Combining Mathematics and Computers

An Honors Thesis (HONRS 499)

by

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I. <u>PURPOSE OF THESIS</u>:

This computer program is a combination of a few commonly experienced and taught applications of mathematics and a file or "record keeping" system for the teacher. It is written in the Turbo Pascal computer language and concerns proportions, percents, and word problems that include sale price problems, Pythagorean theorem applications, and some miscellaneous problems.

The proportions are randomly drawn from a data file of problems, and the percent problems are randomly generated. Once the user has responded to a problem, a randomly chosen statement of praise is displayed on the screen if the answer was correct. If the user answered incorrectly, the correct value is displayed with a randomly chosen encouragement statement.

The main emphasis of my program was upon the word problem section that contains various word problem "shells" for each area. These "shells" determine the type of mathematical manipulation necessary to calculate the answer, but the user can determine what topics the problems concern. Also, the use of the word problem "shells" makes the program more versatile by allowing a wide range of problems of varying difficulty levels to be produced from just a few of these "shells."

The "record keeping" portion is for the convenience of the teacher. It creates and manipulates data bases of information. It records the user's performance on the various portions testing mathematical skills. These files can be viewed, evaluated, and manipulated by the teacher.

II. REASONS FOR THIS THESIS:

I wanted to do produce something that combined my Honors experience, my secondary mathematics education major, and my computer endorsement. I also wanted to create something that I could use once I graduate and attain a full-time teaching position. Recently, I have viewed several mathematical software packages for my MATHS 331 course. While doing this, I noticed that many of these software packages concerned word problems. A few of them even stepped through the process of determining the important information and working a word problem, but none of the programs allowed the user to determine what the word problems would concern. So many students say that word problems are "stupid" and do not apply to their lives. With the word problem shells I have created, the user (who will probably be a student) can decide what the word problem will concern. The mathematical manipulation that is required to solve the problem is determined by the existing shell, but the user chooses the topic.

Proportions and percents seem to be addressed in several different levels of mathematics. They are introduced in junior high and are touched upon repeatedly throughout high school mathematics classes. Since these topics are frequently touched upon, I decided to include them as "drill" portions of my program.

The word problems are divided into three sections: sale prices, Pythagorean theorem applications, and a section of miscellaneous problems. Sale prices are included because they have many "real life" applications, and knowing how to calculate sale prices and discounts can be useful for

everyone. The Pythagorean theorem applications are included because they are frequented quite often throughout the different levels of junior high and high school mathematics classes, including: algebra, geometry, and analytic geometry. The Pythagorean theorem has many applications that are often not realized. The miscellaneous problem section is included to cover a variety of problems without creating five or six different shells for each type. This provides a sampling of different types of word problems that will cause the student to utilize critical thinking skills. There are several types of problems included, so the student needs to decide what is important and what type of mathematical manipulation is necessary. With the two defined word problem sections (sale prices and Pythagorean theorem), the methods used to solve each problem are quite similar even though different portions are asked for, whereas with the miscellaneous problem section, each problem requires a different solution method.

III. DIFFICULTIES THAT OCCURRED WHILE PREPARING MY THESIS:

Overall, the development of my thesis went quite well once I organized my ideas and began writing the program. The most difficult part was deciding upon what software package to use while writing my program. I had decided upon Turbo Pascal, but then had other ideas for graphics to include and investigated Turtle Graphics with Turbo Pascal. This is a combination of Logo commands with the Turbo Pascal programming language. I had written a portion of the program before I looked into the

Turtle Graphics. I converted everything over to the Turtle Graphics with Turbo Pascal, then realized that it was not what I wanted. Luckily, I saved my original copy of the program and had not altered it, so I could still revert back to this version without revising everything once again.

After exploring the demonstration program that accompanied the Turbo Pascal package, I realized that capabilities existed of which I had not known. By investigating the demonstration program, I discovered how to program for these capabilities. With this new knowledge, I was able to make my program do more of what I had imagined.

The only other real barriers I encountered were deciding upon how to limit my program to specific topics and exploring the programming language more fully. I had not programmed with Turbo Pascal for over a year, so I needed to refresh my memory and closely examined some of the programs I had written for the Turbo Pascal programming class I had taken. When experimenting with something new, I always saved the most recent version of the program and saved the newly altered version under an alternate file name so I could keep both versions and have the option to return to an earlier version if it was beneficial.

IV. <u>INTRODUCTION AND "LOGIN"</u>:

To begin this program, the user must change to the drive in which the disk being used is located. If the appropriate drive is the "A" drive, the user must enter "A:" to change the current working drive and enter the word "MATH" at the "A:" prompt. If the appropriate drive is the "B"

drive, the user must enter "B:" to change the current working drive and enter the word "MATHB" at the "B:" prompt. The first screen that appears serves as a welcoming, entry device that acknowledges the user, initializes the program, and allows the user to state whether he is a student or a teacher. This answer (student or teacher) controls the sections of the program to which the user has access. In either case, the user is asked to identify himself by a code before he can gain access to the remaining portions of the program. The teacher must enter the code "teachme" or "TEACHME" to have access to the student files. The students must enter the drive location and name of the data base in which they are located (this should be told to the students by the teacher who created the data base of student records), their names, and appropriate numeric codes to gain access to the mathematical skill testing portion of the program. By entering names and numeric codes, each student is identified by the computer, and the performance of that student (the average scores attained in each part) is recorded in the data base that the teacher may later access to check the performance and progress of each student. The teacher must create a data base of students and codes through the options in the teacher "record keeping" section before the students can "play the game."

