational or motivational games. Two such games, the "Tic Tac Toe Game" and the "Lunar Module Game" are shown in Appendices E and F.

TABLE III: SUMMARY OF UTILIZATION OF HANDS-ON INTERACTIVE CODING OF BASIC VIA PORTABLE TERMINAL

Course	1	2	3	4	5a	5b	5c	6	7	8a	8b	9a	9b	9c	10	Total Group
No. of Students	26	35	16	6	69	20	6	15	*	17	9	12	12	9	34	286
No. using hands-on interactive coding	26	35	-	6	-	20	6	-	-	-	-	12	8	2	10	125 (43.7%)
Frequency of use (no. of times per term)	10	5	-	5	-	1	2	-	-	-	-	1	1	5	5	

TABLE IV: SUMMARY OF UTILIZATION OF DEMONSTRATION AND OTHER SUPPLIED BASIC PROGRAMS VIA PORTABLE TERMINAL

Course	1	2	3	4	5a	5b	5c	6	7	8a	8b	9a	9b	9c	10	Total Group
No. of Students	26	35	16	6	69	20	6	15	*	17	9	12	12	9	34	286
No. of students using programs	26	-	-	6	69	20	6	12	-	17	9	12	8	2	3	190 (66.4%)
Frequency of use (no. of times/term)	10	-	-	5	2	1	2	3	-	7	7	1	1	5	5	

*Not included in the summaries of portable-terminal usage; students have direct access daily to the computer which is located in their school.

Once again, there was considerable variation among schools. The frequency of use of the terminal for the supplied BASIC programs ranged from once per term to ten times per term. Approximately 66% of the students enrolled in computer courses used the programs.

Some of the more advanced students had been using facilities outside of these already mentioned to program in FORTRAN or WATFIV (a newer version of FORTRAN). Forty-four students in four schools used the University of British Columbia computer facilities on the average of once a week. Most of these students used mark sense cards to enter their programs. A few key-punched their programs and two used a terminal to gain access to the computer. One student used a terminal at Simon Fraser University Computing Centre twice a month; six used the facilities at Vancouver City College.

Six students programmed in APL (A Programming Language) for a period of six weeks. The portable terminal they used was connected (via telephone lines) to the computing facilities at Simon Fraser University.

4. Reference Materials Used by Students

Teachers were requested to list the reference materials (catalogue items, books and other materials) used by their students and to indicate their frequency of use.

The "catalogue items" consisted of reference sheets on various aspects of the BASIC language and general use of the computer, and assorted teacher aids (e.g., coding sheets, lists of movies on data processing, etc.) They were supplied by Mr. Dodds and available through Point Grey and John Oliver Computing Centres. The original list of catalogue items was compiled with the aid of computer science teachers. Of the 29 catalogue items available, (see Appendix G) 18 of them were used by students at some time. Those used most frequently were:

Catalogue Item	No. of Students (N = 316)	Frequency
"Error Codes... Educational BASIC	301	Most periods
"A Guide to Hewlett-Packard Educational BASIC"	110	Several times
"How to Use Alpha Data"	95	As required
"Disk Files for Educational BASIC"	85	Occasionally

Teachers cited a total of sixteen books that were used by their students for reference. Those used most frequently were:

Title	Author
Problem Solving with the Computer	E. R. Sage
A Pocket Guide to Hewlett-Packard Computers	Hewlett-Packard Company
Tecnica Series	Tecnica Education Corp.
CAMP (Computer Assisted Mathematics Program) Series	Hatfield & Johnson
BASIC Programming	Kemeny & Kurtz

Among the other materials that teachers specified as being used by students were CARDIAC (Cardboard Illustrative Aid to Computation--a small do-it-yourself cardboard computer), worksheets prepared by the teachers, and the teachers' own outlines and notes.

5. Reference Materials Used by Teachers

The catalogue items used for reference most frequently by teachers are listed below:

Catalogue Item	No. of Teachers (N = 10)
"A Guide to HP Educational BASIC"	8
"Error Codes... Educational BASIC"	7
"How to Use Alpha Data"	7
"Disk Files for Educational BASIC"	7
"Computer Applications"	6

The frequency of use varied considerably among the teachers.

Teachers listed twenty books they used for personal reference. One teacher noted that it was "impossible to list" the numerous books that she consulted. Those most frequently cited were:

Title	Author	No. of Teachers (N = 10)
Problem Solving with the Computer	E. R. Sage	6
CAMP Series	Hatfield & Johnson	6
A Pocket Guide to HP Computers	Hewlett-Packard Co.	5
Tecnica Series	Tecnica Education Corp.	5

The frequency of use of books also varied considerably among the teachers.

Teachers' notes, CARDIAC, films, and UBC WATFIV manuals were among the "other materials" listed as sources of reference.

6. Percent of Teacher Time Spent Instructing Computer Courses

The percent of teaching time (with respect to all regular courses as well as computer courses) spent instructing computer courses ranged from 14% to 50%; the average percent of time spent was 23.3%.

7. Qualifications of Teachers of Computer Courses

(a) Teaching certificates and degrees held:

A summary of the teaching certificates and the degrees held by the instructors is presented in Table V. Four of the ten teachers held Professional Basic (P. B.) certificates, two held Professional Advanced (P. A.) certificates, and four held Professional Advanced-Masters certificates. (P. B. certificate requires five years of professional and academic studies, P. A. certificate requires 6 years, and P. A. -Masters certificate requires a Masters Degree.) All of the teachers held Bachelor degrees; four held Masters degrees as well.

(b) Computer Science Courses taken:

A summary of the number of computer science courses taken by the teachers is presented in Table VI. The average number of courses taken was 2.7.

(c) Background Experience with Computers:

Many of the teachers had considerable background experience with computers (see Table VII): three had worked as programmers or programming analysts in industry and two had taught computer science courses previously at either the high school or university level.

8. Computer Experience of Students Enrolled in Computer Courses

Students from grades 8 to 12 were enrolled in computer classes. The majority of these students (69.9%) had had no previous computer experience, 26.3% had had one year of experience and 3.8% had had two years (see Table VIII). At the present time there is a larger percentage of students from the lower grade levels (grades 8, 9 and 10 - 69.2%) taking computer courses than from the upper grade levels (11 and 12 - 30.7%).

9. General Characteristics that Apply to Students in the Computer Courses

In general, students in computer courses were described as self-motivated students with above-average scholastic aptitude.

TABLE V: A SUMMARY OF THE TEACHING CERTIFICATES AND THE DEGREES HELD BY INSTRUCTORS OF COMPUTER SCIENCE COURSES

Teacher	Teaching Certificate	Degrees
1	PB	B. Sc.
2	PA	B. A.
3	PB	B. Sc.
4	PB	B. Ed.
5	PB	B. Sc.
6	PA	B. A., B. Sc.
7	PA-Masters	B. Ed., M. Ed.
8	PA-Masters	B. Ed., M. Ed.
9	PA-Masters	B. Sc., M. Sc.
10	PA-Masters	B. A., B. Ed., M. Ed.

TABLE VI: SUMMARY OF THE NUMBER OF COMPUTER SCIENCE COURSES TAKEN BY TEACHERS OF COMPUTER SCIENCE

Teacher	No. of Computer Science Courses Taken
1	4
2	3
3	3
4	3
5	4
6	3
7	1
8	2
9	2
10	2
Total	27
Mean No. of Courses	2.7

TABLE VII: SUMMARY OF THE BACKGROUND COMPUTER EXPERIENCE OF COMPUTER SCIENCE TEACHERS

Teacher	Background Experiences
1	Worked as computer operator and programmer analyst
2	None (excluding courses)
3	Worked as programmer analyst
4	Taught previous courses in computer science at high school, college and university level; worked as computer operator
5	None (excluding courses)
6	Worked as programmer
7	Worked as coordinator of student scheduling, taught previous computer science courses at high school level
8	Used the computer for instructing mathematics; considerable experience in graduate courses in computer techniques in the administrative process
9	None (excluding courses)
10	None (excluding courses)

TABLE VIII: SUMMARY OF THE COMPUTER EXPERIENCE OF STUDENTS ENROLLED IN COMPUTER SCIENCE CLASSES

Grade Level	Number of Students				
	0 Yrs. Exp.	1 Yr. Exp.	2 Yrs. Exp.	Total	%
8	69	-	-	69	21.8
9	49	2	-	51	16.1
10	41	58	-	99	31.3
11	38	16	7	61	19.3
12	24	7	5	36	11.4
Total	221	83	12	316	100.0%
%	69.9	26.3	3.8	100%	

TABLE IX: WEIGHTED-MEAN PRIORITIES ON NUMERICAL RANKS ASSIGNED TO SUBJECT AREAS BY TEACHERS TO INDICATE AREAS OF PROBLEMS ON WHICH THE STUDENTS ARE WORKING.

Subject Area	Weighted Mean Priority	Numerical Rank
Mathematics	1.07	1
Science	2.69	2
Commerce	3.17	3
Games	3.70	4
Physics	3.90	5
Chemistry	4.75	6
Social Studies	5.00	7
Biology	5.00	8
Music	8.00	9
English	9.00	10

10. Amount of Teaching Time Spent with Individuals, Small Groups and the Entire Class

Computer course teachers, on the average, spent the largest part of their class time (56.7%) working with individuals. They spent less than a quarter of their time working with small groups (20.0%) and with the entire class (23.0%). (See Figure 1.)

11. Frequency of Instruction of Computer Courses

All fifteen computer classes were 60 minutes in duration. Ten of the classes were held for five periods in a seven-day cycle for the whole year, four were held daily (semestered schools), and one was held for five periods in an eight-day cycle for the whole year.

12. Procedures Used to Evaluate Student Achievement

Subjective evaluations of students (in terms of their initiative, interest and effort) were used in nine of the fifteen courses; performance on tests and assignments was also used as a criterion for evaluation. Samples of the descriptions of evaluation procedures submitted by teachers are:

> "Evidence of work done on the basis of their ability and grade level--no letter grade for first report, rather a comment; second report--letter grade determined by discussion with each student."

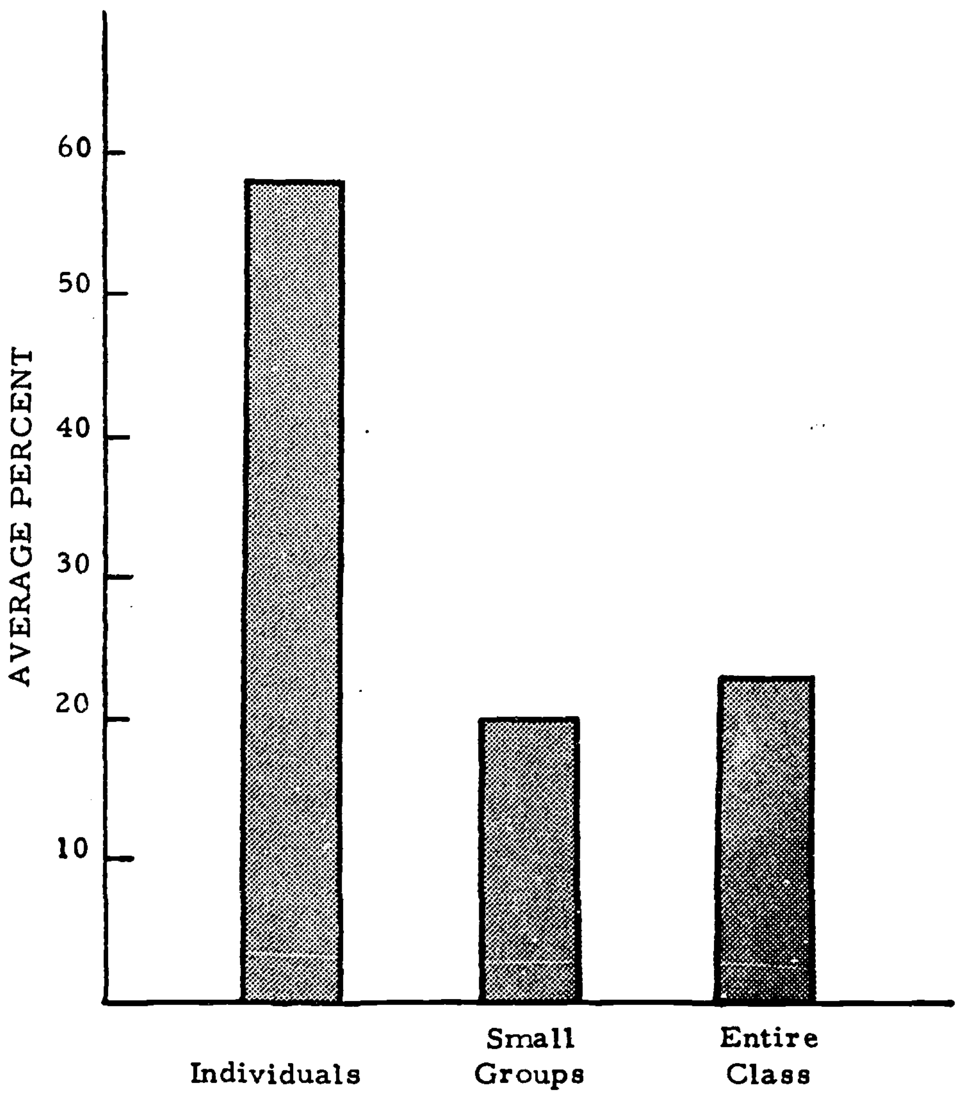
> "Are they self-motivated; have they learned the basic techniques; do they do more than the required amount of work; are they helpful to their classmates."

> "Degree of success in getting computer programs to work, effort and interest, objective tests on computer theory, occasional subjective tests, projects, classwork."

13. Subject Areas in Which Computer Science Students are Working on Problems

Teachers assigned numerical ranks to subject areas to indicate those areas in which their students were working most frequently. From these ranks, weighted mean priorities were calculated, and the priorities were then assigned numerical ranks (see Table IX). Students were working on problems in areas of the traditional school subjects of mathematics, science and commerce most often, but the computer was used to solve problems in such diverse areas as music and English. (Mr. Wayne Dodds' course outline, which was used as a guide by teachers in five schools, stressed business, industrial, government and scientific applications of computers, rather than applications in school subjects.)

FIGURE 1: AVERAGE PERCENT OF TEACHING TIME THAT INSTRUCTORS OF COMPUTER COURSES SPEND WITH INDIVIDUALS, WITH SMALL GROUPS, AND WITH THE ENTIRE CLASS



14. Class Activities Provided

Audio-visual presentations were the most frequently provided class activity. They were presented, on the average, 13.3 times per term, and involved 90.5% of the students enrolled in computer science courses (see Table X). Most of the students (91.1%) were involved in the use of newspaper clippings; a smaller percentage were involved with magazine articles, research assignments and field trips. Field trips were made to the University of British Columbia, Simon Fraser University, John Oliver Secondary School, Point Grey Secondary School, and Vancouver City College; most of the classes took only one field trip.

