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AUTHOR Burger, Vernon K.
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ABSTRACT

The author designed an instructional package including slides and tape cassettes for individual use by students learning to use a hand calculator to perform computations. Students (n=17) using the package were given pretests and posttests of ability and attitude. On the three sets of cognitive objectives, mastery was achieved by 96 percent, 76 percent, and 76 percent of the students, respectively. All students reported favorable attitudes to the unit. The author discusses planned revisions of the program, and relationships among the variables. (SD)

DESIGN, PRODUCTION, EVALUATION, AND REVISION OF A SELF-INSTRUCTIONAL PACKAGE FOR THE HP-45 ELECTRONIC SLIDE RULE

CURRICULUM DEVELOPMENT

by

Vernon K. Burger, M.A.

Cuyahoga Community College Eastern Campus

DR. JAMES E. LORION

A PRACTICUM PRESENTED TO NOVA UNIVERSITY
IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE
DEGREE OF DOCTOR OF EDUCATION

NOVA UNIVERSITY

AUGUST 13, 1974

ABSTRACT

The purpose of this practicum was to design, frabricate, evaluate and recommend revisions of a self-intructional program for the HP-45 electronic calculator. The design and fabrication of the program was accomplished and was included as a part of this practicum in the form of a (1) set of slides, (2) cassette tape, and (3) an instruction manual. The design of the program utilized a learning systems approach which incorporated a rationale, objectives, pre-test, learning activity, and post-test.

The evaluation of the program was based on the number of students achieving mastery, error rate data, and a post-test questionnaire. Of the seventeen students of a physical science class completing the program, 76 percent achieved mastery. Of the students claiming adequate math skills, 100 percent achieved the mastery level of 90 percent. Error rate data produced a number of areas that need to be rewritten, reworked, or the addition of supplementary material.

The post-test questionnaire produced the following conclusions and recommendations: (1) the rationale statement was judged to be moderately successful and is to be rewritten to emphasize the more common, everyday uses of the calculator; (2) most of the students reported that they enjoyed working through the program; (3) overall feelings toward the program were good; (4) 95 percent of the students indicated they will use the HP-45 or similar calculator in the future; (5) the mean post-test scores of students claiming high relevance was significantly higher than the mean post-test scores of students claiming less than high relevance; and (6) there is no significant difference between the mean post-test scores of students claiming to enjoy and not to enjoy working the program.

Additional revisions to the program and further study of some of the relationships were recommended. Based on the success of this program, it was recommended that all learning experiences under the direction of the writer a systematic approach to instruction.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

I. INTRODUCTION

This practicum report deals with the development of an instructional package for learning the use of the HP-45 electronic calculator. The report presents Herrscher's model for individualized instruction packages and supporting rationale. As part of the practicum, an individualized instruction package was designed to cover the more commonly used operations on the HP-45 electronic calculator. This design was then used to fabricate a slide-tape module with an accompanying manual. Seventeen students worked the module and completed the pre-test, post-test, and questionnaire. The results were then analyzed and the package evaluated so that revisions could be recommended.

II. BACKGROUND AND SIGNIFICANCE

The development of powerful hand-held calculators, commonly known as "electronic slide rules", has resulted in both a help and a hinderence to the instructor of physical science and math courses. The advantages to the instructor and the student are (1) decreased time spent on routine calculations for outside study, class, and tests, (2) more time available to learn principles, concepts, and theories, (3) and the simplification of complex math operations. The main disadvantage is the time and effort spent by students in and out of class learning how to use these complex calculators.

The Eastern Campus of Cuyahoga Community College has one Hewlett-Packard Electronic Slide Rule (HP-45) for every two to three students enrolled in chemistry, physics, and higher math courses. These calculators are available for use during class, during class tests, in the testing centers, and to do calculations for homework.

The HP-45 has the capacity to perform over fifty mathematical operations from simple arithmetic to logarithmics and trig functions. Students presently try to learn how to use these calculators by listening to a short presentation in class, reading the instruction book which was judged by students as being "little or no help," and by tutoring from other students. The results have been less than satisfactory.

An informal survey of science and math instructors at Eastern Campus has revealed a definite need for an effective strategy for students to learn how to use the HP-45.

It was the purpose of this practicum to design, fabricate, evaluate, and recommend revision of an individualized instructional package for learning the commonly used operations of the HP-45 calculator.

A review of current literature in the field of community college education leads one to a number of conclusions when one attacks the problems of providing learning for all the students. The essential overall concept is that all students can learn. They may have different skills, different interests, and different learning rates, but they can learn under the proper conditions. Bloom views aptitude to learn as "the amount of time required by the learner to attain mastery of a learning task." (1:97)

Herrscher (2) has been able to tie together most of the ideas and comcepts of learning with what he refers to as "a systematic approach to instruction." This systems approach involves six basic steps: (1) Rationale; (2) Objectives; (3) Pre-assessment; (4) Learning activities; (5) Post-assenssment; (6) Revision. (3:4)

