

# Learning Computer programming through Game Playing

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## ABSTRACT

In this paper we present an approach for teaching and learning Computer Programming through Game playing. This activity is intended to complement traditional teaching of concepts. The focus is on building program *comprehension* rather than program *generation*. In playing the game, students improve their ability to read and understand a program written in a specific language and to follow the logic in a program. They build speed in comprehension, as is required in learning any language. To win the game, students have to play certain steps repeatedly, using different strategies, and with time constraints. This repetitiveness reinforces learning. Once they master the basic elements of a program, they will experience less frustration in coding solutions for more challenging problems. The preliminary results with students using this gaming activity are encouraging.

## Key Words

Pascal, programming, Pascal Shopper, computer games

## INTRODUCTION

There has been an abundance of research carried out to investigate the teaching and learning of programming [2]; what emerges is that clearly computer programming is a difficult topic for many students. For novice programmers, a distinction can be made between programming *comprehension* (the ability to read and understand the outcomes of an existing piece of code) and *generation* (the ability to create a piece of code that achieves certain outcomes) [3]. In [4], the authors argue that “a vital step toward being able to write programs is the capacity to read a piece of code and describe it”.

In this paper, we present a computer programming game, PascAL Shopper, which is one of the activities in an e-course developed for teaching and learning computer programming [1]. The course is

a 2-year course designed for secondary school students (age group 14 -16). It prepares them for the Caribbean Secondary Examination Certificate (CSEC) Information Technology examination administered by the Caribbean Examination Council (CXC). Programming has always posed a major challenge to these students; the PascAL Shopper game is designed to assist students with improving their programming skills in Pascal (Pascal is the recommended language of use for these students by CXC).The game provides students with Pascal code snippets which they are required to debug within a specified time; the game encourages the students to solve these problems through the added incentive of achieving the objective of the game. The game complements the other content in which computer programming concepts are taught using animation.

Pascal Shopper was used by a group of secondary school students in an experimental study. We present the results of the evaluation and make some conclusions about our study.

## DESIGN OF GAME

### Gameplay

PascAl Shopper is about a boy named Al (short for Algorithm) who has some shopping to do. Al has a list of six items which he must buy; these items can be found at three stores, a hardware, a supermarket or a fish market. Al is only allowed to ask for an item eight times throughout the game. If he exhausts his eight chances and does not collect all the items, he loses the game, this means that he must first ask for the item in the correct store(E.g. Asking for a hammer in the fish market instead of hardware) because if he asks for an item which is not sold in that store, a question is lost. When he does ask for the item in the correct store, the player will be presented with a multiple choice question based on Pascal programming which they must answer within a given time limit. The type of questions will be based on which level the player

has chosen. There are four levels which can be chosen. The details of these levels can be seen in Table 1.

Level	Time Limit	Question Description
Easy	15 seconds	Tests General Knowledge of Pascal Programming
Medium	40 seconds	Tests the ability to debug very simple, basic Pascal programs
Hard	40 seconds	Tests the ability to debug more challenging Pascal programs
Expert	120 seconds	Tests the ability to debug complex Pascal programs

**Table 1. Description of the various levels of Pascal Shopper**

These four levels were included to allow the game to be used by all students, regardless of their current programming ability and it also allows the students to continuously challenge themselves.

### Types of Programming Questions

The technique used to evaluate the student's Pascal programming ability is a multiple choice question based on Pascal programming. In the easy level of the game, the player/student is presented simple questions which test general knowledge of Pascal programming. Examples of questions which can be asked are "Which of the following is the assignment operator in Pascal?" or "Which of the following is used to obtain user input in Pascal?". However, in the medium, hard and expert levels, the player will be presented with an actual Pascal program or code snippet which they are required to debug (Figure 1).