15. Teachers' Views on the Strengths and Weaknesses of the Computer-Based Instructional Program and Their Suggestions for its Improvement and Extension

(a) Strengths

The main strengths of the program cited by the teachers were:

"The batching service is good" (3)
"Capable and interested students have enrolled in the course" (3)
"The course develops responsible and independent students who work at their own rate" (3)
"The opportunities arranged by Mr. Dodds for 'hands-on' time are good" (2)
"The problem-solving techniques learned in the course are applicable to other areas" (2)
"The course has provided mathematics and science students with an elective related to their interests" (1)
"The course is an achievement-oriented outlet for bright students" (1)
"The course provides an alternative for non-academic students in mathematics and commerce" (1)

(b) Weaknesses

The following weaknesses of the computer-based instructional program were cited by the teachers:

"Computer classes consist of too many students from different grade levels and with different amounts of computer experience" (3)
"The computer available is not suitable for other languages than BASIC, such as "FORTRAN" (2)
"There should be more field trips and 'hands-on' time" (2)
"There is too much emphasis on programming and not enough on the theory of computer hardware" (2)
"Card-marking is tedious" (1)
"There is no follow-up course on computers" (1)
"There are not enough supplementary exercises available" (1)
"The reference material is limited" (1)

TABLE X: A SUMMARY OF CLASS ACTIVITIES OF COMPUTER SCIENCE COURSES

Activity	Average No. of Times Provided (per class)	Percentage of Students Participating
(a) Audio-visual presentations	13.3	90.5%
(b) Newspaper clippings	5.3	91.1%
(c) Magazine articles	6.1	60.1%
(d) Research assignments	2.5	36.1%
(e) Field trips	1.0	59.5%

c) Suggestions

The suggestions listed by teachers to improve and extend the program were:

"More hands-on time is needed" (4)
"A more advanced course should be started" (1)
"The course should delve deeper into the 'social implications' of computers" (1)
"A computer library should be built up" (1)
"There should be an additional course for non-academic commercial students" (1)
"More supplementary exercises (other than mathematics) should be made available" (1)
"There should be more reference material available" (1)
"There should be more money for field trips" (1)
"There should be more interesting problems supplied" (1)
"There should be more integration with other departments whose students could benefit from the present computer facilities" (1)
"There should be automatic portable terminal connections" (1)
"There should be a batch delivery for a second computer language for senior students" (1)
"There should be problems of a developmental nature for senior students" (1)
"The possibilities of further university-secondary school interaction should be explored"(1)
"Vancouver City College facilities should be open to students in a planned way"(1)

16. Range of Difficulty of the Topics on Which the Computer Course Students Were Working

Teachers were asked to include sample printouts of an easy, an average and a difficult problem for each computer course that they taught. Grade level and experience of the students varied considerably among courses and thus a problem considered difficult by one teacher whose class consisted mainly of grade 9 students might be deemed easy by another who taught twelfth graders. Some of the problems submitted are described below. The actual computer printouts of the programs written to solve the problems are included in Appendix H.

a) Examples of "easy problems"

1. "Address labels"--This program prints labels which include a name, address and telephone number.
2. "Circle measurements" --This program calculates the circumference and area of a circle with a given radius.
3. "Use of Alpha Data feature"--This program illustrates the use of the Alpha Data feature of Hewlett-Packard BASIC by printing a poem.

b) Examples of "average problems"

1. "Birthday probabilities"--This program calculates the probability of two people having their birthdays on the same days for groups of from one to 75 people.
2. "Hourglass shape"--This program prints hourglass designs of various sizes at the desired column position on the page.
3. "Pay cheques"--This program prints out company pay cheques and checks for invalid employee numbers.

c) Examples of "difficult problems"

1. "Bank statement"--This program produces a bank statement which includes balances calculated on the basis of withdrawals and deposits made.
2. "Volume of a sphere"--This program calculates the volume of a sphere by dividing the sphere into rectangular solids (simulates the "calculus" method).
3. "Falling bodies"--This program, written by a grade 10 student,
   --calculates the height, velocity, acceleration and time of a freely falling object at five second intervals
   --determines the relations between height, velocity, acceleration and time for an object experiencing free fall, and
   --calculates the effect of balls of various materials falling from structures of various heights.

V. SUMMARY OF RESPONSES TO A STUDENT QUESTIONNAIRE REGARDING COMPUTER-BASED INSTRUCTION

A questionnaire (see Appendix B) was distributed to 316 students enrolled in computer courses to determine their attitudes toward the courses. A total of 298 questionnaires (94.3%) were returned. The findings of the questionnaire follow:

Difficulty of the Course

Most of the students (58.4%) found the computer course to be about what they had expected in terms of difficulty (see Table XI). However, there was considerable variation in opinions, depending on the particular course the students were enrolled in; for example, the percentage of students that judged the course to be harder than expected ranged from 6.1% in one course to 66.7% in another.

Work Load

In regard to the work load involved in the computer course, approximately half of the students found it to be the same as they had anticipated, one-quarter to be heavier, and one-quarter to be lighter (see Table XII).

How Interesting

When asked how interesting the course was, 43.0% answered "highly interesting", 51.3% "fairly interesting" and 5.7% "not interesting". The percentage of students who found it "highly interesting" ranged from 5.9% to 90.9% (see Table XIII).

Hours Per Week Spent on the Computer Course

The median number of hours per week spent on required work for the computer course (outside of class time) was 1.4 hours; the median number of hours spent for the student's own interest and/or enjoyment was 1.2 hours (see Tables XIV and XV). There were several students (obviously very keen) who spent as many as 15 hours a week on computer work for their own enjoyment.

Relative Amount of Time Spent on the Computer Course

Half of the students spent less time on the computer course (outside of class) than on other subjects; 22.1% spent more time, and 27.2% spent about the same amount of time (see Table XVI). Of those who spent more time on the computer course, 74.2% cited interest in the course as accounting for the extra time (see Table XVII).

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TABLE XI: RESPONSES OF COMPUTER SCIENCE STUDENTS TO ITEM 1 OF THE STUDENT QUESTIONNAIRE "IN RESPECT TO DIFFICULTY, HOW DID YOU FIND THE COMPUTER COURSE?"

(The entry in each cell is the percentage of the group taking the course)

Course	1	2	3	4	5a	5b	5c	6	7	8a	8b	9a	9b	9c	10	Total Group
No. of Students	26	33	16	6	63	17	6	12	30	15	9	11	12	10	32	298
Responses:																
"Easier than I had expected"	15.4	15.2	12.5	33.3	39.7	23.5	-	25.0	36.7	20.0	-	36.4	16.7	10.0	9.4	23.2%
"Harder than I had expected"	26.9	6.1	25.0	16.7	28.6	41.2	66.7	8.3	3.3	6.7	11.1	9.1	8.3	20.0	9.4	18.1%
"About the same as I had expected"	57.7	78.8	62.5	50.0	30.2	35.3	33.3	66.7	60.0	73.3	88.9	54.5	75.0	70.0	81.3	58.4%
No Response	-	-	-	-	1.6	-	-	-	-	-	-	-	-	-	-	0.3%

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TABLE XII: RESPONSES OF COMPUTER SCIENCE STUDENTS TO ITEM 2 RE THE WORK LOAD INVOLVED IN THE COMPUTER COURSE

(The entry in each cell is the percentage of the group taking the course)

Course	1	2	3	4	5a	5b	5c	6	7	8a	8b	9a	9b	9c	10	Total Group
No. of Students	26	33	16	6	63	17	6	12	30	15	9	11	12	10	32	298
Responses:																
"Heavier than I had anticipated"	15.4	12.1	31.3	-	38.1	52.9	16.7	-	-	6.7	11.1	18.2	33.3	20.0	28.1	22.1%
"Lighter than I had anticipated"	15.4	9.1	6.3	16.7	28.6	11.8	-	50.0	53.3	26.7	55.6	27.3	8.3	20.0	21.9	24.5%
"About the same as I had anticipated"	69.2	75.8	62.5	83.3	31.7	35.3	83.3	50.0	46.7	66.7	33.3	54.5	58.3	60.0	50.0	52.7%
No Response	-	3.0	-	-	1.6	-	-	-	-	-	-	-	-	-	-	0.7%

TABLE XIII: RESPONSES OF COMPUTER SCIENCE STUDENTS TO ITEM 3 RE HOW INTERESTING THE COURSE WAS

(The entry in each cell is the percentage of the group taking the course)

Course	1	2	3	4	5a	5b	5c	6	7	8a	8b	9a	9b	9c	10	Total Group
No. of Students	26	33	16	6	63	17	6	12	30	15	9	11	12	10	32	298
Responses:																
"Highly interesting"	69.2	66.7	68.8	16.7	30.2	5.9	33.3	25.0	30.0	33.3	66.7	90.9	50.0	30.0	37.5	43.0%
"Fairly interesting"	30.8	33.3	31.2	83.3	60.3	70.6	66.7	66.7	60.0	66.7	22.2	-	50.0	60.0	62.5	51.3%
"Not interesting"	-	-	-	-	9.5	23.5	-	8.3	10.0	-	11.1	9.1	-	1.0	-	5.7%

TABLE XIV: MEDIAN NUMBER OF HOURS PER WEEK SPENT ON REQUIRED WORK FOR THE COMPUTER COURSE (OUTSIDE OF CLASS TIME)

Course	1	2	3	4	5a	5b	5c	6	7	8a	8b	9a	9b	9c	10	Total Group
No. of Students	26	33	13	5	33	14	6	9	24	13	9	10	11	9	28	243
Median number of hours	1.4	2.0	1.3	1.1	1.1	2.2	2.0	1.0	0.5	0.7	1.0	3.0	2.3	0.7	2.2	1.4

TABLE XV: MEDIAN NUMBER OF HOURS PER WEEK SPENT BY STUDENTS ON COMPUTER WORK FOR THEIR OWN INTEREST AND/OR ENJOYMENT (OUTSIDE OF CLASS TIME)

Course	1	2	3	4	5a	5b	5c	6	7	8a	8b	9a	9b	9c	10	Total Group
No. of Students	24	32	15	5	28	11	6	8	28	12	8	9	12	9	24	231
Median number of hours	0.9	2.8	1.1	1.3	0.9	1.0	0.5	2.5	0.9	0.8	1.3	1.3	1.5	0.3	1.3	1.2

TABLE XVI: RESPONSES OF COMPUTER SCIENCE STUDENTS TO ITEM 5: "ON THE AVERAGE, DID YOU SPEND MORE OR LESS TIME OUTSIDE OF CLASS ON THE COMPUTER COURSE THAN ON OTHER COURSES?"

(The entry in each cell is the percentage of the group taking the course)

Course	1	2	3	4	5a	5b	5c	6	7	8a	8b	9a	9b	9c	10	Total Group
No. of Students	26	33	16	6	63	17	6	12	30	15	9	11	12	10	32	298
Responses:																
"More"	26.9	36.4	18.8	33.3	7.9	41.2	16.7	25.0	13.3	13.3	11.1	18.2	50.0	10.0	31.3	22.1%
"Less"	46.2	15.2	50.0	16.7	63.5	29.4	50.0	58.3	80.0	80.0	44.4	36.4	25.0	70.0	43.8	50.0%
"About the same"	26.9	48.4	31.2	50.0	28.6	29.4	33.3	16.7	6.7	6.7	33.3	36.4	25.0	20.0	25.0	27.2%
"No response"	-	-	-	-	-	-	-	-	-	-	11.1	9.1	-	-	-	0.7%

TABLE XVII: RESPONSES OF COMPUTER SCIENCE STUDENTS TO ITEM 6 "IF YOU SPENT MORE TIME, WHAT ACCOUNTED FOR THE EXTRA TIME?"

(The entry in each cell is the percentage of the group taking the course)

Course	1	2	3	4	5a	5b	5c	6	7	8a	8b	9a	9b	9c	10	Total Group
No. of Students	7	12	3	2	5	7	1	3	4	2	1	2	6	1	10	66
Responses:																
"Heavy work load"	-	-	-	-	-	28.6	-	-	-	-	-	-	-	-	30.0	7.6%
"Interest in the course"	100.0	100.0	66.7	50.0	100.0	28.6	100.0	66.7	75.0	50.0	100.0	50.0	83.3	-	60.0	74.2%
"Other"	-	-	33.3	50.0	-	42.8	-	-	25.0	50.0	-	50.0	16.7	100.0	10.0	16.7%
No Response	-	-	-	-	-	-	-	33.3	-	-	-	-	-	-	-	1.5%

Help from the Teacher

Most of the students (88.3%) had sufficient opportunities to get help from their teacher (see Table XVIII). Eighteen students commented that the classes were too large and as a result the teacher did not have time to help each student. (Courses 5b and 5c were held during the same hour, with the instructor dividing his time between the two classes. Similar setups were used for courses 8a and 8b, and for 9a, 9b and 9c).

Sources of Help

Students ranked teachers as the most important source of help, (see Table XIX), followed by "other students", "computer error messages", "reference material" and "other" sources of help.

Writing of Programs

Approximately 30% of the students wrote programs for their regular (non-computer) courses, as assignments from teachers (see Table XX). Most of these assignments were from mathematics and science courses. A larger percentage of students (46.6%) wrote programs for other courses (most often mathematics and science) on their own initiative (see Table XXI).

Thinking Processes

Half of the students believed that the thinking processes they developed in the computer course had helped in other courses (see Table XXII). The "other courses" cited most frequently were mathematics and science. Seventy-two students commented that the course had helped them to think more logically, 21 said that it had helped them solve the homework problems of other courses, and 13 that they felt they had a better understanding of concepts as a result.

Strengths of the Computer Course

The "strengths" of the computer course most frequently cited by students were:

"Basic knowledge of computers and programming is useful, especially for the future." (85) 28.5%
"The course is interesting." (42) 14.1%
"It helps develop logical thinking." (36) 12.1%
"It helps in other courses." (33) 11.1%
"I like the freedom to progress at my own speed." (19) 6.4%
"The available 'hands-on' computer time is valuable." (14) 4.7%

Weaknesses of the Computer Course

"Students don't have enough "hands-on" experience and access to the computer." (41) 13.8%

"The turn-around time (the time between submitting the program and receiving the output) is too long." (39) 13.1%

TABLE XVIII: RESPONSES OF COMPUTER SCIENCE STUDENTS TO ITEM 7: "HAVE YOU HAD SUFFICIENT OPPORTUNITIES TO GET HELP FROM YOUR TEACHER?"

(The entry in each cell is the percentage of the group taking the course)

Course	1	2	3	4	5a	5b	5c	6	7	8a	8b	9a	9b	9c	10	Total Group
No. of Students	26	33	16	6	63	17	6	12	30	15	9	11	12	10	32	298
Response:																
"Yes"	96.2	93.9	100.0	83.3	87.3	76.5	83.3	83.3	86.7	86.7	66.7	90.9	91.7	80.0	90.6	88.3%
"No"	3.8	6.1	-	16.7	11.1	23.5	16.7	8.3	13.3	13.3	33.3	9.1	8.3	20.0	6.3	10.7%
No response	-	-	-	-	1.6	-	-	8.3	-	-	-	-	-	-	3.1	1.0%

TABLE XIX: RANKINGS OF SOURCES OF HELP IN THE COMPUTER COURSE ACCORDING TO THEIR IMPORTANCE (ITEM 8)

Course	1	2	3	4	5a	5b	5c	6	7	8a	8b	9a	9b	9c	10	Total Group
Source:																
Other students	3	1	3	1	2	3	3	2	3	2	2	3	2	1	1	2
Reference Material	2	2	4	2	4	4	4	4	4	4	4	4	3	3	3	4
Computer Error messages	4	4	2	4	3	2	2	3	2	3	3	2	4	2	4	3
Teachers	1	3	1	3	1	1	1	1	1	1	1	1	1	4	2	1
Other	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5

TABLE XX: RESPONSES OF COMPUTER SCIENCE STUDENTS TO ITEM 9(A): "DID YOU WRITE PROGRAMS FOR OTHER COURSES AS ASSIGNMENTS FROM TEACHERS?"

(The entry in each cell is the percentage of the group taking the course)

Course	1	2	3	4	5a	5b	5c	6	7	8a	8b	9a	9b	9c	10	Total Group
No. of Students	26	33	16	6	63	17	6	12	30	15	9	11	12	10	32	298
Response:																
"Yes"	11.5	21.2	-	66.7	12.7	11.8	33.3	25.0	60.0	6.7	44.4	36.4	66.7	60.0	59.4	29.9%
"No"	88.5	78.8	93.8	33.3	85.7	82.4	66.7	66.7	40.0	93.3	55.6	63.6	33.3	40.0	40.6	68.8%
No response	-	-	6.3	-	1.6	5.8	-	8.3	-	-	-	-	-	-	-	1.3%

TABLE XXI: RESPONSES OF COMPUTER SCIENCE STUDENTS TO ITEM 9 (B): "DID YOU WRITE PROGRAMS FOR OTHER COURSES ON YOUR OWN INITIATIVE?"

(The entry in each cell is the percentage of the group taking the course)

Courses	1	2	3	4	5a	5b	5c	6	7	8a	8b	9a	9b	9c	10	Total Group
No. of Students	26	33	16	6	63	17	6	12	30	15	9	11	12	10	32	298
Responses:																
"Yes"	23.1	72.7	25.0	16.7	27.0	41.2	50.0	41.7	73.3	33.3	44.4	45.5	75.0	20.0	78.1	46.6%
"No"	76.9	21.2	68.8	83.3	61.9	47.1	50.0	50.0	26.7	66.7	22.2	54.5	25.0	60.0	15.6	46.6%
No response	-	6.1	6.3	-	11.1	11.8	-	8.3	-	-	33.3	-	-	20.0	6.3	6.7%

TABLE XXII: RESPONSES OF COMPUTER SCIENCE STUDENTS TO ITEM 10: "HAVE THE THINKING PROCESSES THAT YOU HAVE DEVELOPED IN THE COMPUTER COURSE HELPED YOU IN ANY OTHER COURSES?"