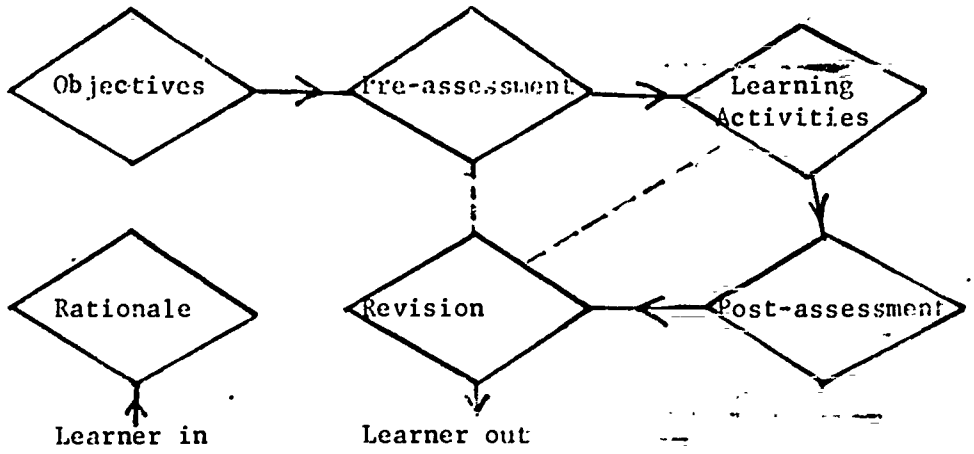

Figure 1. An Instructional System (3:4)

All instructional units should begin with a rationale. In order for the learning to be meaningful and have the student motivated, the learner must know and be convinced that the particular topic is important and can be useful to him.

The importance of well-written behavioral or performance objectives can not be over-stressed. An objective as used here is "a specific, observable student action or product of student action." (2:13) The objective, once written, must meet three criteria. (1) It must specify a student action or product of such action, (2) It must specify the conditions of performance, and (3) It must establish the minimum level of performance. (2:35) If students are to learn, they must be told what they are expected to learn.

Pre-assessment or a pre-test serves a number of functions. It determines whether or not the learner has the prerequisite capabilities to profit from the instruction. It can assist in redirecting the learner if he already can accomplish some or all of the behaviors specified in the objectives. (3:6) The pre-test and post-test combination also provides valuable feedback to the instructor

as to the effectiveness of instruction. The pre-test also gives the learner examples of the desired behavior so he knows exactly what he is trying to accomplish.

The learning activities are the means by which the student accomplishes the behaviors specified in the objectives. The most crucial elements to incorporate into the learning activities are: explicit directions, material broken into short segments, frequent practice, knowledge of results, positive reinforcement, and the use of appropriate media. (3:20) Another consideration emphasized by Roueche would be that "instruction should permit individual difference and permit students to learn and proceed at their own rate." (5:87)

Post-assessment is where the student and the instructor find out how successful they have been. The post-test must, of course, measure what was specified in the objectives. Mager states "if it's worth teaching, isn't it worth knowing if we have succeeded?" (4:9) It is also important to judge success or lack of success based on predetermined criteria. To compare students' performance to one another in a small class denies the whole concept of fairness and true desire for student learning. Criterion referenced tests are necessary when "instruction is adapted to the individual learning rates of students..." (3:8)

Revision of the instructional process is based on a systematic process of obtaining feedback from the learner. (3:9) The use of error rate data, post-test questionnaire, and learner interview, are three sources of revision data.

With this systems approach to learning as a guiding process,

it was the purpose of this practicum to design, fabricate, evaluate, and recommend revision of an individualized instruction program for the use of the HP-45 electronic calculator.

III. PROCEDURES

The initial phase of the practicum was the designing of an individualized instruction package on the use of the more commonly utilized functions of the HP-45 calculator. The design followed a systems approach format suggested in Herrscher's "implementing individualized instruction." The learning activities section attempted to include all the crucial elements as mentioned previously. A number of students and instructors were interviewed to determine how the HP-45 was useful to them and which operations they would suggest be presented. The rationale was then written and included in both the instruction manual (Appendix I) and the audio script (Appendix II and tape-slide).

The operations that were chosen to be covered were: (1) general operation; (2) keying numbers; (3) addition, substraction, multiplication, and division; (4) display and rounding options; (5) chain calculations; (6) scientific notation; (7) square and square root; (8) trig functions and logs; (9) raising numbers to powers and roots. From these operations, behavioral objectives were written and presented to the students on page three of the instruction manual (Appendix I). Affective objectives were also set, for it was the purpose of the program to have students actually use the calculators.

A pre-assessment instrument was then constructed from the

objectives. The pre-test and post-test were identical in problem types with only different numerical values used on the post-test. The pre-test did not have students actually work the problems but simply asked if they could work them with paper and pencil and/or the HP-45. This is shown on page four and five of the instruction manual (Appendix I).

The learning methodology selected in addition to the instruction manual was a slide-tape or audio-tutorial format. Storyline cards were constructed and the script written to include introduction, rationale, objectives, and learning activities. Since the students would be working problems on the HP-45 along with the slide-tape, a method of showing the correct answers was sought. With some experimentation with lighting and photographic technique, it was discovered that the display of the calculator could be made visible. As can be seen by viewing the slides, the display shows exactly what the student should see on his/her calculator. Also included in each frame was the problem being worked and the "keying in" sequence for that problem.