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What is the error in the following code?
1. (This code swaps the letters in position i and j in string str)
2. procedure swap(var str:string; i,j :integer);
3.   var c: char;
4.   begin
5.     c:= str[i];
6.     str[i]:= str[j];
7.     str[j]:=c;
8.   end;

A) Line 6 is supposed to be str[j]:= str[i];
B) c is supposed to be of type string
C) Line 7 is supposed to be C:=str[j];
D) There is no error

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**Figure 1. Screenshot showing question format in Pascal Shopper**

The idea behind using this approach can be compared to the learning of a foreign language. When learning a new language, reading and understanding words and small phrases are always the first aspects of the language which we learn. After mastering these, we move on to more complex sentence construction. Similarly, in Pascal Shopper, the player is presented with small Pascal code snippets which they are required to read to understand, they must determine what the outcome of the code is and what problem the code attempts to solve. Finally they must identify the error in the code if any exists. Using this approach, the students are forced to read and describe code and we believe that once the students have mastered this ability, the actual writing of Pascal programs will become easier for them.

In Figure 1, we see that the player is asked to identify the error in the given code snippet. At the beginning of the snippet, the player is told what the code is supposed to do. At the bottom, the player is presented with four multiple options to choose the answer.

A similar approach to the one shown above is used throughout the entire game. The game does not

focus on the problem solving aspect of programming; instead the actual programming is tested. However it should be noted the problem solving programming aspects are still necessary for the user to be successful in the game. In Figure 1, the player is already given the core of the solution and they are required to look for errors regarding the implementation of the solution in Pascal. All questions contain at most one error.

When the player gets a question incorrect, in addition to not receiving the item for which they asked, they are also not given the correct solution to the question. This was done to encourage students to play the game repeatedly even if they are not interested in winning the actual game. The questions which are presented to the players are randomly chosen from a question bank containing over sixty question, so while it is unlikely that players will be given the same question within a couple of attempts at the game, if they play the game continuously, they will get another chance at questions they may have previously gotten incorrect

## EXPERIMENT

### Methodology

The experimental study was performed on a group of twenty, form-five secondary school students. The experiment took place in the following manner.

1. *The students were given a short quiz which contained 10 multiple choice questions similar to those found in the medium level of Pascal Shopper*
2. *The students were then asked to play the medium level of Pascal Shopper. They were not told how many times to attempt the game. The students were not aware they would only be given forty minutes to play the game.*
3. *The students were given the same quiz they attempted before they played Pascal Shopper. The students did not know that they would be given a second quiz.*
4. *Finally the students were given a questionnaire to complete.*

It should be noted that the students had no prior knowledge of the experiment. Also, the students were not told about their performance in the first quiz before they played Pascal Shopper or attempted the second quiz

## Experiment Results.

The results of the experiments produced the following results. From Figure 2, it is shown that a majority of the students' performance increased in the second quiz from the first quiz after playing Pascal Shopper.

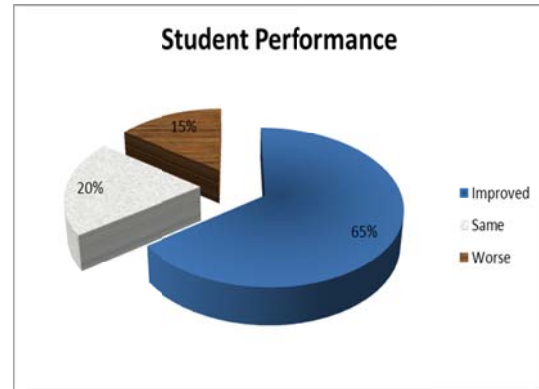


Figure 2. Pie chart representing students' performance

Figures 3 and 4 show the difference in the students' performance between the two quizzes, they clearly show that most of the students made substantial improvements in their performances. The average mark in the first quiz was 4.7 (out of 10), the average mark in second quiz was 5.8 which shows an average improvement of 11% after using Pascal Shopper.