(The entry in each cell is the percentage of the group taking the course)

Course	1	2	3	4	5a	5b	5c	6	7	8a	8b	9a	9b	9c	10	Total Group
No. of Students	26	33	16	6	63	17	6	12	30	15	9	11	12	10	32	298
Responses:																
"Yes"	76.9	51.5	43.8	16.7	33.3	23.5	66.7	41.7	30.0	46.7	88.9	81.8	66.7	50.0	65.6	49.0%
"No"	23.1	36.4	50.0	83.3	50.8	70.6	33.3	25.0	53.3	40.0	11.1	9.1	16.7	40.0	34.4	40.6%
No response	-	12.1	6.3	-	15.9	5.9	-	33.3	16.7	13.3	-	9.1	16.7	10.0	-	10.4%

"The course is boring." (21--ten of whom were from one class) 7.0%
"The present hardware is inefficient; there are too many breakdowns." (15) 5.0%
"Card marking is too long and tedious." (13) 4.4%
"The classes are too mixed up; there are too many students with different levels of experience in one class." (12) 4.0%

Suggestions

The following suggestions to improve the course were made by students:

"Get a computer for each school." (54) 18.1%
"Students should have better access to and more time on the computer." (51) 17.1%
"Languages other than BASIC should be taught." (17) 5.7%
"There should be a better selection of computer problems to choose from." (15) 5.0%
"There should be better batching service and turn-around time." (12) 4.0%

Results of the Increasing Use of Computers

When asked how the increasing use of computers was good for people, the students replied:

"Jobs are done quicker, more efficiently and the workload is decreased." (143) 48.0%
"Boring, repetitious jobs and laborious calculations are eliminated." (32) 10.7%
"The results are more accurate than if done by hand." (21) 7.0%
"More jobs are created." (19) 6.4%
"People have more leisure time." (16) 5.4%

Several students were concerned about the adverse effects of computers. In reply to the question, "How is the increasing use of computers bad for people?" students replied:

"It creates unemployment." (99) 33.2%
"People become too dependent on computers and may grow lazy." (62) 20.8%
"Computers are depersonalizing." (25) 8.4%
"Computers invade privacy." (22) 7.4%
"It is not bad." (10) 3.3%
"Computers will take over the world." (6) 2.0%

Future Help

Students were asked how the course would help them in the future. The most common replies are listed below:

"It might lead to a job in the computer field." (62) 20.8%
"The course gives good insight into computers and programming." (46) 15.4%
"A basic knowledge of computers is needed in the business world." (28) 9.4%
"It won't help unless I pursue a career in computers." (18) 6.0%
"The computer course will help me in university or higher level computer courses." (17) 5.7%

Career Plans

The majority of the students (57.0%) were undecided as to whether they would pursue a career in the computer field; 28.5% had decided against working with computers and 12.4% had plans to enter the field (see Table XXIII).

Letter Grades

The marks that students received in the computer course were, in general, better than average. The median letter grade received was "B". (see Table XXIV)

TABLE XXIII: RESPONSES OF COMPUTER SCIENCE STUDENTS TO ITEM 14: "DO YOU PLAN TO PURSUE A CAREER IN THE COMPUTER FIELD?"

(The entry in each cell is the percentage of the group taking the course)

Course	1	2	3	4	5a	5b	5c	6	7	8a	8b	9a	9b	9c	10	Total Group
No. of Students	26	33	16	6	63	17	6	12	30	15	9	11	12	10	32	298
Response																
"Yes"	19.2	12.1	12.5	15.7	4.8	5.9	-	8.3	16.7	6.7	22.2	27.3	41.7	10.0	9.4	12.4%
"No"	19.2	24.2	50.0	-	27.0	47.1	33.3	41.7	26.7	26.7	22.2	9.1	16.7	10.0	43.8	28.5%
"Undecided"	61.5	60.6	37.5	83.3	65.1	41.2	66.7	50.0	56.7	66.7	33.3	63.6	41.7	80.0	46.9	57.0%
No response	-	3.0	-		3.2	5.9	-	-	-	-	22.2	-	-	-	-	2.0%

TABLE XXIV: MEDIAN LETTER GRADES OF STUDENTS ENROLLED IN COMPUTER COURSES

Course	1	2	3	4	5a	5b	5c	6	7	8a	8b	9a	9b	9c	10	Total Group
Median letter grade	C+	A	B	A	C	C+	B	B	B	B	B	A	B	C+	C+	B

VI. SETS OF PROBLEMS IN PROGRAMMING

A committee of computer course teachers developed two sets of problems in order to obtain objective evidence of the problem-solving ability of students. (A distinct set was developed for the grade 8 students, who had an inadequate mental maturity and mathematics background to solve the problems designed for the upper level students.) The problem sets were to be given out after the students had completed a minimum of 60 hours of instruction. Each student was asked to select one of the problems (in one of the areas of mathematics, commerce or science), write a computer program to solve it, and get the program to run (without errors) on the computer. Teachers kept track of the number of computer trial runs the student required to complete his assignment.

Table XXV summarizes the performance of the students on the programming problems. The majority of the students (53.8%) completed the problem successfully in three or fewer runs; 23.3% did not complete the problem in the number of runs allowed by the teacher. (All classes were permitted at least five runs; a few had no restriction on the number of runs allowed.) The grade eight students had the most difficulty perfecting their programs: 63.9% were unsuccessful in five runs. (All grade eight students were taught by the same instructor.)

The greatest percentage of the errors made (44.0%) were errors in the logic of the students' programs; 26.9% were "Syntax" errors (in punctuation, spelling, etc.). Card-marking errors accounted for 20.3%, and machine errors (e.g. the misreading of a card by the computer mark sense card reader) accounted for 5.8% of the errors.

TABLE XXV: SUMMARY OF STUDENT PERFORMANCE ON PROGRAMMING PROB..EMS

Course	Runs	1*	2	3	4	5a*	5b & 5c*	6	7	8a*	8b*	9a	9b	9c	10	Total Group
No. of students who attempted problem		26	23	16	6	61	25	11	30	16	9	11	-	-	24	258
Percentage of	1	11.5	17.4	-	33.3	1.6	12.0	-	10.0	-	11.1	9.1	-	-	4.2	7.4
students who	2	23.1	34.8	43.8	50.0	8.2	20.0	27.3	30.0	6.3	-	27.3	-	-	29.2	22.1
completed problem	3	11.5	39.1	25.0	-	11.5	28.0	27.3	46.7	25.0	22.2	27.3	-	-	16.7	23.3
in the given number	4	23.1	8.7	12.5	16.7	9.8	8.0	18.2	10.0	12.5	22.2	27.3	-	-	37.5	15.5
of runs	5	11.5	-	6.3	-	4.9	16.0	18.2	-	18.8	11.1	-	-	-	12.5	7.8
	6+	-	-	-	-	-	-	-	3.3	-	-	9.1	-	-	-	0.8
% of students unsuccessful		19.2	-	12.5	-	63.9	16.0	9.1	-	37.5	33.3	-	-	-	-	23.3
Logic errors (%)		38.8	31.0	20.0	16.7	61.7	46.9	26.9	44.8	48.8	62.5	45.8	-	-	38.0	44.0
Syntax errors (%)		17.9	31.0	25.7	16.7	34.6	38.8	46.2	10.3	17.1	21.9	37.5	-	-	30.0	26.9
Card-marking errors (%)		38.8	20.7	54.3	-	-	12.2	3.8	44.8	7.3	6.3	16.7	-	-	16.0	20.3
Machine errors (%)		-	17.2	-	33.3	-	2.0	15.4	-	17.1	9.4	-	-	-	14.0	5.8
Miscellaneous errors (%)		4.5	-	-	33.3	3.7	-	7.7	-	9.8	-	-	-	-	2.0	3.0

* Maximum 5 runs allowed

VII. OBSERVATION OF THREE CLASSES IN COMPUTER-BASED INSTRUCTION

An independent observer visited three classrooms:

- to observe the interaction among students and teachers,
- to interview students,
- to take note of their activities, and
- to record any comments of the teachers regarding the computer course.

The classes visited were course numbers 1, 2, and 9 (a, b and c). All three classes were one hour in length.

In general, students appeared enthusiastic about the course. In one class, where the student-teacher relationship was exceptionally good, the enthusiasm and progress of the students were also exceptional. Actual instruction time was limited in all classes; the emphasis was on independent work. Detailed descriptions of the three classes follow.

Course 1

Teacher 1 devoted half of the class time to problem discussion; the other half was used for independent work. No lecture was given, since the course was nearing completion at the time of the visit and the students were finishing up course work. In this latter respect it was not a typical class.

The students (at the grade 10, 11 and 12 levels) were seated alphabetically in rows. There was considerable talking among students during the hour, but no moving about. The teacher remained at his desk and students with problems approached him. There was little hesitancy on the part of the students to ask for help. About one-half of the students were working very intently on their own.

Three students, who had taken the course previously, were acting as lab assistants. These students hoped to see a more advanced course, which would include FORTRAN and business languages, offered in the future. One of the assistants commented that "Seventy percent of the students go to the teacher for help rather than go to the lab assistants." This is consistent with the results of the student questionnaire (see Table XIX): the class ranked the teacher as the most important source of help.

Several students expressed annoyance at the turn-around time (one day is usually required for the return of programs). One commented, "I wouldn't mind doing extra work if it (the turn-around service) weren't so slow."

The responses of the students on the questionnaires indicated that many thought that computers would cause unemployment. The teacher (who had not touched upon the subject in class), suggested that the students had got this impression from their parents, most of whom were "blue-collar workers and may have transferred their fear of automation to their children."

Teacher 1 felt that students' complaints about not having a computer in the school might be resolved by the additional 'hands-on' computer time he planned to provide one evening per week, for students next term. He thought BASIC was a good language for introducing students to programming, and also commended the Vancouver School Board for the excellent opportunities available to teachers to upgrade their programming knowledge.

Course 2

One half hour of Course 2's class time was devoted to problem discussion, the other half to independent work. The teacher described it as a fairly typical class, though no new work was taken. The problem discussion period was quite formal--students raised their hands to ask questions and there was no talking otherwise. During the period of independent work, however, there was considerable interaction. Students formed small groups and the noise level was high.

Students actively sought help and advice from the teacher after the formal problem discussion. Teacher-student rapport was very evident. (One student approached the teacher to apologize for any interruption that was caused by a small disturbance).

The instructor described the class as extremely bright and keen. This was substantiated by the questionnaire results: the median grade was "A" and the class spent a median of 2.8 hours (the largest amount of time of all the courses) on computer work outside of class for their own enjoyment.

The class was comprised of students from grades 9, 10, 11 and 12. When the instructor was asked to comment on the success of the mixed class, he said that, in general, it had worked out well, but the fact that the lower grades hadn't had the mathematics background for some of the more interesting computer problems was a disadvantage. He would prefer to break the class into two distinct classes, one consisting of grade 9 and 10 students and the other of grade 11 and 12 students.

This class did not rate the teacher as the most important source of help. The instructor remarked that this was true, since a number of his students had progressed beyond his knowledge of programming and he could be of little assistance to them. Twenty of the students were meeting regularly with education students at the University of British Columbia who instructed them in additional languages and introduced them to the UBC computing facilities.

One of the students wrote a program to forecast football game results. His predictions became so good that The Province (a Vancouver newspaper) asked him for permission to print his computer predictions. As it turned out, the student's predictions were more accurate than those of the newspaper's regular forecaster.

Asked about the enthusiasm of the class, one student remarked that "Thirty percent of the students are very devoted to the course". A grade 12 student added, "I wouldn't be surprised if they fed on computer cards".

The students felt that the mark sense cards and the mark sense card reader were the most frustrating aspect of the course. Commented one student: "I've submitted perfect programs and have had them rejected because of an invisible speck of dust."

A motto tacked above the blackboard: "It is unworthy of excellent men to lose hours like slaves in the labour of calculation" was quoted by several students when they were asked how the increasing use of computers was good for people.

Course 9 (a, b, c)

The difficulties encountered in teaching students with vastly different background experience were apparent in this class. The first ten minutes were used for problem assignment and discussion. The class was then divided into three groups (a, b and c) which were treated as separate classes. Group 9c went to the cafeteria to work on their own; the two remaining groups were given short lectures separately. Then a few students left to work on the portable typewriter terminal attached by telephone lines to the computer. Those working on the terminal were obviously engrossed in the activity, and said that they would like to have more time on it in the future.

There was little teacher-student interaction during the class time--mostly due to the fact that every available minute of class time had to be used to address the three groups separately. However, the students remarked on the willingness of the teacher to help them with their problems. The instructor commented, "It's just about impossible to teach three levels at the same time."

One student remarked that "The Level 1 (9a) students seem the most interested." (On the questionnaire, 90.9% of the 9a students rated the course as "highly interesting" as compared with 50.0% and 30.0%, respectively, for 9b and 9c).

Only two of the 35 students in the class were girls. (A similar situation was found in the other classes visited: Course 1, with 26 students, had no girls; and Course 2, with 35 students, had one girl). When asked to comment why more girls hadn't signed up for the computer class, one girl remarked: "The counsellors don't bring up the computer course unless asked about it specifically--they'd rather see the girls in cooking."

TABLE XXVI: ANALYSIS BY "t" TEST OF PRE- AND POST-TEST SCORES OF COMPUTER SCIENCE STUDENTS (N= 15) ON FOUR TEST SECTIONS OF THE COMPUTER PROGRAMMER APTITUDE BATTERY

	Verbal Meaning		Reasoning		Letter Series		Number Ability	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post
Mean Raw Score	10.53	13.80	11.87	15.00	13.87	15.67	12.73	13.13
Standard Deviation	4.96	4.71	2.72	3.67	3.88	3.32	3.40	4.03
Difference Between Means	3.27		3.13		1.80		0.40	
"t" Value		1.79 (n.s.d.)	2.56*			1.32 (n.s.d.)		0.28 (n.s.d.)

Legend: n.s.d. -- no significant difference
* -- significant at .02 level

VIII. THE COMPUTER PROGRAMMER APTITUDE BATTERY

The Computer Programmer Aptitude Battery (CPAB) was developed by Jean Maier Palormo of Science Research Associates, Inc., to aid data-processing managers and personnel directors in selecting persons with the aptitude for computer programmer and systems analyst positions. It is generally administered to university graduates or high school graduates with technical training who are seeking such positions. The Battery comprises five separately timed tests, measuring the following skills and aptitudes:

Verbal Meaning (38 items - 8 min.)	a test of communications skill; vocabulary commonly used in mathematical, business and systems engineering literature
Reasoning (24 items - 20 min.)	a test of ability to translate ideas and operations from word problems into mathematical notations
Letter Series (26 items - 10 min.)	a test of abstract reasoning ability, finding a pattern in the given series of letters
Number Ability (28 items - 6 min.)	a test of facility in using numbers; ability to estimate quickly reasonable answers to computations
Diagramming (35 items - 35 min.)	a test of ability to analyze a problem and order the steps for solution in a logical sequence.

The CPAB was administered to a Grade 11 computer science class at Templeton Secondary School in Vancouver as a pre-test in January, 1973 (at the beginning of the course), and as a post-test in June, 1973 (upon the completion of the course). Mrs. Zelter, the instructor of the course, did not administer the Diagramming section in January because of a time limitation:

An analysis by "t" test of the mean scores of the computer science class on the pre- and the post-test was made (see Table XXVI). Although the performance of the students improved on all sections of the Battery on the post-test, there were no statistically significant differences between pre- and post-test scores on the Verbal Meaning, Letter Series or Number Ability sections. However, improvement made on the Reasoning test was statistically significant at the .02 level.

To get a general idea of how the students fared on the CPAB, their performance on the battery (the post-test results) was compared to that of two groups for which published norms were available: a group of computer programmer trainees and applicants, and a group of experienced computer programmers and systems analysts. The educational level of both groups was considerably higher than that of the computer science students.

Two-thirds of the computer programmer trainees and applicants were applying for jobs with a civil service agency in the eastern United States and the remainder were enrolled for introductory computer systems training at universities or computer manufacturer sites. Approximately half of this group were college graduates.