At the end of each of the three sections additional practice with the correct answers included is provided in the instruction manual. In an attempt to help the student become less dependent on the slide-tape format for learning additional operations, part three was written in a style and format resembling the owner's manual. While it does include more explanation, problems, and practice than the owner's manual, it does introduce the symbols and method of presentation so that students can learn additional operations on their own.

In addition to the post-test, a post-test questionnaire was also constructed to assess learner attitudes toward the program and towards the HP-45. The last section of the questionnaire asks for areas where the program can be improved.

The completed program was then used in the learning resource center by seventeen students of a non-mathematical physical science course at the Eastern Campus of Cuyahoga Community College. This sample was chosen mainly because the students were readily accessible and also had varying degrees of math skills. Students were asked to work all sections of the program even if they claimed inadequate math skills. However, only where students claimed adequate math ability was the performance used to determine the effectiveness of instruction. Students did not receive any additional instruction outside of their experience with the program.

The results of the pre-test, post-test, and post-test questionnaire were grouped and entered on a summary sheet to permit ready access. The data was then analyzed to obtain the following information:

1. What percent of the students achieved mastery (90% or better) on the post-test?
2. What was the error rate data for each question on the post-test?
3. Was the program relevant to the students?
4. Did students enjoy working through the program?
5. How did students describe their feelings about their involvement with the program?
6. Did students plan to use a calculator to a greater extent as a result of their involvement with the program?
7. Do students plan to use the HP-45 whenever it can be helpful?

8. What do students recommend for improving the program?

9. Based on the above information, what revisions should be recommended to improve the program?

The procedures for treating the data for number one through eight were to enter the data, in some cases calculate percentages, and then summarize. Classification as to adequate or inadequate math skills was determined from the scoring of the pre-test.

After the data had been collected and grouped, a number of mean scores appeared to have some relationship to items of the questionnaire. As a result of this discovery, two secondary hypotheses were postulated.

1. The mean post-test score of students claiming high relevance is significantly higher than the mean post-test score of students claiming less than high relevance.
2. The mean post-test score of students claiming to enjoy the program at least to a great extent is significantly higher than students claiming to enjoy the program less than to a great extent.

For a study relationship of mean post-test scores and student claims, a t-test is called for. The sample size was seventeen, post-test scores on an interval scale, and student claims providing a dichotomy on a nominal scale. A one-tailed test is used when a relationship in a particular direction is sought. Desired level of significance is .01 with the degree of freedom being 15. Critical t under these conditions is 2.60.

IV. RESULTS

The results of the pre-test, post-test, and the questionnaire

were grouped and entered on a summary sheet to permit ready access. The scores of the post-test were ranked in order from high to low as shown in Table 1 and Figure 1. The expected level of performance to demonstrate mastery was 24 or better of the 27 post-test items.

TABLE 1

FREQUENCY DISTRIBUTION OF 17 POST-TEST SCORES

Interval	Frequency
26-27	9 *
24-25	4 *
22-23	0
20-21	1
18-19	2
16-17	0
14-15	1
Total	17

*90% or better: mastery level

Of the seventeen students who worked the program, thirteen or 76% achieved at least a mastery level score of twenty-four. Table 2 shows a breakdown of each of the three sections, where it was found that 94 percent achieved mastery in Part I. In Parts II and III, the percent of students achieving mastery was 76 percent and 76 percent respectively. As shown in Table 3 however, when analysis includes only students claiming adequate math skills, the mastery rate is 100 percent in all sections. It is interesting to note that 56 percent