V. STUDENT OPTIONS:

Once the student has entered his name and the appropriate numeric code, he is presented with a menu of options consisting of proportions,

percents, word problems, or to end the session. Depending upon the student's choice, the corresponding problems or menus appear and prompt the student as to what he is to do next.

A. Proportions

A data file of proportion problems is accessed, and problems are randomly chosen and displayed on the screen. The proportion appears as two fractions set equal to one another with a variable placed in any one of the four positions. The student is prompted to enter the appropriate value for the variable to make the statement true. Once the student has answered, a random praise statement will appear indicating that the student answered correctly, or a random encouragement statement will appear along with the correct value for the variable, depending upon the response the student has entered.

The student determines the number of problems he wishes to attempt before any of the problems are given. The practice session can be as long or short as the student wishes. Once the specified number of problems is completed, the percentage correct is calculated and displayed on the screen. This provides feedback to the student concerning his performance, and the student has the option to attempt another set of problems if he wishes.

B. Percents

The percent portion of the program also allows the student to determine the number of problems he wishes to attempt. When the

specified number of problems has been completed, the percentage correct is displayed, and the student has the option to attempt more problems if the wishes.

The percent problems are displayed as fractions for which the student is to utilize long division to determine the appropriate corresponding percent (rounded to the nearest hundredth of a percent). The fractions are randomly generated. The numerator is a random number between 0 and 54. The denominator is a random number between 1 and 100. This allows for a wide range of percents both above and below 100%.

C. Word Problems

When the student chooses the word problems, another menu appears asking the type of word problem preferred: sale price, Pythagorean theorem, or miscellaneous. Within each of these subdivisions, there exist several different problem shells. The basic outline of the word problem is previously determined, but the student is given the opportunity to "personalize" the problem. Depending upon the problem that is chosen, the student is prompted to choose from a menu of topics or enter one of his own, and enter names, objects, dollar amounts, test scores, or distances. When the choices are completed, the screen is cleared and the word problem appears in its entirety. Each section containing the type of problem the student may choose contains several different problem shells that concern the type of problem selected. Specifically which problem that appears is decided randomly. This varies the questioning pattern and requires the student to do more critical thinking about what each problem

is asking rather than determining the method used and merely applying it to each problem without actually thinking about what is being done.

After answering each problem, the student is given the option of continuing with another problem of the same type or returning to the menu of choices. When the student chooses to do no more problems of that type, the student's performance is evaluated, the percentage correct is displayed on the screen and recorded in the appropriate section in the data base file specified at the beginning of the session. This provides immediate feedback to the student and also allows the teacher to see how well the student is progressing.

1. sale prices

There are four sale price problem shells. The student may be asked to enter the original price of the item the student has chosen and the discount percentage. Then the word problem appears in its entirety, and the student may be asked to enter either the sale price or the difference in the original price and the sale price. The student may also be asked to enter the original price and the sale price and be asked to determine the discount percentage or enter the sale price and the discount percentage, then determine the original price.

2. Pythagorean theorem

The five Pythagorean theorem problem shells concern a variety of topics, but each one is solved by utilizing Pythagorean's theorem: "In a right triangle, the square of the length of the hypotenuse is equal to the

sum of the squares of the lengths of the other two sides." In terms with which most people are familiar, "c squared equals a squared plus b squared." In each case, the student must determine what part of the right triangle has the missing value to appropriately apply the theorem.

3. miscellaneous problems

There are eight problem shells in this section, each one dealing with a different topic. These problems concern: calculating differences, averaging test scores, applications of multiplication, determining the number of objects defective if the total number and the percentage that are defective are known, calculating hourly wages, determining area, permutations, and algebraic applications. The difficulty level of these problems can be varied quite a bit, but there are also a few "easy" problems such as the one concerning calculating differences to encourage students and convince them that not all word problems are impossible. Word problems are merely every day occurrences placed in mathematical terms, and students are already solving these types of problems without realizing it.

VI. PRAISE AND ENCOURAGEMENT GRAPHICS SCREENS:

Within each section of the mathematical skills testing problems, the student is given the percentage of problems that he answered correctly. Along with this numeric feedback, the student is given visual reinforcement if he attains either a 100% or at least an 85%. When a student

achieves a perfect score, the screen is cleared, then covered with points of color and words of praise including: congratulations, 100%, super, and excellent. If the student attains at least an 85% but not a perfect score, a different graphics screen appears with the points of color and phrases including: you are doing great, at least an 85% but not yet perfect, getting there, and now try for 100%. These screens can be used as an incentive for the student to do his best and see what may appear.

VII. ENDING SCREEN:

The final screen of the students' portion of the program is a graphics screen. Its function is similar to that of the first screen that appeared to welcome the student. This screen displays some graphics, then says "goodbye" to the student.

VIII. "TEACHER SECTION":

Once a teacher has entered the appropriate code, he is given a menu of options that are quite different than that for the students. The teacher has the opportunity to create and manipulate any of the data base information as well as enter the student program if the teacher enters himself into the appropriate data base.

The menu of options given the teacher are quite self – explanatory, so I will merely reiterate the menu options: create a data base, view a record in a data base, add a record to a data base, sort a data base

(alphabetically), add scores to a data base, change a field in a data base (such as a name or code of a student), create a teacher's report, create a report cards file, enter the student program, or exit the program. When one of the first eight options is entered, directions and some examples are provided explaining what to do or how to access certain files such as the teacher's report or the report cards file outside the program. The teacher may also choose to enter into the student portion of the program or exit the entire program when he is ready.