The experienced computer programmers and systems analysts included personnel from a variety of business and industrial installations, including computer manufacturers. Approximately 80% of these were college graduates, and their median experience in the computer programmer field was three to four years.

A comparison of the mean raw scores of the computer science students (after they had finished their semester-length course) with that of the programmer trainees and the experienced programmers on the CPAB is presented in Table XXVII.

The performance of the computer science students on the CPAB was impressive. Their average score was better than that of the programmer trainees and applicants on four of the five sub-tests, and better than the average score of the experienced programmers and analysts on three of the tests. The average score on the Total Battery for the grade 11 students far exceeded that of the programmer trainees (85. 73 compared with 64. 86) and was quite close to the average score of the experienced programmers. The only section of the test on which the computer science students scored lower than both norm groups was Verbal Meaning. They did exceedingly well on the Diagramming section (mean score = 28. 13 compared to 25. 46 for the experienced programmers), and on the Letter Series section (mean score = 15. 70 compared to 11. 72 for the experienced programmers).

The fact that the computer science students compared favourably with programmer trainees prior to taking the course (pre-test mean scores for the students were higher than those of programmer trainees on three of four sub-tests) might indicate that students with abilities that would adapt well to a programming career are attracted to the course. It is significant that a one semester course in computer science improved the performance of the students so that they compared favourably to the group of experienced programmers and systems analysts on all but the Verbal Meaning section of the Computer Programmer Test Battery. The statistically significant improvement on the Reasoning section is especially noteworthy.

TABLE XXVII: MEAN RAW SCORES OF THE GRADE 11 COMPUTER SCIENCE CLASS, THE PROGRAMMER TRAINEES, AND THE EXPERIENCED PROGRAMMERS ON THE COMPUTER PROGRAMMER APTITUDE BATTERY

	Computer Science Class (N = 15)	Programmer Trainees (N = 298)	Experienced Programmers (N = 229)
Verbal Meaning	13.80	16.77	21.58
Reasoning	15.00	9.49	14.77
Letter Series	15.70	10.46	11.72
Number Ability	13.13	12.13	15.90
Diagramming	28.13	16.15	25.46
Total Battery	85.73	64.86	89.39

IX. SURVEY OF STUDENT USAGE OF THE HEWLETT-PACKARD COMPUTERS

Mr. Wayne Dodds, Computer Consultant for the Vancouver School Board, annually conducts a survey of student usage of the Hewlett-Packard computers (currently in operation at John Oliver and Point Grey Secondary Schools).

Table XXVIII shows the number of schools, teachers and students that have used the computer facilities during the past three years. The table includes students who used the computer in regular subject areas as well as those enrolled in special computer courses and members of computer clubs.

The increase from 700 students in 1970/71 to 5100 students in 1972/73 represents more than a 600% increase in the number of students using the computer facilities. Growth is expected to continue.

A breakdown of computer usage according to subject area is presented in Table XXIX. The most growth occurred in the areas of mathematics and science. Mr. Dodds noted the need for the improvement of the computers (by purchase of additional hardware) to better suit the requirements of the commerce program.

This year, eight secondary schools involved half or more of their Grade 8 students by having a special unit of study (two to four weeks) on the computer, as part of their regular mathematics courses. Four of the schools used the computer with some of their General Mathematics students. In addition, a total of 220 elementary students from eight schools used the computer facilities during the 1972/73 school year.

The percentage of students using the computer varied considerably among schools--from 4% to 44% (see Table XXX). There was also considerable variation among schools in the amount of time spent using the portable terminal (see Table XXXI). Students in one school used the terminal on a total of 40 days; other schools never requested to use it. In all, the terminal was used on 146 days (out of a possible 200 days) throughout the school year, during which time it was actually in use for a total of 238 hours (an average of 1.63 hours per day).

An analysis of the computer programs run (via batch processing) is automatically produced daily by the computer and summarized twice a month (see Table XXXII). The statistics generated enable the computer consultant to predict what demands will be made on the computer system in the future and what need there may be for improved equipment to handle the volume of work.

Demands were made on the computer to run student programs throughout the entire 1972-73 school year (see Figure 2). The low points on the graph corresponded to the opening of school in September, the semester change in January, the weeks before Easter vacation (when mid-term exams are held in some classes) and the closing of school in June.

TABLE XXVIII: SUMMARY OF COMPUTER USAGE DURING THE 1970/71, 1971/72 AND 1972/73 SCHOOL YEARS

School Year	Number of Schools	Number of Teachers	Number of Students
September/70-June/71	4	7	700
September/71-June/72	16	66	3400
September/72-June/73	18	77	5100

TABLE XXIX: SUMMARY OF COMPUTER USAGE, BY SUBJECT AREA, DURING THE 1971/72 AND 1972/73 SCHOOL YEARS

	No. of Schools (out of 18)				No. of Teachers				No. of Students			
Year	Math	Science	Commerce	Computer	Math	Science	Commerce	Computer	Math	Science	Commerce	Computer
71-72	13	2	13	11	24	2	23	15	1631	119	857	766
72-73	16	6	11	11	36	11	14	14	2571	746	815	844

TABLE XXX: SUMMARY OF COMPUTER USAGE DURING THE 1972/73 SCHOOL YEAR FOR 18 VANCOUVER SECONDARY SCHOOLS (IN DESCENDING ORDER IN TERMS OF PERCENTAGE OF ENROLMENT USING THE COMPUTER)

School Name	Math	Science	Commerce	Computer	Club	Elementary	Total	% of Enrolment
A	2 - 190	2 - 329	1 - 195	1 - 34	1 - 10	1 - 20	778	44
B	4 - 326			1 - 43	1 - 10	1 - 29	379	30
C	4 - 265			1 - 18			283	29
D	2 - 62	1 - 62	2 - 160	3 - 320		1 - 90	652	27
E	5 - 351		1 - 55		1 - 9		415	23
F	2 - 125	4 - 202	2 - 85	1 - 21			433	20
G	2 - 130		1 - 51	1 - 35	1 - 20	1 - 80	316	20
H	2 - 214		2 - 109				323	18
I	3 - 227		1 - 8	1 - 26			261	17
J	2 - 120	2 - 80		1 - 34	1 - 10		244	15
K		1 - 75					75	15
L	1 - 70			1 - 159			229	13
M	2 - 115		1 - 75	2 - 55			245	12
N	1 - 210		1 - 30					
O	2 - 46			1 - 35	1 - 10		91	9
P	1 - 30						30	9
Q		1 - 40	1 - 25		1 - 15		80	4
R	1 - 30		1 - 22				52	4
Totals	36 -2511	11 - 746	14 - 815	14 - 780	7 - 84	4 -219	5155	18

TABLE XXXI: SUMMARY OF USAGE OF PORTABLE TERMINAL DURING THE 1972/73 SCHOOL YEAR

School	Total Number of Days on which Terminal was Used	Total Number of Hours of Terminal Use
A	40	60.50
B	1	1.00
C	0	0.00
D	1	1.50
E	11	20.25
F	10	15.00
G	17	22.00
H	0	0.00
I	6	8.25
J	12	19.50
K	0	0.00
L	10	17.75
M	6	9.00
N	0	0.00
O	11	26.50
P	5	9.00
Q	16	27.25
R	0	0.00
Total	146	237.50

TABLE XXXII: SAMPLE OF THE SUMMARY OF PROGRAMS BATCHED, PRODUCED TWICE MONTHLY BY THE COMPUTER

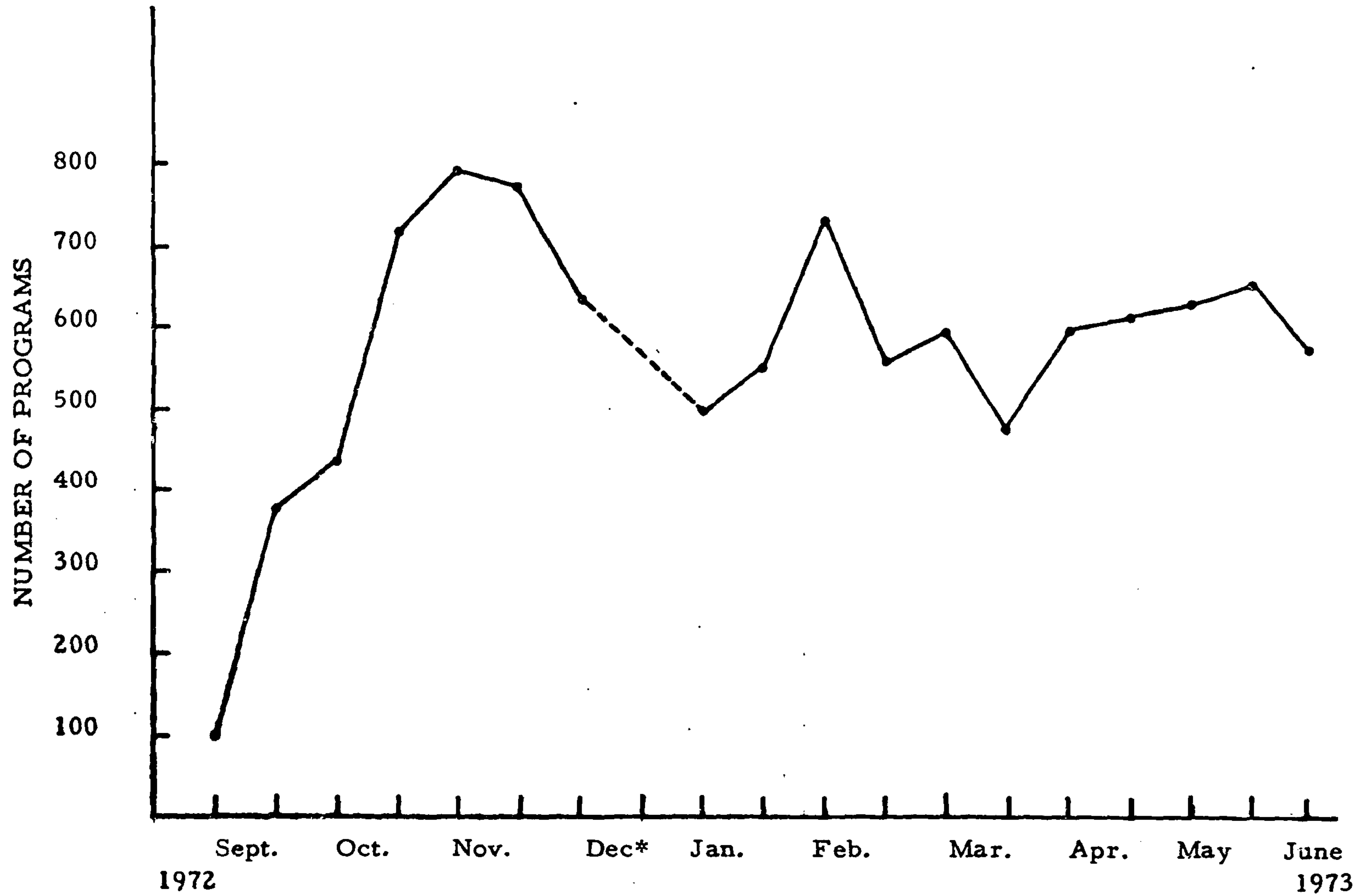
BATCH ANALYSIS, MONTHLY STATISTICS

NOV 17/72 AM

	AVERAGE PER DAY	MAXIMUM PER DAY	YEAR-TO-DATE T O T A L S	AVERAGE PER PROGRAM
PROGRAMS RUN	443	748	8323	---
ERROR 8W'S*	11	16	181	2 %
TIME ,COMPUTER	25	38	9	3
CARDS READ	6912	11036	128597.	16
PAGES USED	588	915	11166	1.3
TIME,ELAPSED	129	190	44	17
...TIMES IN..,	MINUTES	MINUTES	HOURS	SECONDS

*Time limit exceeded--execution cancelled automatically.

FIGURE 2: AVERAGE NUMBER OF PROGRAMS RUN DAILY, 1972-73
CALCULATED SEMI-MONTHLY



*The computer was not in operation during the Christmas holidays.

X. SUMMARY AND DISCUSSION

At the present time, computer courses are being offered in eleven Vancouver Secondary Schools. The students in these courses primarily use the Hewlett-Packard computers installed at Point Grey Secondary School and John Oliver Secondary School.

Ten of the secondary schools participated in an evaluation of computer-based instruction. The teachers of fifteen computer courses in these schools (a total of ten different teachers) were asked to complete questionnaires. From this survey the principal findings were:

1) The ultimate goal of the computer course was to provide students with a general knowledge of computers and to introduce elementary programming techniques.

2) The four main topics of the computer courses were:
   (a) introduction to computers,
   (b) flowcharting and problem solving techniques,
   (c) programming in BASIC language, and
   (d) social implications of computers.

3) Most of the students (96.9%) used the pickup/delivery service for Batch Mode BASIC on a daily basis.

4) The majority of students used the hands-on Batch Mode BASIC facility in the evening, i.e., they went to the computer centre and submitted their programs (in batches) to the computer directly. Mark sense cards were used more frequently than paper tapes to submit programs.

5) Approximately 40% of the students used the portable terminal for hands-on interactive coding of BASIC. A larger percentage of the students (60%) used demonstration and other supplied BASIC programs on the portable terminal.

6) Other languages (FORTRAN, APL) were used by some of the high school students. They used the facilities at the University of British Columbia, Simon Fraser University and Vancouver City College.

7) "Catalogue items" available were used frequently by both students and teachers. In general, both students and teachers used the same books for reference. (See items IV-4 and IV-5).

8) On the average, teachers spent 23.3% of their teaching time instructing computer courses.

9) Four of the ten teachers held Professional Basic teaching certificates, two held Professional Advanced certificates, and four held Professional Advanced-Masters certificates. All of the teachers held Bachelor degrees; four held Masters degrees as well.

10) The average number of computer science courses that had been taken by the teachers was 2.7.

11) In general, the teachers had considerable background experience with computers.

12) The majority of students enrolled in computer courses did not have previous computer experience. There was a larger percentage of students from the lower grade levels taking computer courses than from the upper levels (Grades 11 and 12).

13) In general, students in computer courses were described as self-motivated, with above-average scholastic aptitude.

14) The teachers of computer courses spend the largest part of their class time working with individuals rather than with small groups or with the entire class.

15) The duration of class periods for all fifteen courses was 60 minutes.

16) Among the procedures used by teachers to evaluate student achievement were subjective evaluations in terms of the initiative, interest and effort shown by the student, and performance on tests and assignments.

17) The problems which the students were using the computer to solve were most often in the areas of mathematics, science and commerce.

18) Audio-visual presentations were the most frequently provided class activities.

19) As strengths of the computer-based instructional program, teachers cited the good batching service, the calibre of students that were attracted to the course, and the fact that the course developed responsible and independent students who worked at their own rate.

20) As weaknesses of the program, the teachers cited the mixture of grade levels and the wide range of computer experience of the students in their classes, the fact that the computers available were only suitable for BASIC language, and that there weren't enough field trips and "hands-on" time.

21) The suggestion most often cited to improve the computer-based instructional program was that more "hands-on" time be provided.

22) The computer problems worked on by students ranged from very simple to exceedingly complex.

A total of 298 students enrolled in computer courses completed a "student questionnaire regarding computer-based instruction". The principal findings of that survey were:

1) Most of the students found the computer course to be about what they had expected in terms of difficulty; however, there was considerable variation among courses.

2) About half of the students found the work load in the computer course to be what they had expected.

3) Students' interest in the course varied considerably among courses: the percentage who found it "highly interesting" ranged from 5.9% in one class to 90.9% in another.

4) The median number of hours per week spent on required work for the computer course (outside of class time) was 1.4 hours; the median time for the student's own interest and enjoyment was 1.2 hours.

5) The largest percentage of students spent less time on the computer course (outside of class) than on other subjects. Of those who spent more time on the computer course, 74.2% cited interest in the course as accounting for the extra time.

6) Approximately 90% of the students remarked that they had had sufficient opportunities to get help from their teacher.

7) Students ranked teachers as the most important source of help in the course, followed by "other students", "computer error messages", "reference material" and "other" sources of help.

8) About one-third of the students said they wrote programs for other courses as assignments from teachers; almost half of the students wrote programs for other courses on their own initiative.