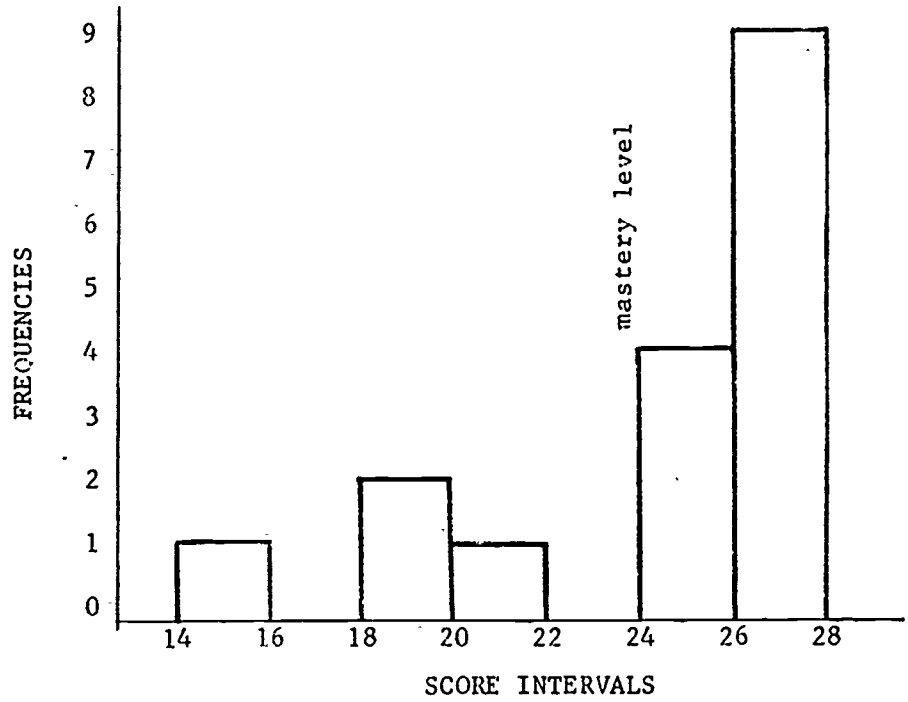

Figure 1. Histogram of 17 Post-test Scores

TABLE 2

NUMBER AND PERCENT OF STUDENTS ACHIEVING MASTERY

	Part I	Part II	Part III
Total number of students completing program	17	17	17
Number (percent) of those students achieving mastery	16 (96%)	13 (76%)	13 (76%)

of the students claiming inadequate math skills for Part II were able to achieve mastery in that section. Additionally the mastery rate in Part III for students claiming inadequate math skills was 69 percent.

TABLE 3

NUMBER AND PERCENT OF STUDENTS ACHIEVING MASTERY CLASSIFIED BY MATH SKILLS

	Part I	Part II	Part III
Number of students claiming adequate math skills	16	8	4
Number (percent) of those students achieving mastery	16 (100%)	8 (100%)	4 (100%)
Numb . of students claiming inadequate math skills	1	9	13
Number (percent) of those students achieving mastery	0 (0%)	5 (56%)	9 (69%)

An analysis of missed items of the post-test produced Table 4 which lists questions missed on the post-test. The error rate data was grouped to show items missed by students achieving or not achieving mastery and by students claiming adequate or inadequate math skills. Students claiming adequate math skills had difficulty with only items 8, 11, and 14. As shown in Table 4, the majority of missed items were by students claiming inadequate math skills. When the dichotomy of mastery vs. non-mastery is examined, Part II, which is items 10 through 14, shows mastery students having missed almost as often as non-mastery students.

TABLE 4

ERROR RATE DATA FOR POST-TEST

Item	Total	Students missing items			
		Mastery	Non-Mastery	Adequate Math	Inadequate Math
8	4	1	3	3	1
10	1		1	0	1
11	2	2		1	1
12	4	1	3	0	4
13	5	2	3	0	5
14	8	4	4	1	7
15	1	0	1	0	1
16	2		2	0	2
17	2		2	0	2
18	2		2	0	2
19	5	1	4	0	5
20	4	1	3	0	4
21	2	1	1	0	2
22	3	1	2	0	3

In response to the post-test question "Do you feel the material dealt with in this program is relevant to your present or future needs?", almost 50 percent of the students responded "very relevant." As shown in Table 5, a sizable amount felt the material had less than high relevance.

TABLE 5

FREQUENCY DISTRIBUTION OF STUDENT RESPONSES TO RELEVANCY

Response	Frequency
Very Relevant	8
Relevant	1
Some Relevance	3
Very Little Relevance	3
Not Relevant	2
Total	17

As shown in Table 6, the response to the question "How much did you enjoy working through this program?", had a distribution that was quite different. It appears that almost all students enjoyed working the program to at least some extent.

TABLE 6

FREQUENCY DISTRIBUTION OF STUDENT RESPONSES TO ENJOYMENT

Response	Frequency
Very much	6
To a Great Extent	4
Some	5
Very Little	2
None	0
Total	17

In response to the question "Which statements best describe your feelings about your involvement with this self-instructional program?", sixteen of the seventeen responded it was "interesting." The next highest was "inspiring' with five responses. As shown in Table 7, the only other high response was to "sure beats the lecture method."

TABLE 7

FREQUENCY DISTRIBUTION OF STUDENT RESPONSES TO FEELINGS ABOUT THE PROGRAM

Response	Frequency
Interesting	16
Inspiring	5
Sure beats lecture method	4
A real treat	2
Too time consuming	2
Did it to please the instructor	1
OK	1
All other	0

In attempting to determine if students would use a calculator to a greater extent in the future, the responses from questions four and five from the questionnaire were analyzed. It was determined that eight students planned to use a calculator to a greater extent with a mean increase of 2.5. Four students indicated the same, while three students said they would use calculators less. In response

to the question "Do you plan to use the HP-45 whenever it can be helpful?", sixteen of the seventeen students said "yes."

For the relationship of mean post-test scores of students claiming high relevance and less than high relevance, a null hypothesis of $P_1 = P_2$ was postulated. As shown in Table 8, a t-ratio of +2.65 was obtained and found to be significant at the .01 level of significance. In view of this finding, the above null hypothesis was rejected. Therefore, it was concluded that the mean post-test score of students claiming high relevance is significantly higher than the mean post-test score of students claiming less than high relevance.