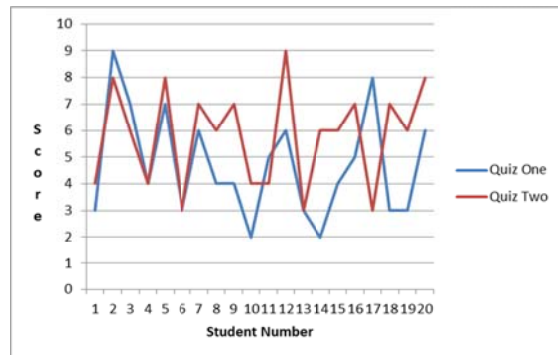
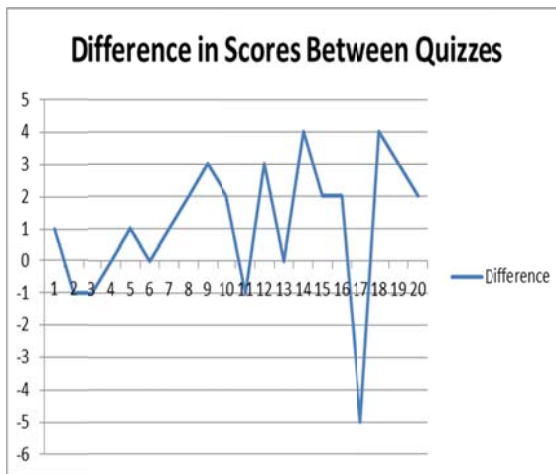
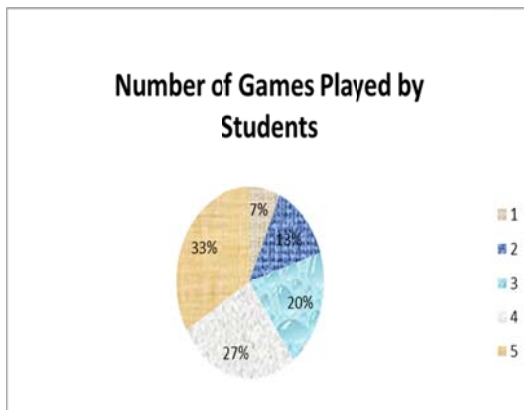


Figure 3. Line graph comparison of students' score in two quizzes



**Figure 4.** Line graph representation of difference in quiz scores

The breakdown of the number of games played by each student can be seen in Figure 5. We see that 60% of all students played at least four games. Results of the experiment showed that 85% (17) of the students succeeded at winning the game and 59% (10) of them continued playing the game even after they had won.



**Figure 5.** Pie chart showing the number of games student who played between one and five games

An analysis conducted on the results on the questionnaire completed by the students concluded the following;

1. 85% of students said that they would have continued playing the game until they won.
2. 85% of students thought that the game would help them to perform better on the

second quiz. (The students were never told how they performed)

3. 95% of students agreed to try the other levels of the game
4. 85% of students said they preferred playing Pascal Shopper as opposed to doing similar questions in a written format.
5. 90% of students said that the game helped them understand basic Pascal programming better.
6. 95% of students said that the game helped improve their skills in identifying common Pascal programming errors.
7. 90% of the students said that they would like to more activities like Pascal Shopper in their classroom environment.

The questionnaire also asked the students to give recommendations about how the Pascal Shopper game can be improved and become more helpful to them. A range of responses were given, but the most common recommendation received was to add sporting gameplay instead of the shopping gameplay to the game.

#### CONCLUSION

The result of the experiment clearly shows that Pascal Shopper was useful in helping students improve their basic comprehension of Pascal programs. The technique of using a game to evaluate and teach basic Pascal programming was also successful, the students were encouraged to play the game repeatedly, regardless of the fact that game compromised mainly of programming questions which these students would normally not be enthusiastic about doing. Continuous attempts at the game provided the students the opportunity to study Pascal code and become familiar with the common errors which they make and they would therefore be less likely to repeat these mistakes in their own programming. Additionally the student also develops the skill of being able to describe a piece of code as opposed to simply reading it.

The time constraint on the questions was also very helpful because the students were required to think quickly about the code snippet and the problem it attempts to solve and this is a useful skill for an examination.

The game also provides a chance for a student to understand the Pascal programming language since the questions in game presents a problem, and attempts to the solve the problem using Pascal. The students can therefore learn from these questions

while trying to solve them. Again, this aspect would be very useful for people who are new to programming and Pascal.

We can conclude that games can be successfully utilized in teaching programming to students.

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