9) Half of the students believed that the thinking processes they developed in the computer course had helped them in other courses; a slightly smaller percentage thought they had not.

10) The most frequently cited strength of the computer program, according to students, was that "knowledge of computers and programming is useful, especially for the future".

11) The most frequently cited weakness of the computer course was that the students didn't have enough "hands-on" experience and access to the computer.

12) The most frequently cited suggestion to improve the course was "get a computer for each school".

13) When asked how the increasing use of computers was good for people, the most common reply of the students was that "Jobs are done quicker, more efficiently, and the workload is decreased".

14) One-third of the students were concerned that the increasing use of computers would create unemployment.

15) Asked how the course would help them in the future, one-fifth of the students thought that it might lead to a job in the computer field.

16) Slightly more than 12% of the students had definite plans to enter the computer field.

17) The median letter grade received by students in the computer courses was "B".

The contention that the teacher role sometimes changes in a computer-oriented teaching situation was supported by the findings of this study. The students in Courses 2 and 4 rated teachers third in order of importance as sources of help, behind "other students" and "reference material". The median letter grade in both these classes was "A", and the students had progressed to the point that the material found in the standard texts used was not detailed enough for their purposes. Both teachers admitted that some students were so advanced that they could serve merely as guides and lead the students to appropriate reference material, but neither found the change in role "threatening". They were, in fact, delighted at the progress of their students. (Course 9c students also rated teachers lowly, but it was discovered that this was due to the fact that the size of the class prevented the teacher from being available to assist students--especially the advanced ones).

The performance of the computer science students on the programming problems gave further credence to Bates' (in 16, p. 83) claim that students encounter the most difficulties in developing a logical approach to a problem: the greatest number of errors made by the computer science students were in the logic of their programs. The success that the students had in completing the problem was in line with their reported letter grades: 63.9% of the grade 8 students, whose median letter grade was "C", did not complete their problems, but all of the students in the courses with a median letter grade of "A" successfully completed their problems in four or fewer runs.

Interviews with teachers and students in three classes generally supported the findings of the questionnaires.

The performance of one computer science class on the Computer Programmer Aptitude Battery indicated that the students were better prepared to enter the programming field than were a group of more highly educated applicants for programming positions. It was also evident that the students' ability to "translate ideas and operations from word problems into mathematical notations" (as measured by the Reasoning section) had improved significantly by the end of the computer science course.

Statistics compiled annually by Mr. Wayne Dodds revealed that the number of students using the computer facilities had increased substantially in the last few years (from 700 in 1970-71 to 5100 in 1972-73). The most growth occurred in the mathematics and science areas.

XI. CONCLUSION

The present study indicates that the computer courses offered in Vancouver secondary schools have succeeded: in teaching students simple programming, in increasing their ability to analyze and solve problems, and in making them aware of the nature and social implications of computers. In most courses, students have been encouraged to work independently and progress at their own speed.

Experience with the computer has not been confined to students enrolled in computer science classes. Students in mathematics, science and even in music and English have been using the computer to solve problems. In some instances, elementary pupils have been taught to write simple programs.

Indications are that the number of computer users in Vancouver schools will continue to increase in coming years.

BIBLIOGRAPHY

1. BONHAM, Glenn. "The Computer in the Classroom". School Progress, June, 1969. pp. 34-35.

2. CHAPMAN, E. W. A Study of Computer-oriented Courses on the Secondary School Level. Research paper. Storrs: University of Connecticut, 1968.

3. CHARP, S. "Computer Programming Courses in Secondary Schools". The Computer in American Education. Edited by Allen, D., and D. Bushnell, New York: John Wiley and Sons, 1967. Chapter 11, pp. 133-145.

4. "Computer & Curriculum - North York's Computer Science Program". School Progress, June, 1970, pp. 25-27.

5. Computer Programmer Aptitude Battery -- Manual Science Research Associates, Inc. (Developed by Jean Maier Palormo).

6. DODDS, W. References and Guide for the Computers 11 Course. Vancouver School Board, 1972.

7. "Getting to Know the Computer". School Progress, April, 1970, pp. 48-49.

8. JOHNSON, D. A. and G. R. Rising. Guidelines for Teaching Mathematics. Belmont, California: Wadsworth Publishing Co., 1967. Chapter 19, "The Role of Computers", pp. 258-70.

9. LERNER, S. The Computer as an Aid in Teaching Mathematics. An instructional bulletin. Los Angeles: City Schools Board of Education: 1967.

10. MAVAN, David. "How Students Learn Computer Science at Thornlea". School Progress, June, 1969, pp. 36-37.

11. MOODIE, A. G. An Evaluation of Student Experience with Computers in the Instructional Program of Two Secondary Schools of Vancouver, 1969-70. Research Report 70-13, Department of Research and Special Services, Vancouver School Board, June 30, 1970.

12. PETRAK, J. and J. Schellenberg. "Computer in the Classroom". Teaching Mathematics, Vol. 7, No. 2, Sept. 1971, 11. 20-45.

13. POST, D. L. ed. The Use of Computers in Secondary School Mathematics. Newburyport, Massachusetts: Entelek, 1970.

14. Recommendations Regarding Computers in High School Education. Conference Board of the Mathematical Sciences, Committee on Computer Education, Washington, D. C., April, 1972.

15. SCHEEPMAKER, F., ed. Proceedings of the IFIP World Conference on Computer Education. New York: Science Associated International, 1970.

BIBLIOGRAPHY (Cont'd.)

16. TILLET, P. "Computer Orientation in Secondary Mathematics". AEDS Journal, Spring 1973, pp. 79-88.

17. WOLFE, L. R. "Computer Concepts Possessed by Seventh Grade Children". Arithmetic Teacher 15:35-39, January 1968.

APPENDIX A

QUESTIONNAIRE FOR TEACHERS ABOUT COMPUTER-BASED INSTRUCTION

________ (Teacher) ________ (School) ________ (Course) ________, 1973. (Date)

________ (Enrolment)

Questionnaire for Teachers about Computer-Based Instruction

(Note: Please complete one return for each computer course taught.)

1. What is the ultimate goal of this course? ________

2. List the topics covered and the specific objectives in each one.

Topics	Objectives

3. Indicate the approximate number of students who have been using the following facilities during the school year (September, 1972 to January, 1973). Under 'Frequency of Use' specify how often the facility is used (e.g., every lesson, about once a month, etc.).

Facility	No. of Students	Frequency of Use
Pickup/delivery for Batch Mode BASIC on Hewlett Packard computers		
Hands-on batch mode BASIC in evenings: a) Optic card student programs b) Paper tape student programs		

Facility	No. of Students	Frequency of Use
Hands-on interactive coding of BASIC via portable terminal		
Demonstration and other supplied BASIC programs via portable terminal		
* FORTRAN (or WATFIV) at: a) UBC b) SFU c) Langara d) BCIT e) Other ________ ________ ________		

* Specify whether optic mark or keypunching was used for items (a) through (e).

For 'Other', specify other languages and hardware, if any.

4(a) List the reference materials used by your students, the number of students using them, and the frequency of use.

Reference Materials	No. of Students	Frequency of Use
Catalogue items (specify):		
________	________	________
________	________	________
________	________	________
Books (specify):		
________	________	________
________	________	________
________	________	________
________	________	________
Other materials (specify):		
________	________	________
________	________	________

4(b). List the reference materials used by <u>yourself</u> and the frequency of use.

Reference Materials	Frequency of Use
Catalogue items (specify):	
______________________	______________________
______________________	______________________
______________________	______________________
Books (specify):	
______________________	______________________
______________________	______________________
______________________	______________________
______________________	______________________
______________________	______________________
Other Materials (specify):	
______________________	______________________
______________________	______________________

5. What percent of your teaching time do you spend instructing computer courses?

__________%

6. What teaching certification do you have? ______________________

7. What degrees do you hold? ______________________

8. List any courses you have taken in computing science ______________________

____

9. What background experience have you had with computers?

____

____

10. Complete the following table for the students in your course.

	Number of Years of Computer Experience						
	0	1	2	3	4	5 or more	Total
Grade 8							
Grade 9							
Grade 10							
Grade 11							
Grade 12							
Other (e.g. Occup.)							
Total							

11. List any general characteristics that apply to the students in your computer course (e.g., motivation, scholastic aptitude). ______________________

____

12. What percent of your teaching time do you spend working with:

a) individuals ______%
b) small groups ______%
c) the entire class ______%

Total = 100 %

13. What is the frequency of instruction in this course?

__________periods (of ______ minutes each) in a cycle of ______days.

14. What procedures do you use to evaluate student achievement? __________

____

____

____

15. In which of the following subject areas are the problems on which your students are working? (Rank in order of frequency only those that apply.)

En_____ SS_____ Gu_____ Hi_____ Law_____ Ec_____ Ma_____

Sc_____ Bio_____ Ch_____ Ph_____ Co_____ Mu_____ Games_____

Surveys_____ Others (specify)______________________________

16. How many times during the year have the following class activities been provided? Approximately how many students have participated? Include any additional enrichment activities not listed.

Activity	Number of Times	Number of Students
(a) audio-visual presentation		
(b) newspaper clippings		
(c) magazine articles		
(d) research assignments		
(e) field trips (specify locations) ________________		
(f) ________________		
(g) ________________		

17. List what you consider to be the strengths and weaknesses of the computer-based instructional program in your school and make any suggestions you might have for its improvement and extension.

(a) Strengths	(b) Weaknesses

(c) Suggestions for improvement and extension

____

____

____

18. To indicate the range of difficulty of the topics on which your students are working, kindly include a sample printout of an easy, an average, and a difficult problem.

APPENDIX B

STUDENT QUESTIONNAIRE REGARDING COMPUTER-BASED INSTRUCTION

Grade______ School____________________ Computer Course_______ Date____________

Student Questionnaire Regarding Computer-Based Instruction

1. In respect to difficulty, how did you find the computer course? (Check one)

   ______(A) easier than I had expected

   ______(B) harder than I had expected

   ______(C) about the same as I had expected

2. The work load involved in the computer course was: (Check one)

   ______(A) heavier than I had anticipated.

   ______(B) lighter than I had anticipated.

   ______(C) about the same as I had anticipated.

3. The course itself was: (check one)

   ______(A) highly interesting.

   ______(B) fairly interesting.

   ______(C) not interesting.

4. How many hours per week did you spend (outside of class time)

   ______(A) on required work for the computer course?

   ______(B) on computer work for your own interest and/or enjoyment?

5. On the average, did you spend more or less time outside of class on the computer course than on other courses? (Check one)

   ______(A) more

   ______(B) less

   ______(C) about the same

6. If you spent more time, what accounted for the extra time?

_____ (A) heavy work load

_____ (B) interest in the course

_____ (C) other (specify) ______________________________

7. Have you had sufficient opportunities to get help from your teacher? (Check one and comment if necessary)

_____ (A) Yes

_____ (B) No Comment ______________________________

8. Rank the following according to their importance as sources of help in the computer course. (i.e., Insert "1" for the source that helped you the most, "2" for the second most important source of help, etc.) Any additional sources of help you consider important but are not listed, may be entered beside "Other" and ranked accordingly.

_____ other students

_____ teachers

_____ reference material

_____ other ______________________________

_____ computer error messages

9. Did you write programs for other courses

(A) as assignments from teachers ? (Check one)

_____ Yes Name the courses ______________________________

_____ No

(B) on your own initiative? (Check one)

_____ Yes Name the courses ______________________________

_____ No

Comment, if necessary ______________________________

10. Have the thinking processes that you have developed in the computer course helped you in any other courses?

____

What courses? ___________________________________

How? ____

11. Please list what you consider to be the strengths and/or weaknesses of the computer course. In addition list any suggestions you might have to improve the course.

Strengths

1. ____

2. ____

3. ____

4. ____

5. ____

Weaknesses

1. ____

2. ____

3. ____

4. ____

5. ____

Suggestions for improvement

1. ____

2. ____

3. ____

4. ____

5. ____

12. The use of computers is increasing.

    (a) How is this good for people?

    ____

    ____

    (b) How is this bad for people?

    ____

    ____

13. How will this course help you in the future?

    ____

    ____

14. Do you plan to pursue a career in the computer field?

    _____ (A) Yes

    _____ (B) No

    _____ (C) Undecided

15. On your last report card, what was your letter grade standing in the computer course? ____________________

APPENDIX C

PROBLEM SET (GRADES 9-12)

APPENDIX C

COMPUTER SCIENCE (Grades 9-12)

Date:____________________ Name:__________________________

School:__________________________

Grade:__________________________

INSTRUCTIONS:

1. You have one class period to answer ONE of the following problems. Be sure that you read over all questions before you make your choice.

2. If your problem does not work on the first run, you may correct it and re-run it as many times as you wish as long as you hand in a printout for every run you make.

3. Your program control cards should be labelled like this:

   SCRATCH your teacher's name..your school

   LIST

   RUN..your name your grade

NOTE: Remember that you are to answer only ONE problem.

RECORD OF COMPUTER RUNS

Run No.	Date	Reason for re-run
1		
2		
3		
4		
5		
6		
7		
8		

PROBLEM 1:

Temperatures can be measured on both the Fahrenheit and Celsius (Centigrade) temperature scales. When Fahrenheit temperatures (F) are given, the equivalent Celsius temperatures (C) can be calculated using this formula:

$$C = \frac{5}{9} \times (F - 32)$$

Mercury is liquid at room temperature. It has a freezing point of -38.87° C and a boiling point of 356.58° C. This means that mercury will be:

a) in a solid state for Celsius temperatures less than -38.87° C.
b) in a liquid state for Celsius temperatures from -38.87° C to 356.58° C.
c) in a gaseous state for Celsius temperatures higher than 356.58° C.

Write a program that will:

a) Print the title TEMPERATURES AND STATES OF MERCURY
b) Print column titles FAHRENHEIT TEMPERATURE   CELSIUS TEMPERATURE   STATE OF MERCURY
c) Read the Fahrenheit temperature (F) of a mercury sample.
d) Calculate the equivalent Celsius temperature (C) of the mercury sample.
e) Determine whether the sample is in a solid, liquid or gaseous state.
f) Print under appropriate column titles, values for F, C and one of the comments: SOLID, LIQUID or GAS.

Use these values of F as data for your program:

32, -40, 0, 1.65E6, 911, -2.25, 455, -66, 763, -25, 1111

Include enough additional data to prevent the computer from printing the out of data error (ERROR 56) at the end of your printout.

Some of your printout should look like this:

```
 RUN ..YOUR NAME   CLASS

TEMPERATURES AND STATES OF MERCURY

FAHRENHEIT     CELSIUS        STATE OF
TEMPERATURE    TEMPERATURE    MERCURY

 32             0             LIQUID
-40            -40            SOLID
```

Write out your program listing (including SCRATCH, LIST and RUN commands) on the BASIC coding form provided.

Code your program on cards and submit it for running on the computer.

PROBLEM 2:

The standard pay rate at the ABC Repair Company is $4.30 per hour up to and including 40 hours per week. The overtime pay rate is time and one half the standard rate (1.5 times $4.30) for all hours worked in excess of 40 per week. Gross pay (G) is calculated by adding the standard pay to the overtime pay. A deduction (D) of 20% (use .20) of gross pay is made for taxes. Net pay (N) is calculated by subtracting the deductions from the gross pay.

Write a program that will:

a) Print out the title ABC REPAIR COMPANY PAYROLL
b) Print out the column titles

TIME WORKED	GROSS PAY	DEDUCTIONS	NET PAY
(HOURS)	($)	($)	($)

c) Read the number of hours worked per week (H).
d) Reject any incorrect input data by printing out the hours worked followed by the comment INVALID DATA.
e) Calculate values for gross pay (G), deductions (D) and net pay (N) for each value of H.
f) Print under their appropriate column titles, values for H, G, D and N.

Use these values of H as data for your program:

40, -2, 48, 15.5, 0, 41.5, 54, 40.5, -3.5, 44

Include enough additional data to prevent the computer from printing the out of data error (ERROR 56) at the end of your printout.

Some of your printout may look like this:

```
RUN ..YOUR NAME   GRADE

ABC REPAIR COMPANY PAYROLL

TIME WORKED    GROSS PAY     DEDUCTIONS    NET PAY
(HOURS)        ($)           ($)           ($)

 40             172           34.4          137.6
-2             INVALID DATA
```

Write out your program listing (including SCRATCH, LIST and RUN commands) on the BASIC coding form provided.