TABLE 8

CALCULATION OF t-RATIO FOR MEAN POST-TEST SCORES OF STUDENTS CLAIMING HIGH RELEVANCE AND LESS THAN HIGH RELEVANCE

	High Relevance	Less Than High Relevance
n	8	9
Mean	26.25	22.11
S.D.	1.04	4.26
$\bar{X}_1 - \bar{X}_2$	+4.12	
t-ratio		+2.65 *

* significant at .01 level

For the relationship of the mean post-test score of students claiming to enjoy the program at least to a great extent and less

than a great extent, a null hypothesis of $P_1 = P_2$ was postulated. As shown in Table 9, a t-ratio of +1.04 was obtained and found to be nonsignificant. In view of this finding, the above null hypothesis was accepted. There is no significant difference between the mean post-test score of students claiming to enjoy the program at least to a great extent and the mean post-test score of students claiming to enjoy the program less than to a great extent.

TABLE 9

CALCULATION OF t-RATIO FOR MEAN POST-TEST SCORES OF STUDENTS CLAIMING TO ENJOY AT LEAST TO A GREAT EXTENT AND LESS THAN A GREAT EXTENT

	To a Great Extent	Less Than A Great Extent	
n	10	7	
Mean	25.00	22.71	
S.D.	2.45	4.99	
$\bar{X}_1 - \bar{X}_2$		+2.29	
t-ratio			+1.04

V. CONCLUSIONS AND RECOMMENDATIONS

The purpose of this practicum was to design, fabricate, evaluate, and recommend revisions of a self-instructional program for the HP-45 electronic calculator. The design and fabrication of the program was accomplished and is included as part of this practicum in the form of a (1) set of slides, (2) script of narration, (3) cassette tape, (4) and copies of instructional manual. The program

is in the learning resource center at this time and is available for use by any student.

The evaluation of the program was based on the number of students achieving mastery, error rate data, and the post-test questionnaire. Of the seventeen students completing the program, 76 percent achieved mastery. At first examination, this figure indicates that the expected 90 percent level was not attained. Upon further examination, however, it was found that of the students who claimed adequate math skills, 100 percent achieved mastery. Although not all students who claimed inadequate math skills achieved mastery, 56 percent did in Part II and 69 percent did in Part III. This could be due to the students underestimating their math skills or learning to do operations on the HP-45 they really didn't understand. The writer leans towards the second hypothesis and recommends that it be further studied. Only four students claimed adequate math skills to complete the entire program, however thirteen students achieved mastery. It was therefore concluded that nine students achieved mastery without adequate math skills. Based on the above statistics the overall program was judged to be successful.

Error rate data produced some areas that need rewriting, reworking, or the addition of supplementary material. In particular, item 8 indicates students having difficulty with arithmetic chaining operations. It is recommended that additional instruction and practice be provided for that operation. Items 10 through 14 show students also having difficulty with the manipulation of scientific notation. Based on student feedback, it is recommended that supplemental material be made available reviewing the concepts

involving scientific notation. Additionally, the script should be revised to include greater emphasis on the entering of negative exponents. As a result of student interviews, it was discovered that items missed in Part III were not as a result of not knowing how to complete operations, but rather as a result of not knowing what the symbols and operations meant. This is verified by the high error rate of students claiming inadequate math skills.

The success of the rationale statements was judged to be moderate; only 50 percent claiming the program was very relevant. It is recommended that a second program be produced which emphasizes the more common, everyday rationales and operations for the non-mathematically oriented student. The existing program appears to meet the needs of the mathematically oriented student.

Most students reported that they enjoyed the experience of working the unit. Learner interviews determined that students that had less than an enjoyable time claimed it was not the program, but the mathematical nature of the learning material. "I hate math!" was a fairly common response.

Overall feelings toward the program were good. Only two students indicated any negative feelings toward the program with five claiming they had an "inspiring" experience.

It appears that 95 percent of the students will use the HP-45 or similar calculators in the future. The one student who stated "No" claimed she was too old to change now and liked doing it the old-fashioned way. The overwhelming response to use a calculator indicates the overall success of the program.

The mean post-test scores of students claiming high relevance was significantly higher than the mean post-test scores of students claiming less than high relevance. This profound conclusion has been reported in the literature for quite some time. The statistical verification of this hypothesis had a very good effect on the writer in providing a "first hand" experience with a concept previously accepted on faith and philosophical thought. The recommendation is to select learning outcomes that are relevant to the learner and/or to provide meaningful rationales for all learning experiences.

There is no significant difference between the mean post-test scores of students claiming to enjoy and not to enjoy working the program. This lack of relationship produces a number of "spin-off" hypotheses and re-testing. Is the sample too small and distribution of scores to skewed to allow for further generalization? Do students learn just as well when fear motivated? Should instruction be designed so that students do enjoy the experience? For the purpose of this practicum report it is concluded that with this sample there was no significant difference in the mean post-test scores. Further study is definitely recommended.

It is recommended that the previously stated revisions to the program be carried out, and slide numbers be placed on each slide with audio reference made to these numbers. Student interviews and instructor observations make this addition necessary to simplify review of previous sections or slides. Do to the success of this program, it is recommended that all learning experiences under the direction of the writer be restructured to follow a systematic

approach to instruction. This change has in part been accomplished and will continue in the future.