Code your program on cards and submit it for running on the computer.

PROBLEM 3:

Write a program that will read in a number, X, and then print out values for X, 4-X, $\sqrt{X}$ and 1/X under these column titles:

X   4-X   X↑.5   1/X

Include checks for undefined answers. (Hint: These may occur for $\sqrt{X}$ and 1/X). If an undefined answer is found, have the computer print the message UNDEFINED under the appropriate column title.

Write a program that will:

a) Print the main title PROPERTIES OF X.
b) Print the column titles X 4-X X↑.5 1/X
c) Read a value of X.
d) Identify any values of X that will cause one or more of the expressions 4-X, X↑.5 or 1/X to be undefined.
e) Calculate values for 4-X, $\sqrt{X}$ and 1/X.
f) Print, under their appropriate column titles, values for X, 4-X, $\sqrt{X}$ and 1/X or the message UNDEFINED.

Use these values of X as data for your program:

25, -4, 81, -81, 9, -36, 0, 2.25 E6, 1.69 E-8, 64.76, -127.8

Include enough additional data to prevent the computer from printing the out of data error (ERROR 56) at the end of your printout.

Some of your printout may look like this:

```
RUN ..YOUR NAME   GRADE

PROPERTIES OF X

X              4-X            X↑.5           1/X

 25            -21             5.            4.00000E-02
-4              8             UNDEFINED     -.25
```

Write out your program listing (including SCRATCH, LIST and RUN commands) on the BASIC coding form provided.

Code your program on cards and submit it for running on the computer.

APPENDIX D

PROBLEM SET (GRADE 8)

APPENDIX D

COMPUTER SCIENCE (Grade 8)

Date: ____________________

Name: ____________________

School: ____________________

Grade: ____________________

INSTRUCTIONS:

1. You have one class period to answer ONE of the following problems. Be sure that you read over all questions before you make your choice.

2. If your problem does not work on the first run you may correct it and re-run it as many times as you wish as long as you hand in a printout for every run you make.

3. Your program control cards should be labelled like this:

   SCRATCH your teacher's name. . your school

   LIST

   RUN. . your name your grade

NOTE: Remember that you are to answer only ONE problem.

RECORD OF COMPUTER RUNS

Run No.	Date	Reason for re-run
1		
2		
3		
4		
5		
6		
7		
8		

PROBLEM 1:

To decide whether an object will float or sink, one must calculate the DENSITY (D)= mass per unit volume of the object. This is done by taking the MASS (M) in grams (gm) and dividing by the VOLUME (V) in cubic centimenters (cm^3) given by the formula:

$$\text{DENSITY} = \frac{\text{MASS}}{\text{VOLUME}}$$

For this exercise, let us assume that if the density is LARGER than 1 gm/cm^3 it will SINK and if it is LESS THAN or EQUAL to 1 gm/cm^3 it will FLOAT. For example when mass is 5.4 gm and volume is 2 cm^3

$$\text{DENSITY} = \frac{\text{MASS}}{\text{VOLUME}} = \frac{5.4}{2} = 2.7$$

Write a program that will:

a) print column titles - MASS VOLUME DENSITY STATE
b) read the mass (M) and the volume (V)
c) calculate the density (D)
d) test to see if the object will float or sink
e) print under each title the mass (M), volume (V), density (D) and the comment FLOAT or SINK

Using the following DATA:

MASS (M)	VOLUME (V)
5.4	2
2.45	3.5
1.4	1.5
47.88	4.2
24.85	7.1

Some of your printout should look like this:

```
 RUN YOUR NAME     CLASS
MASS           VOLUME          DENSITY         STATE
 5.4            2               2.7            SINKS
 2.45           3.5             .7             FLOATS
```

Write out your program listing (including SCRATCH, LIST and RUN commands) on the BASIC coding form provided.

Code your program on cards and submit it for running on the computer.

PROBLEM 2:

To decide whether a FRACTION (F) is a proper fraction or an improper fraction divide the NUMERATOR = top number (N) by the DENOMINATOR = bottom number (D).

$$\text{FRACTION} = \frac{\text{NUMERATOR}}{\text{DENOMINATOR}}$$

If the answer is LARGER THAN or EQUAL to 1 it is an IMPROPER fraction and if it is LESS than 1 it is a PROPER fraction. For example:
when numerator is 7 and denominator is 2

$$\text{FRACTION} = \frac{\text{NUMERATOR}}{\text{DENOMINATOR}} = \frac{7}{2} = 3.5$$

Write a program that will:

a) print column titles - NUMERATOR DENOMINATOR FRACTION TYPE
b) read the numerator (N) and the denominator (D)
c) calculate the fraction (F) in decimal form
d) test to see if the fraction is proper or improper
e) print under each title the numerator (N), denominator (D), fraction (F) and the comment IMPROPER or PROPER

Using the following DATA:

NUMERATOR (N)	DENOMINATOR (D)
7	2
4	5
9	8
63	64
27	31

Some of your printout should look like this:

```
RUN YOUR NAME     CLASS
NUMERATOR         DENOMINATOR     FRACTION       TYPE
 7                 2               3.5           IMPROPER
 4                 5               .8            PROPER
```

Write out your program listing (including SCRATCH, LIST and RUN commands) on the BASIC coding form provided.

Code your program on cards and submit it for running on the computer.

APPENDIX E

TIC TAC TOE GAME

APPENDIX E

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```
RUN

T I C   T A C   T O E   G A M E .

PURPOSE:  GET 3 X'S IN A LINE BEFORE COMPUTER GETS 3 O'S  .
EACH TIME COMPUTER PRINTS ? MARK, YOU MUST TYPE YOUR ANSWER.

TYPE A NUMBER BETWEEN 1 AND 500.
?36
TYPE NUMBERS 1TO 9 TO ANSWER WHERE YOU PUT EACH X,BELOW:

1 2 3
4 5 6
7 8 9

YOU ARE X, I AM O
YOU GO FIRST.
      YOUR X?3
- - X
- O -
- - -
      YOUR X?9
- - X
- O O
- - X
      YOUR X?4
- O X
X O O
- - X
      YOUR X?8
- O X
X O O
O X X
      YOUR X?1
STALEMATE.  NOBODY WINS.


WOULD YOU LIKE TO PLAY AGAIN? INPUT 1 IF YES, 0 IF NO?1
TYPE NUMBERS 1TO 9 TO ANSWER WHERE YOU PUT EACH X,BELOW:
```

APPENDIX F

LUNAR MODULE GAME

APPENDIX F

RUN
CONTROL CALLING LUNAR MODULE. MANUAL CONTROL IS NECESSARY
YOU MAY RESET FUEL RATE K EACH 10 SECS TO 0 OR ANY VALUE
BETWEEN 8 & 200 LBS/SEC. YOU'VE 16000 LBS FUEL. ESTIMATED
FREE FALL IMPACT TIME-120 SECS. CAPSULE WEIGHT-32500 LBS
FIRST RADAR CHECK COMING UP

COMMENCE LANDING PROCEDURE

TIME,SECS	ALT,MILES+FEET		VELOCITY,MPH	FUEL,LBS	FUEL RATE
0	120	0	3600	16500	K= ?0
10	109	5015.98	3636	16500	K= ?0
20	99	4223.94	3672	16500	K= ?0
30	89	2903.94	3708	16500	K= ?100
40	79	2510.69	3544.6	15500	K= ?0
50	69	3059.19	3580.6	15500	K= ?100
60	59	4580.44	3410.87	14500	K= ?150
70	50	4147.72	3125.48	13000	K= ?0
80	42	283.352	3161.48	13000	K= ?200
90	33	4468.01	2742.56	11000	K= ?200
100	26	4482.8	2289.27	9000	K= ?200
110	21	871.386	1795.99	7000	K= ?200
120	16	4830.28	1255.62	5000	K= ?200
130	14	1274.88	658.919	3000	K= ?185
140	13	1284.79	49.002	1150	K= ?100
150	13	3046.78	-292.948	150	K= ?0
160	14	1799.35	-256.948	150	K= ?10
170	15	309.899	-259.984	50	K= ?200

FUEL OUT AT 170.25 SECS
ON THE MOON AT 437.79 SECS
IMPACT VELOCITY OF 684.452 M.P.H.
FUEL LEFT IS 0 LBS.
SORRY, BUT THERE WERE NO SURVIVORS-YOU BLEW IT! IN FACT
YOU BLASTED A NEW LUNAR CRATER 190.125 FT. DEEP
TRY AGAIN? ANSWER 1 FOR YES, 0 FOR NO. YOUR ANSWER?1
FIRST RADAR CHECK COMING UP

APPENDIX G

CATALOGUE ITEMS

CATALOGUE REFERENCES & AIDS FOR HP COMPUTER USERS April 1, 1973

Educational Basic Language (100's)

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Item #	Description	Per Teacher	One Per Student
101	CARD IMAGES, HP BASIC, full size, on looseleaf size paper, 6 images to a sheet, 3 to a side. Can be used for beginners to practice, as exam answer sheets, preparation of examples, etc.		X
102	ERROR CODES ... EDUCATIONAL BASIC, on looseleaf size paper, printed both sides: Code #'s, with Meanings, and with Probable Causes. Single page.		X
103	EDUCATIONAL BASIC, summary of all Commands, Statements, Operators, Matrices, Card image, and Examples, on single page, both sides		X
104	HOW TO MARK CARDS ... and FUNDAMENTAL USAGE OF BASIC, on single page, looseleaf size paper, both sides. Contains large example of HP card and how to mark coding onto it, together with all the rules of BASIC which refer to cards.		X
105	A GUIDE TO HP EDUCATION BASIC, a 100 page paper back textbook by the computer manufacturer. It has been found to be of little use to the beginning teacher, (even less use to students) but is useful to moderately experienced teachers of computer topics, as a quick memory aid, etc.	1	
106	HOW TO USE ALPHA DATA, is a single looseleaf size page, printed both sides, with code numbers, general rules, and five example programs (regular, Disk, Matrices, use of IF, and "packing"). Can be used with all Vancouver School Board versions of BASIC.		X
107	HOW TO USE CALL (11), CALL (17), & CHOOSE JOB PRIORITY, is a single looseleaf page, containing general rules and example programs, and also containing the times, in milliseconds, required to do each operation, and the limits, under each priority: A, B, C.		X
108	EXAMPLE USES OF THE MATH FUNCTIONS, is a single looseleaf size page, printed both sides, showing how and why to use BASIC's built-in functions.		X
109	HOW TO USE THE PORTABLE TERMINAL, is a single looseleaf size page, with cautions & procedures.	5	
110	PROGRAM DIRECTORY FOR THE PORTABLE TERMINAL, is a several page list and description & request-code number of programs stored on tape at each computer.	1	
111	HOW TO SAVE CORE MEMORY, TO ALLOW BIGGER PROGRAMS, is a few pages of rules and examples, which assumes familiarity with the coding techniques involved.		X

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Disk Basic Language (200's)

Item #	Description	per Teacher	One per Student
201	DISK single page, looseleaf size paper, both sides. Is a summary of all the CALL's possible, file sizes, error Code #'s, Meanings, and Probable Causes		X
202	DISK FILES FOR ED. BASIC (SIMULATED), is a dozen paged pamphlet textbook by Mr. W. Dodds, VSB. Contains example coding, purposes, and detailed rules of all the features of Disk File Basic software, as developed by Mr. W. Dodds for VSB.	10	

Business Basic Language (300's)

Item #	Description	per Teacher	One per Student
301	HOW TO USE 'BUSINESS' BASIC, is a 5 page summary of all the differences and extras, with rules & examples. Character data, format, card files. (Assumes user already knows regular BASIC).	20	

Teacher Aids, General (400's)

Item #	Description	per Teacher	One per Student
401	CODING SHEETS, on single page, looseleaf size. Is an aid to students to organize their work, by coding statement #'s and body under the appropriate columns, title their program, etc. Can easily be run off by each school for own use.	1	
402	MOVIES ON DATA PROCESSING, is a two dozen paged booklet combining the lists of free movies loaned by several companies (4 or 5 month lead time).	1	
403	REFERENCE TEXTS FOR TEACHERS is a looseleaf page list of titles, authors, and publishers; and usefulness in Vancouver's setting is indicated, where possible. Purchase cost of these books is each school's responsibility, unless specially arranged otherwise.	1	
404	HOW TO MARK & SUBMIT DATA & RUN CARDS FOR UTILITY AND SIMULATION PROGRAMS IN BASIC, is a 3 page explanation, with large pictures of the BASIC card, intended for non-programmers, etc.	30	
405	ED. BASIC OVERHEAD TRANSPARENCY OF CARD, greatly enlarged, for use with overhead projectors.	1	
406	TEST & SURVEY CARD OVERHEAD TRANSPARENCY (large) for explaining how to mark multiple-choice card.	1	
407	TEST SCORER PROGRAM, TEACHER'S INSTRUCTIONS, explains how to use the multiple-choice test scoring service, via computer pickup/delivery.	1	

Item #	Description		
408	SURVEY ANALYSIS PROGRAM, TEACHER'S INSTRUCTIONS, explains how to use multiple-choice survey analysis service, via computer pickup/delivery.	1	
409	TEACHERS' GUIDE TO CURRICULUM COMPUTER SERVICES, explains how your students can use VSB computers.	1	

Computer Course (#500's)

Item #	Description		
501	COMPUTER APPLICATIONS, is a course topic outline prepared by Mr. Dodds, as an introductory, survey type of course for credit, aimed at grade 11, but easily modified for other grade levels. It is submitted once yearly to Victoria Dept of Ed for request to offer as a credit course, experiment. There is a 20 page teacher's guide which doubles as student reference, plus a 9 page set of questions plus a 5 page set of answers, plus other reference materials.	5 5 1	1

Commerce Via Computers (#600's)

601	COMPUTERS FOR COMMERCE, INTRODUCTORY UNIT, is a 10 lesson, detailed, 21 pages set of lesson plans exercises, solutions, suitable for beginners, by Mr. Dodds.	5	

Math Via Computers (#700's)

701	COMPUTERS FOR MATH, is a 10 lesson introduction by Mr. Dodds. A detailed, 19 page set of lesson plans, exercises, solutions. Suitable for beginners, Grades 8 to 12 Math Courses.	1	

Science Via Computers (800's)

801	HOW TO USE POINT GRAPH PLOTTER (BATCH RUN VERSION) explains how to use this program which is already written and tested and works. It can plot and do graph analysis on whole class, for each student.	15	
802	SCIENCE 9 HORSEPOWER EXPERIMENT CALCULATIONS, explains how each student can use a program which is already written, to do or check his calcs.	30	
803	SCIENCE 10 UNIT VI, SIMULATION OF EXPERIMENT 3, explains how to use this program which is already written. Also example of how to simulate, in general.	15	

* * * *	MATH, SCIENCE, COMMERCE, SOCIAL STUDIES: -Also phone Mr. Dodds (731-1131 local 260 or 273) regarding many textbooks and other professionally published materials, which are available to you.	1	

APPENDIX H

EXAMPLES OF COMPUTER PROGRAMS WRITTEN BY STUDENTS

Examples of Computer Programs Written by Students

a 1.

```
 SCRATCH DEBBIE JOYCE BLOCK D#1
JAN 17/73--A

5  FOR X=1 TO 6
10  PRINT "DEBBIE JOYCE"
15  PRINT "1036 EAST 20TH AVE."
20  PRINT "874-3641"
25  PRINT
30  PRINT
35  NEXT X
9999  END

 RUN
DEBBIE JOYCE
1036 EAST 20TH AVE.
874-3641


DEBBIE JOYCE
1036 EAST 20TH AVE.
874-3641


DEBBIE JOYCE
1036 EAST 20TH AVE.
874-3641


DEBBIE JOYCE
1036 EAST 20TH AVE.
874-3641


DEBBIE JOYCE
1036 EAST 20TH AVE.
874-3641


DEBBIE JOYCE
1036 EAST 20TH AVE.
874-3641
```

a 2.
```
SCRATCH A M J MAGEE CLEMENS
SEPT 27/72-A

10  PRINT "CIRCLE MEASUREMENTS"
20  PRINT
30  PRINT "RADIUS","CIRC","AREA"
40  READ R
50  DATA 0,1,2,3.14159,4,5,6,7,8,9,100,200,314.159,10000,31415.9
60  LET P=3.14159
70  PRINT R,2*P*R,P*R↑2
80  GOTO 40
9999  END

 RUN
CIRCLE MEASUREMENTS

RADIUS          CIRC            AREA
 0               0               0
 1               6.28318         3.14159
 2               12.5664         12.5664
 3.14159         19.7392         31.0062
 4               25.1327         50.2654
 5               31.4159         78.5397
 6               37.6991         113.097
 7               43.9823         153.938
 8               50.2654         201.062
 9               56.5486         254.469
 100             628.318         31415.9
 200             1256.64         125664.
 314.159         1973.92         310062.
 10000           62831.8         3.14159E+08
 31415.9         197392.         3.10062E+09
ERROR 56 IN LINE  40
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a 3.
```
SCRATCH WINDERMERE PETRAK
NOV 24/72 -6

10  REM DOROTHY GIROUX 11A
20  CALL (11)
30  LET Z=9.00000E+37
40  READ A,B,C,D,E,F,G,H,I,J,K,L,M,N,O,P,Q,R,S,T,U,V,W,X,Y
50  IF A=0 THEN 999
60  DATA 1,2,3,4,5,6,8,9,11,12,13
70  DATA 14,15,16,18,19,20,21,22
80  DATA 23,25,-20,-18,-1,0,0,0,0,0,0
90  DATA 0,0,0,0,0,0,0,0,0,0,0,0,0,0,0
95  DATA 0,0,0,0
100  PRINT Z,T;G;U;Y;P;G;M;R;J;D;Y;T;E
110  PRINT Z,B;E;Y;H;L;Y;P;R;C;G
120  PRINT Z,D;E;P;N;E;O;A;Q;E;Y;G;A;P;Q;E;Y;Q;M;Y;P;R;C;C;E;E;D;V
130  PRINT Z,A;L;D;Y;H;L;0;P;R;C;G
140  PRINT Z,D;E;P;N;E;U;A;Q;E;Y;E;L;Q;E;O;N;O;H;P;E;P;X
150  PRINT Z,H;F;Y;A;Y;K;A;L;Y;D;M;E;P;Y;L;M;Q;Y;I;E;E;N;Y;N;A;C;E
160  PRINT Z,T;H;Q;G;Y;G;H;P;Y;C;M;K;N;A;L;H;M;L;P;V
170  PRINT Z,N;E;O;G;A;N;P;Y;H;Q;Y;H;P;Y;B;E;C;A;R;P;E
180  PRINT Z,G;E;Y;G;E;A;O;P
190  PRINT Z,A;Y;D;H;F;F;E;O;E;L;Q;Y;D;O;R;K;K;E;O;W
200  PRINT
210  PRINT Z,J;E;Q;Y;G;H;K;Y;P;Q;E;N;Y;Q;M
220  PRINT Z,Q;G;E;Y;K;R;P;H;C;Y;G;E;Y;G;E;A;O;P;V
230  PRINT Z,G;M;T;E;S;E;O;Y;K;E;A;P;R;O;E;D
240  PRINT Z,M;O;Y;F;A;O;Y;A;T;A;U;W
999  END

RUN GIROUX DOROTHY
```

```
WHY SHOULD WE
BE IN SUCH
DESPERATE HASTE TO SUCCEED,
AND IN SUCH
DESPERATE ENTERPRISES?
IF A MAN DOES NOT KEEP PACE
WITH HIS COMPANIONS,
PERHAPS IT IS BECAUSE
HE HEARS
A DIFFERENT DRUMMER.

LET HIM STEP TO
THE MUSIC HE HEARS,
HOWEVER MEASURED
OR FAR AWAY.
```

b 1.
```
SCRATCH....CRAVEN
JAN5/73   -B

10    REM JOB 4
20    PRINT "STUDENTS", "PROBABILITY", "PERCENT"
25    LET F=1
30    READ N
50    FOR I=365 TO (366-N) STEP -1
60    LET F=F*(1/365)
70    NEXT I
80    LET P=1-F
90    PRINT N, P, P*100
120   IF N=1 THEN 9999
130   LET F=F/((366-N)/365)
135   LET N=N-1
140   GOTO 80
5555  DATA 75
9999  END

RUN....KEN ROBERTSON
```

STUDENTS	PROBABILITY	PERCENT
75	.99972	99 972
74	.999649	99.9649
73	.999561	99.9561
72	.999453	99.9453
71	.999321	99.9321
70	.99916	99.916
69	.998964	99.8964
68	.998726	99.8726
67	.99844	99.844
66	.998096	99.8096
65	.997683	99.7683
64	.99719	99.7191
63	.996604	99.6604
62	.99591	99.591
61	.995089	99.5089
60	.994123	99.4123
59	.992989	99.2989
58	.991665	99.1665
57	.990122	99.0122
56	.988332	98.8332
55	.986262	98.6262
54	.983877	98.3877
53	.981138	98.1138
52	.978005	97.8005
51	.974432	97.4432
50	.970374	97.0374

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.
.

b 1.

STUDENTS	PROBABILITY	PERCENT
10	.116948	11.6948
9	9.46242E-02	9.46242
8	7.43356E-02	7.43356
7	5.62360E-02	5.6236
6	4.04629E-02	4.04629
5	2.71360E-02	2.7136
4	1.63563E-02	1.63563
3	8.20470E-03	.82047
2	2.74026E-03	.274026
1	5.96046E-07	5.96046E-05

b 2.

```
SCHAICH WINDERMERE PETRAK
OCT 17/72 -D

10  CALL (11)
20  PRINT TAB(28)"HOURGLASS SHAPE"
30  PRINT TAB(28)"@@@@@@@@@@@@@@@"
40  PRINT
50  READ A,B,C,N
60  DATA 5,0,-1,35,0,5,1,35,-9,0,0,0
62  DATA 9,0,-1,25,0,9,1,25,-9,0,0,0
63  DATA 17,0,-1,50,0,17,1,50,99,0,0,0
65  IF A=-9 THEN 10
70  IF A=99 THEN 1000
80  FOR X=A TO B STEP C
90  LET Z=(N+X)-(N-X)
100  PRINT TAB(N-X);
110  FOR Y=0 TO Z
120  PRINT "X";
130  NEXT Y
135  PRINT
140  NEXT X
150  GOTO 50
1000  END

 RUN P.DAYKIN 9E RM.121
```

```
HOURGLASS SHAPE
@@@@@@@@@@@@@@@

XXXXXXXXXXX
 XXXXXXXXX
  XXXXXXX
   XXXXX
    XXX
     X
     X
    XXX
   XXXXX
  XXXXXXX
 XXXXXXXXX
XXXXXXXXXXX
```

```
b 3.  SCRATCH L. SIMPSON BLK. D
    NOV. 21/72 H

    2  CALL (11)
    5  LET I=9.00000E+37
    7  CALL (55,1)
    10  READ A,B,C
    15  IF A=0 THEN 9999
    17  CALL (9,1,1,R,S,T,U,V,W,X,Y,Z)
    20  IF A>R THEN 17
    25  IF A=R THEN 45
    30  PRINT "NO SUCH EMPLOYEE # AS"A
    33  PRINT
    40  GOTO 7
    45  LET P=INT((B*Z+C*Z*1.5-Y)*100+.5)/100
    50  FOR A=1 TO 12
    55  PRINT "******";
    60  NEXT A
    65  PRINT
    70  PRINT TAB(7);"ACME ROAD-RUNNER ROAD GLUE CO., LTD."
    75  PRINT TAB(42);"NOV. 21/72"
    80  PRINT
    85  PRINT TAB(14);"PAY $"P
    90  PRINT
    95  PRINT
    100  PRINT TAB(14);"TO "I;S;0;T;U;V;W;X;I
    105  PRINT
    110  PRINT
    115  PRINT TAB(6);"ACME BANK"
    120  PRINT TAB(6);"COYOTEVILLE NEVADA"
    125  PRINT
    130  FOR A=1 TO 12
    135  PRINT "******";
    140  NEXT A
    150  PRINT
    155  PRINT
    160  GOTO 10
    165  DATA 1436,40,3
    170  DATA 2894,40,0
    175  DATA 3025,21,0
    180  DATA 3257,40,6
    9998  DATA 0,0,0
    9999  END

     RUN
  ************************************************************************
        ACME ROAD-RUNNER ROAD GLUE CO., LTD.
                                         NOV. 21/72

              PAY $ 102.05


              TO N VLAZY


        ACME BANK
        COYOTEVILLE NEVADA

  ************************************************************************
  NO SUCH EMPLOYEE # AS 3025
```

c 1. SCRATCH ELWIN WITZKE 9G BLK. **BEST COPY AVAILABLE**

RUN 1000

DATE	PARTICULARS	WITHDRAWL	DEPOSIT	BALANCE
JULY 21	BRIAN + MITH	.00	5.50	5.50
JULY 24	SAT. COLLECTING	.00	51.00	56.50
JULY 26	COLLECTING	.00	23.00	79.50
JULY 27	COLLECTING	.00	19.00	98.50
JULY 31	BILL FOR JULY	95.00	.00	3.50
AUG. 23	BIKE REGISTR	1.00	.00	2.50
AUG. 24	S.C. @ .14	.14	.00	2.36
SEPT. 1	DEPOSIT	.00	97.00	99.36
SEPT. 5	DEPOSIT	.00	9.00	108.36
SEPT. 5	BILL FOR AUG.	87.32	.00	21.04
SEPT.	S.C. .14@	.28	.00	20.76
OCT. 2	DEPOSIT	.00	78.00	98.76
OCT. 4	DEPOSIT	.00	18.00	116.76
OCT. 5	BILL FOR SEPT.	100.22	.00	16.54
OCT. 17	S.C. @ .14	.14	.00	16.40
OCT. 19	CASH	14.00	.00	2.40
NOV. 8	DEPOSIT	.00	103.00	105.40
NOV. 8	BILL FOR OCT.	100.75	.00	4.65
NOV. 17	CANUCK YEARBOOK	1.10	.00	3.55
NOV. 17	S.C. @ .14	.28	.00	3.27
DEC. 1	DEPOSIT	.00	91.00	94.27
DEC. 5	BILL FOR NOV.	85.93	.00	8.34

```
READY
1  FRMT (7,2)
5  LET B=0
10  PRINT "DATE","PARTICULARS","WITHDRAWL","DEPOSIT","BALANCE"
15  FOR X=1 TO 2
20  PRINT
30  NEXT X
50  READ $D,$P,W,D
60  LET B=B+D-W
70  PRINT $D,$P,W :F 1,D :F 1,B :F 1
80  GOTO 50
900  DATA "JULY 21","BRIAN + MITH",0,550
910  DATA "JULY 24","SAT. COLLECTING",0,5100
920  DATA "JULY 26","COLLECTING",0,2300
930  DATA "JULY 27","COLLECTING",0,1900
940  DATA "JULY 31","BILL FOR JULY",9500,0
950  DATA "AUG. 23","BIKE REGISTR",100,0
960  DATA "AUG. 24","S.C.  @ .14",14,0
970  DATA "SEPT. 1","DEPOSIT",0,9700
980  DATA "SEPT. 5","DEPOSIT",0,900
990  DATA "SEPT. 5","BILL FOR AUG.",8732,0
1000  DATA "SEPT.","S.C.  .14@",28,0
1010  DATA "OCT. 2","DEPOSIT",0,7800
1020  DATA "OCT. 4","DEPOSIT",0,1800
1030  DATA "OCT. 5","BILL FOR SEPT.",10022,0
1035  DATA "OCT. 17","S.C.  @ .14",14,0
1040  DATA "OCT. 19","CASH",1400,0
1050  DATA "NOV. 8","DEPOSIT",0,10300
1060  DATA "NOV. 8","BILL FOR OCT.",10075,0
1070  DATA "NOV. 17","CANUCK YEARBOOK",110,0
1080  DATA "NOV. 17","S.C.  @ .14",28,0
1090  DATA "DEC. 1","DEPOSIT",0,9100
1200  DATA "DEC. 5","BILL FOR NOV.",8593,0
9999  END
```

c 2.

```
SCRATCH MR, OLSEN  KITS****
          -C

1  DATA 10,20,5,50
5  LET W=0
10  LET R=10
20  READ B
30  LET A=R/B
40  LET X=.5*A
50  LET Y=SQR(R↑2-X↑2)
60  LET D=A
65  IF (R↑2)-(X↑2)-(Y↑2) <= 0 THEN 90
70  LET Z=SQR(R↑2-X↑2-Y↑2)
80  LET T=Z*A*D
85  LET W=W+T
90  LET Y=Y-D
100  IF Y <= 0 THEN 120
110  GOTO 70
120  LET X=X+A
130  IF X >= R THEN 145
140  GOTO 50
145  LET W=W*8
150  PRINT "AREA="W,"#STRIPS="B
155  IF B#0 THEN 5
9999  END

 RUN D.L.J.
AREA= 4041.59                    #STRIPS= 10
AREA= 4139.37                    #STRIPS= 20
AREA= 3867.88                    #STRIPS= 5
AREA= 4181.1                     #STRIPS= 50
ERROR 56 IN LINE  20
```