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APPENDIX

MANUEL FOR

INSTRUCTION ON USE OF THE HP-45

Self-Instructional Unit: HP-45

Instructor: Vernon K. Burger

Institution: Cuyahoga Community College

Course Title: All Science and Math

Topic: How To Use the HP-45 Electronic Calculator

Target Group: All students who need to do mathematical calulations

Approximate Working Time: 1-2 Hours

Hello and welcome to the world of modern calculators and perhaps a different way of learning. Ramon Turner, a student here and I have prepared what we believe to be an efficient and pleasureful way of learning how to use the HP-45 calculator. To use this program, you should have the following things:

1. One HP-45, (available from the Science Preparation Room).
2. One tray of slides.
3. A cassette tape.
4. (Carrels are available to in the Library and the Science Lab area).
5. And lastly this manual.

If you have all of the above, you are ready to start. Put the slide tray on the projector and advance to the first slide. Put the cassette into the tape recorder, start it, and follow the directions. Above all, learn to use the HP-45 and enjoy the process.

V. K. Burger

RATIONALE

Using the HP-45 can result in (1) time savings during study and exams, (2) greater use of mathematical calculations, (3) an ability to do more difficult operations, (4) a feeling of being "up-to-date", and (5) higher grades.

OBJECTIVES

All cognitive and psychomotor objectives will be tested by means of a post-test administered under the following conditions and standard of performance:

1. The test will be completed in the Library and will be unsupervised.
2. No references will be allowed.
3. Only the HP-45 calculator will be used.
4. Each item will be scored either right or wrong. To be scored "right", the answer must be 100% correct.
5. A score of 90% or better will be considered as a "pass".
6. The score will in no way be used in determining a grade for a credit course.

COGNITIVE AND PSYCHOMOTOR

1. Given an HP-45, turn it on, if it is operating properly, describe which keys are used for simple arithemetic functions and clear an improper entry.
2. Using the HP-45, add, subtract, multiply, and divide any two number.
3. Using the HP-45, perform chain calculations involving addition, subtract, multiplication, and division.

4. Using the HP-45, select or fix the number of decimal places display.
5. Using the HP-45, enter and perform all arithmetic calculation involving scientific notation and specify the number of decimals displayed for any answer.
6. Using the HP-45, perform the following operations on any number:
    a. square
    b. square root
    c. log
    d. antilog
    e. any number of any power
    f. roots greater than 2
    g. find, sin, cos, or tan
    h. find arc sin, arc cos, or arc tan.

AFFECTIVE

7. Express satisfaction with and interest in using the HP-45 and other calculators.
8. Express a greater interest in using the HP-45 after finishing this program than before.
9. Use the HP-45 whenever it can be helpful.

PRE-ASSESSMENT

Please place "+" if you think you can do the problem presented or a "—" if you think you can not.

		With a pencil and paper	With the HP-45
1.	$621 + 422 =$		
2.	$129 - 89 =$		
3.	$62 \times 99 =$		
4.	$\frac{5472}{12} =$		
5.	$56 \times 83 \times 760 =$		
6.	$\frac{98 \times 23}{16} =$		
7.	$\frac{760}{800} \times \frac{300}{273} \times 22.4 =$		
8.	$(5.9 \times 3.2) + (62 \times .52) =$		
9.	Express the product of $1.52 \times .89$ with		
	a. 2 decimals		
	b. 3 decimals		
	c. 4 decimals		
	d. 0 decimals		

Go on to page 5 to complete the pre-test

	With a pencil and paper	With the HP-45

10. Express the product of 459 X 852 as

    1. a whole number
    2. a number in scientific with 2 decimals
    3. Scientific notion with 3 decimals

11. $3.14 \times 6.02 \times 10^{23} =$

12. $\frac{3.92 \times 10^{23}}{6.02 \times 10^{23}} =$

13. $\frac{7.81 \times 10^{-7}}{1.6 \times 10^{-19}} =$

14. $\frac{6.42 \times 10^{-6}}{3.01 \times 10^{9}} =$

15. $2.54^{2} =$

16. $\sqrt{13.5} =$

For 17 to 20 assume you had log and trig . tables.

17. $\log_{10} 45 =$

18. Antilog 3.14 =

17. $(6.2)^{4} =$

18. $\sqrt[3]{16} =$

19. SIN $35^{\circ} =$

20. ARC TAN 1.15 =

After you have completed this pretest, start the slide projector and tape record .

PART I PRACTICE

1. $37.2 + 32 =$

2. $98.6 + 32 =$

3. $1262 \div 42.1 =$

4. $47.2 - 32 =$

5. $32 - 47.2 =$

6. $2960 - 1472 =$

7. $62.4 \times 1.98 =$

8. $11.34 \times 17 =$

9. $.0831 \times 273 =$

10. $\frac{273}{302} =$

11. $\frac{731.2}{760} =$

12. $\frac{57.2}{18.0} =$

13. $\frac{62.4 \times 1.23 \times 296}{731} =$

14. $16.1 \times \frac{760}{714} \times \frac{304}{273} =$

15. $\frac{3.24 \times 2 \times 63.5}{56.0 \quad 3} =$

16. $(63 \times 2.1) - (26 \times 1.7) =$

17. $\frac{63 + 26}{2.1 \quad 1.7} =$

18. $62.4 \ \frac{(81 + 16)}{16 \quad 81}$

Answers:

1. 69.20
2. 130.60
3. 1304.10
4. 15.20
5. -15.20
6. 1488.00
7. 123.55
8. 192.78
9. 22.69
10. .90
11. .96
12. 3.18
13. 31.08
14. 19. 08
15. 2.45
16. 88.10
17. 45.29
18. 328.23

1. Express the answer of $\frac{2}{3}$ as

   a. 2 Decimals

   b. 1 Decimal

   c. 7 Decimals

   d. 0 Decimal

2. $(6.023 \times 10^{23}) \times (3.142) =$

   Express the product in scientific notation with

   a. 9 Decimals

   b. 2 Decimals

   c. 2 Decimals

   d. 1 Decimal

   e. 0 Decimal

   For Problems 3 to 6 express answer with 2 Decimals

3. $\frac{1.204 \times 10^{24}}{6.02 \times 10^{23}} =$

4. $\frac{1.23 \times 6.02 \times 10^{23}}{2.30} =$

5. $(1.61 \times 10^{-19})\ (6.02 \times 10^{23}) =$

6. $\frac{1.06 \times 10^{4}}{1.06 \times 10^{10}} =$

Answers

1. a. .67
   b. .7
   c. .6666667
   d. 1
2. a. $1.892426600 \times 10^{24}$
   b. 1.891×10^{24}
   c. 1.89×10^{24}
   d. 1.9×10^{24}
   e. 2×10^{24}
3. 2.00
4. 3.22×10^{22}
5. 9.69×10^{4}
6. 1.00×10^{-6}

NOW TURN TO PAGE 8 FOR PART 3

PART 3

The objective of this section is for you to perform the following operations on any number:

a. square

b. square root

c. log

d. antilog

e. any number to any power

f. roots greater than 2

g. find sin, cos, or tan

h. find arc, sin, cos, or arc tan

a. To square any number using the HP-45, you simply key in the number to be squared and push the $\boxed{x^2}$ key. To square 6, you would

Press: See displayed

6 $\boxed{x^2}$ ⟶ 36.00

Now square 3.14

Press: See displayed

3.14 $\boxed{x^2}$ ⟶ 9.36

b. To take the square root of a number you must utilize the alternate function. The symbol for the primary functions appears on the kdy, printed in gold, like this $\boxed{\sqrt{x}\ /\ x^2}$. To use the alternate function, press the gold key before pressing the associated key like  $\boxed{\sqrt{x}\ /\ x^2}$. Alternate functions are indicated like this ⟶  throughout Part 3 and in the owner's handbook.

Take the square root of 36.

Press: See displayed

36 [√X] ⟶ 6.00

Now try $\sqrt{9.86}$

Press: See displayed

9.86 [√X] ⟶ 3.14

c. A logarithm (base 10) is the exponent to which 10 is raised to equal the number. For example, the $\log_{10}$ of 100 is 2. That means, 10 is raised to the second power ($10^{(2)} = 100$). To take the logarithm (base 10) for a number you utilize the alternate function of the [IN] key. For example, $\log_{10}$ 100 =

Press: See displayed

100 [log] ⟶ 2.00

Try LOG_{10} 45=

Press: See displayed

45 [LOG] ⟶ 1.65

d. The antilog is just the reverse of the LOG. 10 is being raised to that number. In this case you would utilize the alternate function of the key [E^X] which is [10^X]. Take the antilog of 2.

Press: See displayed

2 [10^X] ⟶ 100.00

Now try antilog 3.49

Press: See displayed

3.49 [10^X] ⟶ 3090.30

e. To raise a number of a power greater than 2 or a decimal power the alternate function [Y^X] is used. You key in the number enter, the exponent, then [shift] [Y^X]. For example, calculate 2^9 (2 X 2 X 2 X 2 X 2 X 2 X 2 X 2 X 2).

Press:		See displayed
2	[ENTER ↑] 9 [shift] [Y^X]	512.00

Now try 3.62^4

Press:		See displayed
3.62	[ENTER ↑] 4 [shift] [Y^X]	→ 171.73

f. In conjunction with [1/X] [shift] [Y^X] provides a simple way to extract roots. For example, find the cube foot of 5 ($\sqrt[3]{5}$). Taking the cube root is the same as raising 5 to the 1/3 or .33 power.

Press:		See displayed
5	[ENTER ↑]	→ 5.00
3	[1/X]	→ 0.33 (reciprocal of 3)
[shift]	[Y^X]	→ 1.71 (cube root of 5)

Now try $\sqrt[5]{3125.}$

Press:		See displayed
3125	ENTER	3125.00
5	[1/X]	0.20 (reciprocal of 5)
[shift]	[Y^X]	→ 5.00 (fifth root of 3125)

g. and h.