c 3. SCRATCH
JAN 9/73 -C


```
10  REM MAJOR PROGRAM #1
15  REM  IN THIS PROGRAM AIR FRICTION IS ENTIRELY NEGLECTED
20  CALL (11)
40  PRINT TAB(25)"FALLING BODIES"
50  PRINT TAB(72);TAB(72)
70  PRINT "ILLUSTRATING THE HEIGHT,VELOCITY,ACCELERATION,AND TIME ";
80  PRINT "OF A FREELY"
90  PRINT "FALLING OBJECT AT THE END OF EACH OF THE FIRST 5 SECONDS"
100  PRINT
120  PRINT "HEIGHT"TAB(29)"TIME"TAB(41)"VELOCITY"TAB(57);
130  PRINT "ACCELERATION"
140  PRINT
150  PRINT "0 FEET"TAB(19)"*"TAB(29)"0 SEC"TAB(41)"0 FT/SEC";
160  PRINT TAB(57)"0 FT/SEC↑2"
170  FOR T=1 TO 5
180  LET G=32
190  LET Y=-.5*G*T↑2
200  LET V=-G*T
210  LET A=-32
220  FOR Z=1 TO -Y/10
230  PRINT
240  NEXT Z
250  PRINT Y"FEET"TAB(19)"*"TAB(28);T"SEC"TAB(41);V"FT/SEC";
260  PRINT TAB(57);A"FT/SEC↑2"
270  NEXT T
290  CALL (11)
310  PRINT "RELATIONS BETWEEN HEIGHT,VELOCITY,ACCELERATION,AND TIME ";
320  PRINT "FOR AN OBJECT"
330  PRINT "EXPERIENCING FREE FALL"
340  PRINT
350  PRINT TAB(2)"TIME"TAB(18)"HEIGHT"TAB(36)"VELOCITY";
355  PRINT TAB(55)"ACCELERATION"
360  FOR T=6 TO 60
363  LET Y=-.5*G*T↑2
367  LET V=-G*T
370  IF T=60 THEN 400
380  PRINT T"SEC"TAB(18);Y"FT"TAB(36);V"FT/SEC"TAB(56);A"FT/SEC↑2"
390  NEXT T
400  PRINT TAB(2)"1 MINUTE"TAB(18);Y"FT"TAB(36);V"FT/SEC"TAB(56);
405  PRINT A"FT/SEC↑2"
420  CALL (11)
440  PRINT TAB(5)"DROPPING A SUPER BALL OFF THE EMPIRE STATE BUILDING ";
445  PRINT "1472 FT"
447  LET G=32
450  LET H1=1472
460  LET V1=SQR(2*G*H1)
470  LET V8=0
480  LET T1=(V1-V8)/G
490  PRINT
500  PRINT "THE SUPER BALL TOOK"T1"SECONDS TO FALL TO THE GROUND FROM"
505  PRINT "THE TOP OF THE EMPIRE STATE BUILDING"
510  PRINT "THE VELOCITY OF THE SUPER BALL JUST BEFORE IT HIT THE ";
515  PRINT "GROUND WAS"
530  PRINT V1"FT/SEC"
540  LET R1=.94
550  LET V9=R1*V1
```

```
560  LET V2=0
570  LET Y2=H1*R1↑2
580  LET T2=(V9-V2)/G
590  PRINT "THE SUPER BALL BOUNCED AND ROSE TO THE HEIGHT OF"Y2"FEET ON"
595  PRINT "THE FIRST BOUNCE"
600  PRINT "THE SUPER BALL TOOK"T2"SECONDS TO RISE"
610  LET N=B=S=J=0
620  LET N=N+1
630  LET H9=H1*R1↑(2*N)
640  IF H9>1.00000E-03 THEN 620
650  PRINT "THE SUPER BALL BOUNCED"N"TIMES"
660  FOR M=1 TO 5
670  PRINT
680  NEXT M
690  PRINT "DROPPING THE SUPER BALL AND BALLS OF DIFFERENT ";
700  PRINT "SUBSTANCES OFF THE EMPIRE"
710  PRINT "STATE BUILDING AND OTHER BUILDINGS"
720  PRINT
725  PRINT
730  PRINT TAB(19)"EMPIRE STATE BUILDING  1472 FT"
740  PRINT
745  PRINT
750  PRINT "TYPE OF    NUMBER OF   TIME TO     VELOCITY     BOUNCED ";
755  LET P=0
760  PRINT "TO   TIME IT"
770  PRINT "BALL       BOUNCES     FALL TO THE  JUST BEFORE   THE";
780  PRINT " HEIGHT   TOOK TO"
790  PRINT TAB(23)"GROUND"TAB(36)"IT HIT"TAB(50)"OF"TAB(63)"RISE"
792  PRINT TAB(25)"*SEC*"TAB(37)"*FT/SEC*"TAB(52)"*FT*"TAB(64)"*SEC*"
794  PRINT
795  LET J=J+1
800  IF J<2 THEN 810
805  RESTORE
810  READ R2
815  IF R2=111 THEN 9999
820  IF S=1 THEN 880
830  IF S=2 THEN 900
840  IF S=3 THEN 920
850  IF S=4 THEN 940
860  LET H3=1472
870  GOTO 950
880  LET H3=1056
890  GOTO 950
900  LET H3=607
910  GOTO 950
920  LET H3=410
930  GOTO 950
940  LET H3=184.5
950  LET V5=SQR(2*G*H3)
960  LET V3=R2*V5
970  LET V7=0
975  LET T5=(V7-V5)/G
980  LET Y3=H3*R2↑2
990  LET T3=(V3-V2)/G
1000  LET N2=0
1010  LET N2=N2+1
1020  LET H7=H3*R2↑(2*N2)
1030  IF H7>1.00000E-03 THEN 1010
1040  LET P=P+1
1045  IF P=1 THEN 1170
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```
1050  IF P=2 THEN 1190
1060  IF P=3 THEN 1210
1070  IF P=4 THEN 1230
1080  IF P=5 THEN 1250
1090  IF P=6 THEN 1270
1100  IF P=7 THEN 1290
1110  IF P=8 THEN 1310
1120  IF P=9 THEN 1330
1130  IF P=10 THEN 1350
1135  IF P=11 THEN 1370
1140  PRINT TAB(11);N2;TAB(23);-T5;TAB(36);V5;TAB(50);Y3;TAB(63);T3
1160  GOTO 810
1170  PRINT "SUPER";
1180  GOTO 1140
1190  PRINT "GLASS";
1200  GOTO 1140
1210  PRINT "STEEL";
1220  GOTO 1140
1230  PRINT "CLAY";
1240  GOTO 1140
1250  PRINT "IVORY";
1260  GOTO 1140
1270  PRINT "IRON";
1280  GOTO 1140
1290  PRINT "MAPLE";
1300  GOTO 1140
1310  PRINT "CORK";
1320  GOTO 1140
1330  PRINT "COPPER";
1340  GOTO 1140
1350  PRINT "LEAD";
1360  GOTO 1140
1370  FOR L=1 TO 5
1380  PRINT
1390  NEXT L
1400  LET B=B+1
1410  IF B<2 THEN 1420
1415  RETURN
1420  PRINT TAB(25)"EIFFEL TOWER  1056 FT"
1430  LET S=1
1440  GOSUB 740
1480  PRINT TAB(26)"SPACE NEEDLE  607 FT"
1490  LET S=2
1500  GOSUB 740
1540  PRINT TAB(22)"TORONTO DOMINION TOWER  410 FT"
1550  LET S=3
1560  GOSUB 740
1600  PRINT TAB(20)"LEANING TOWER OF PISA  184.5 FT"
1610  LET S=4
1620  GOSUB 740
1630  DATA .94,.97,.95,.93,.8,.7,.66,.6,.14,2.00000E-02,0,111
1740  REM THE RESILENCE FACTORS ARE: GLASS.97;STEEL.95;SUPER BALL.94
1750  REM CLAY.93;IVORY.80;IRON.70;MAPLE.66;CORK.60;COPPER.14;LEAD.02
9999  END

 RUN BRIAN ROACH 10C
```

FALLING BODIES

ILLUSTRATING THE HEIGHT,VELOCITY,ACCELERATION,AND TIME OF A FREELY FALLING OBJECT AT THE END OF EACH OF THE FIRST 5 SECONDS

HEIGHT		TIME	VELOCITY	ACCELERATION
0 FEET	*	0 SEC	0 FT/SEC	0 FT/SEC↑2
-16 FEET	*	1 SEC	-32 FT/SEC	-32 FT/SEC↑2
-64 FEET	*	2 SEC	-64 FT/SEC	-32 FT/SEC↑2
-144 FEET	*	3 SEC	-96 FT/SEC	-32 FT/SEC↑2
[illegible]56 FEET	*	4 SEC	-128 FT/SEC	-32 FT/SEC↑2

=400 FEET * 5 SEC =160 FT/SEC =32 FT/SEC↑2

RELATIONS BETWEEN HEIGHT,VELOCITY,ACCELERATION,AND TIME FOR AN OBJECT EXPERIENCING FREE FALL

TIME	HEIGHT	VELOCITY	ACCELERATION
6 SEC	-576 FT	-192 FT/SEC	-32 FT/SEC↑2
7 SEC	-784 FT	-224 FT/SEC	-32 FT/SEC↑2
8 SEC	-1024 FT	-256 FT/SEC	-32 FT/SEC↑2
9 SEC	-1296 FT	-288 FT/SEC	-32 FT/SEC↑2
10 SEC	-1600 FT	-320 FT/SEC	-32 FT/SEC↑2
11 SEC	-1936 FT	-352 FT/SEC	-32 FT/SEC↑2
12 SEC	-2304 FT	-384 FT/SEC	-32 FT/SEC↑2
13 SEC	-2704 FT	-416 FT/SEC	-32 FT/SEC↑2
14 SEC	-3136 FT	-448 FT/SEC	-32 FT/SEC↑2
15 SEC	-3600 FT	-480 FT/SEC	-32 FT/SEC↑2
16 SEC	-4096 FT	-512 FT/SEC	-32 FT/SEC↑2
17 SEC	-4624 FT	-544 FT/SEC	-32 FT/SEC↑2
18 SEC	-5184 FT	-576 FT/SEC	-32 FT/SEC↑2
19 SEC	-5776 FT	-608 FT/SEC	-32 FT/SEC↑2
20 SEC	-6400 FT	-640 FT/SEC	-32 FT/SEC↑2
21 SEC	-7056 FT	-672 FT/SEC	-32 FT/SEC↑2
22 SEC	-7744 FT	-704 FT/SEC	-32 FT/SEC↑2
23 SEC	-8464 FT	-736 FT/SEC	-32 FT/SEC↑2
24 SEC	-9216 FT	-768 FT/SEC	-32 FT/SEC↑2
25 SEC	-10000 FT	-800 FT/SEC	-32 FT/SEC↑2
26 SEC	-10816 FT	-832 FT/SEC	-32 FT/SEC↑2
27 SEC	-11664 FT	-864 FT/SEC	-32 FT/SEC↑2
28 SEC	-12544 FT	-896 FT/SEC	-32 FT/SEC↑2
29 SEC	-13456 FT	-928 FT/SEC	-32 FT/SEC↑2
30 SEC	-14400 FT	-960 FT/SEC	-32 FT/SEC↑2
31 SEC	-15376 FT	-992 FT/SEC	-32 FT/SEC↑2
32 SEC	-16384 FT	-1024 FT/SEC	-32 FT/SEC↑2
33 SEC	-17424 FT	-1056 FT/SEC	-32 FT/SEC↑2
34 SEC	-18496 FT	-1088 FT/SEC	-32 FT/SEC↑2
35 SEC	-19600 FT	-1120 FT/SEC	-32 FT/SEC↑2
36 SEC	-20736 FT	-1152 FT/SEC	-32 FT/SEC↑2
37 SEC	-21904 FT	-1184 FT/SEC	-32 FT/SEC↑2
38 SEC	-23104 FT	-1216 FT/SEC	-32 FT/SEC↑2
39 SEC	-24336 FT	-1248 FT/SEC	-32 FT/SEC↑2
40 SEC	-25600 FT	-1280 FT/SEC	-32 FT/SEC↑2
41 SEC	-26896 FT	-1312 FT/SEC	-32 FT/SEC↑2
42 SEC	-28224 FT	-1344 FT/SEC	-32 FT/SEC↑2
43 SEC	-29584 FT	-1376 FT/SEC	-32 FT/SEC↑2
44 SEC	-30976 FT	-1408 FT/SEC	-32 FT/SEC↑2
45 SEC	-32400 FT	-1440 FT/SEC	-32 FT/SEC↑2
46 SEC	-33856. FT	-1472 FT/SEC	-32 FT/SEC↑2
47 SEC	-35344. FT	-1504 FT/SEC	-32 FT/SEC↑2
48 SEC	-36864. FT	-1536 FT/SEC	-32 FT/SEC↑2
49 SEC	-38416. FT	-1568 FT/SEC	-32 FT/SEC↑2
50 SEC	-40000. FT	-1600 FT/SEC	-32 FT/SEC↑2
51 SEC	-41616. FT	-1632 FT/SEC	-32 FT/SEC↑2
52 SEC	-43264. FT	-1664 FT/SEC	-32 FT/SEC↑2
53 SEC	-44944. FT	-1696 FT/SEC	-32 FT/SEC↑2
54 SEC	-46656. FT	-1728 FT/SEC	-32 FT/SEC↑2
55 SEC	-48400. FT	-1760 FT/SEC	-32 FT/SEC↑2
56 SEC	-50176. FT	-1792 FT/SEC	-32 FT/SEC↑2
57 SEC	-51984. FT	-1824 FT/SEC	-32 FT/SEC↑2
58 SEC	-53824. FT	-1856 FT/SEC	-32 FT/SEC↑2
59 SEC	-55696. FT	-1888 FT/SEC	-32 FT/SEC↑2
1 MINUTE	-57600. FT	-1920 FT/SEC	-32 FT/SEC↑2

DROPPING A SUPER BALL OFF THE EMPIRE STATE BUILDING 1472 FT

THE SUPER BALL TOOK 9.59166 SECONDS TO FALL TO THE GROUND FROM THE TOP OF THE EMPIRE STATE BUILDING
THE VELOCITY OF THE SUPER BALL JUST BEFORE IT HIT THE GROUND WAS 306.933 FT/SEC
THE SUPER BALL BOUNCED AND ROSE TO THE HEIGHT OF 1300.66 FEET ON THE FIRST BOUNCE
THE SUPER BALL TOOK 9.01616 SECONDS TO RISE
THE SUPER BALL BOUNCED 115 TIMES

DROPPING THE SUPER BALL AND BALLS OF DIFFERENT SUBSTANCES OFF THE EMPIRE STATE BUILDING AND OTHER BUILDINGS

EMPIRE STATE BUILDING 1472 FT

TYPE OF BALL	NUMBER OF BOUNCES	TIME TO FALL TO THE GROUND *SEC*	VELOCITY JUST BEFORE IT HIT *FT/SEC*	BOUNCED TO THE HEIGHT OF *FT*	TIME IT TOOK TO RISE *SEC*
SUPER	115	9.59166	306.933	1300.66	9.01616
GLASS	234	9.59166	306.933	1385.	9.30391
STEEL	139	9.59166	306.933	1328.48	9.11208
CLAY	98	9.59166	306.933	1273.13	8.92025
IVORY	32	9.59166	306.933	942.08	7.67333
IRON	20	9.59166	306.933	721.28	6.71416
MAPLE	18	9.59166	306.933	641.203	6.3305
CORK	14	9.59166	306.933	529.92	5.755
COPPER	4	9.59166	306.933	28.8512	1.34283
LEAD	2	9.59166	306.933	.5888	.191833

EIFFEL TOWER 1056 FT

TYPE OF BALL	NUMBER OF BOUNCES	TIME TO FALL TO THE GROUND *SEC*	VELOCITY JUST BEFORE IT HIT *FT/SEC*	BOUNCED TO THE HEIGHT OF *FT*	TIME IT TOOK TO RISE *SEC*
SUPER	113	8.12404	259.969	933.082	7.6366
GLASS	228	8.12404	259.969	993.59	7.88032
STEEL	136	8.12404	259.969	953.04	7.71784
CLAY	96	8.12404	259.969	913.334	7.55536
IVORY	32	8.12404	259.969	675.84	6.49923
IRON	20	8.12404	259.969	517.44	5.68683
MAPLE	17	8.12404	259.969	459.994	5.36187
CORK	14	8.12404	259.969	380.16	4.87442
COPPER	4	8.12404	259.969	20.6976	1.13737
LEAD	2	8.12404	259.969	.4224	.162481

SPACE NEEDLE 607 FT

TYPE OF BALL	NUMBER OF BOUNCES	TIME TO FALL TO THE GROUND *SEC*	VELOCITY JUST BEFORE IT HIT *FT/SEC*	BOUNCED TO THE HEIGHT OF *FT*	TIME IT TOOK TO RISE *SEC*
SUPER	108	6.15934	197.099	536.345	5.78978
GLASS	219	6.15934	197.099	571.126	5.97456
STEEL	130	6.15934	197.099	547.818	5.85138
CLAY	92	6.15934	197.099	524.994	5.72819
IVORY	30	6.15934	197.099	388.48	4.92747
IRON	19	6.15934	197.099	297.43	4.31154
MAPLE	17	6.15934	197.099	264.409	4.06517
CORK	14	6.15934	197.099	218.52	3.69561
COPPER	4	6.15934	197.099	11.8972	.862308
LEAD	2	6.15934	197.099	.2428	.123187

TORONTO DOMINION TOWER 410 FT

TYPE OF BALL	NUMBER OF BOUNCES	TIME TO FALL TO THE GROUND *SEC*	VELOCITY JUST BEFORE IT HIT *FT/SEC*	BOUNCED TO THE HEIGHT OF *FT*	TIME IT TOOK TO RISE *SEC*
SUPER	105	5.06211	161.988	362.276	4.75839
GLASS	213	5.06211	161.988	385.769	4.91025
STEEL	126	5.06211	161.988	370.025	4.80901
CLAY	90	5.06211	161.988	354.609	4.70777
IVORY	29	5.06211	161.988	262.4	4.04969
IRON	19	5.06211	161.988	200.9	3.54348
MAPLE	16	5.06211	161.988	178.596	3.341
CORK	13	5.06211	161.988	147.6	3.03727
COPPER	4	5.06211	161.988	8.036	.708696
LEAD	2	5.06211	161.988	.164	.101242

LEANING TOWER OF PISA 184.5 FT

TYPE OF BALL	NUMBER OF BOUNCES	TIME TO FALL TO THE GROUND *SEC*	VELOCITY JUST BEFORE IT HIT *FT/SEC*	BOUNCED TO THE HEIGHT OF *FT*	TIME IT TOOK TO RISE *SEC*
SUPER	98	3.39577	108.665	163.024	3.19292

GLASS	200	3.39577	108.665	173.596	3.2939
STEEL	119	3.39577	108.665	166.511	3.22598
CLAY	84	3.39577	108.665	159.574	3.15807
IVORY	28	3.39577	108.665	118.88	2.71662
IRON	17	3.39577	108.665	90.405	2.37704
MAPLE	15	3.39577	108.665	80.3602	2.24121
CORK	12	3.39577	108.665	66.42	2.03746
COPPER	4	3.39577	108.665	3.6162	.475408
LEAD	2	3.39577	108.665	7.38000E-02	6.79154E-02