The following Trignoometric functions are provided.

sin	(sine)	$\sin^{-1}$	(arc sine)
		$\cos^{-1}$	(arc cosine)
cos	(cosine)	$\tan^{-1}$	(arc tangent)
tan	(tangent)		

To use the sin, cos, and tan functions key in the number and press the appropriate function key. To use the arc function, press [ ], than press the associated function key. For example, arc sin .866 ($\sin^{-1}$ (.866)).

Press: See displayed

.866 [ ] [sin] ——————→60.00

As you can see by looking at the key board, we have not covered all the functions of the Hp-45. If you wish to know more, you should sign-out an "Owners Handbook" from the Science Prep Room. Some of the additional operations are:

1. Operational Stack
2. Data Storage Registers (memories)
3. Last X
4. Metric/U.S. Unit Conversion Constants
5. Statistical Functions
6. Degree-Radians
7. Etc.

On the next page are practice problems for Part 3. When you finish, please complete post-test and questionnaire and return it to your instructor.

Practice for Part 3		Answers	
1.	12^2 =	1.	144.00
2.	6.96^2 =	2.	48.44
3.	3.14^2 =	3.	9.86
4.	$\sqrt{169}$ =	4.	13.00
5.	$\sqrt{6.74}$ =	5.	2.54
6.	$\sqrt{23.2}$ =	6.	4.82
7.	Log_{10} 1,000 =	7.	3.00
8.	Log_{10} 87.2 =	8.	1.94
9.	$\text{Log}_{10} 6.02 \times 10^{23}$ =	9.	23.78
10.	$\text{Log}_{10} 1.61 \times 10^{-6}$ =	10.	-5.79
11.	Antilog 2.92 =	11.	831.76
12.	Antilog -5.82 =	12.	0.00 (SC12 - 1.51×10^{-7})
13.	1.21^5 =	13.	2.59
14.	$6^{2.31}$ =	14.	62.74
15.	$6.42^{1.5}$ =	15.	16.27
16.	$\sqrt[3]{27}$ =	16.	3.00
17.	$\sqrt[4]{62.4}$ =	17.	2.81
	$\sqrt{}$ .079616 =	18.	6.00
19.	Sin 45° =	19.	.71
20.	Cos 45° =	20.	.71
21.	Tan 45° =	21.	1.00
22.	Arc Tan 2.36	22.	67.00°
23.	Arc Sin .23	23.	13.30°
24.	Arc Cos. .50	24.	60°

POST-TEST

Name _____

1. $861 + 387 =$ _____

2. $321 - 287 =$ _____

3. $73 \times 62 =$ _____

4. $\frac{3960}{14} =$ _____

5. $3.02 \times 62 \times 321 =$ _____

6. $\frac{58 \times 2.3}{16.7} =$ _____

7. $16.4 \times \frac{760}{821} \times \frac{314}{273} =$ _____

8. $(67 \times 23) - (36.19 \times 42.57)$ _____

9. Express the product of $3.41 \times .67$ with

   a. 2 decimals _____

   b. 3 decimals _____

   c. 4 decimals _____

   d. No decimals _____

10. Express the product of 862×187 as

    a. a whole number _____

    b. a number in scientific notation with 2 decimals _____

    c. scientific notation with 3 decimals

11. $1.72 \times 6.023 \times 10^{23} =$ _____

12. $\frac{1.262 \times 10^{24}}{9.04 \times 10^{23}}$ _____

13. $\frac{3.92 \times 10^{-4}}{1.8 \times 10^{-14}} =$ _____

14. $\frac{1 \times 10^{-14}}{6.42 \times 10^{6}} =$ _____

15. $11.3^{2} =$ _____

16. $\sqrt{137.4} =$ _____

17. $\text{Log}_{10}\ 93.2 =$ _____

18. Antilog 2.67 = _____

17. $(4.5)^{5} =$ _____

18. $\sqrt[4]{31.4} =$ _____

19. $\cos 41^{\circ} =$ _____

20. Arc Sin .41 = _____

POST-TEST QUESTIONNAIRE

Mr. V. K. Burger is interested in improving this program based on your answers to the following questions.

1. Do you feel the material dealt within this program is relevant to your present or future needs? (Circle One).

1	2	3	4	5
Not Relevant	Very Little Relevance	Some Revalance	Relevant	Very Relevant

2. How much did you enjoy working through this program?

1	2	3	4	5
None	Very Little	Some	To a Great Extent	Very Much

3. Which statements best describe your feelings about your involvement with this self-instructional program?

_____	too easy	_____	boring
_____	inspiring	_____	can take it or leave it
_____	a waste of time	_____	a real treat
_____	interesting	_____	dull
_____	o.k.	_____	too time consuming
_____	just another course requirement	_____	did it to please the instructor
_____	sure beats the lecture method		

4. Did you use small calculator before your involvement with this unit?

1	2	3	4	5
None	Very Little	Some	To a Great Extent	Very Much

5. Assuming availability of a calculator, how often do you plan to use the HP-45 or similar calculator?

1	2	3	4	5
None	Very Little	Some	To a Great Extent	Very Much

6. Do you plan to use the HP-45 whenever it can be helpful? Yes () No ()

7. Please state your feeling toward the unit and also state how the unit might be improved? (Complete this question on Page 16).

Attitude

Improvements

Part I

Part II

Part III

Other