Mathematics Ability and Anxiety, Computer and Programming Anxieties, Age and Gender as Determinants of Achievement in Basic Programming

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Received 04 Mar 2014 Accepted 11 Mar 2014

Abstract- Computer programming which forms the major component of most technological inventions is perceived by most computer science students as difficult. Some researchers have also reported that failure rates in programming courses are between 30% and 40%. It has therefore become necessary to study factors that could influence achievement in programming. This study therefore investigated the interaction between some selected factors (mathematics ability, mathematics anxiety, computer anxiety, programming anxiety, age and gender) and achievement in Basic Programming. The study adopted a correlational design with achievement in Basic programming as the dependent variable, while mathematics ability, mathematics anxiety, computer anxiety, programming anxiety, age and gender serve as the independent variables. Three scales namely: mathematics anxiety ($r = 0.82$), computer anxiety ($r = 0.82$) and programming anxiety ($r = 0.82$) rating scales were used for data collection. Data collected were analysed using Pearson Product Moment Correlation (PPMC) coefficient and multiple regression analyses. The result of the analysis showed that the correlation between mathematics ability and achievement in Basic programming are positive and significant. The composite effect of the factors under study on achievement in Basic programming is 20.8%. Efforts should be made to motivate students to improve their mathematics ability so as to improve programming performance and consequently improve efficiency in programming.

Keywords: Mathematics, Computer, Programming, Ability, Anxiety and Achievement.

Introduction

The importance of computer programming in this age of technological development cannot be over emphasized. The Nigerian Information Technology (IT) industry in particular is in dire need of indigenous programmers. Most of the software packages presently in use in Nigerian industries, schools and financial institutions are either foreign (developed outside Nigeria) or locally adapted [1]. However, computer programming which forms the major component of most technological inventions is perceived by computer science students as difficult. Many students who are proficient at other subjects sometimes fail to succeed in programming [2]. This is because programming is different from other disciplines. There have been many studies in recent years into achievement in computer programming [2,3,4,5]. Some scholars reported that failure rates in programming courses are about 30% to 40% [6,7]. Previous researches indicate that students with programming background particularly in structured programming [7,8], investigative personality [9] mathematical background [10,11,12,13] have better programming achievement. Some other researchers found that scores in aptitude tests, prior records of academic achievement (such as school GPA) and effort or self motivation explain significantly the variations in programming achievement of students [14,15,16]. Specifically studies on cognitive factors’ prediction of computer programming achievement revealed that demographic, cognitive and academic variables and computer exposure strongly predicted class performance [15,16]. Other studies considered variables such as learning styles [2], self efficacy [18], comfort level [19,20], personality type [21,22], mental model [7] as positive predictors of programming achievement.

Mathematics ability has for a long time been reported to positively relate to performance in computer science courses (including programming) in many studies [10,11,12,23,24,25,26,27]. Other researchers reported that mathematics background and ability significantly predicted achievement in computer and analytical skills associated with both disciplines [2,5].

Computer anxiety was found to contribute to computer ability [28]. Computer anxiety has been defined as a fear of computers when using one, or fearing the possibility of using a computer [29]. It differs from negative attitudes towards computers which entails beliefs and feelings about computers rather than one’s emotional reaction towards using computers [30]. Computer anxiety is characterised as an affective response on emotional fear of potential negative outcomes such as damaging the equipment or looking foolish [31]. From an information processing perspectives, the negative feelings associated with high anxiety detract cognition resources from task performance [32]. Thus, programming achievement of students has been seen to be negatively affected by computer anxiety.

Related to computer anxiety is mathematics anxiety which is very common among students. It was noted that many students who suffer from mathematics anxiety have little confidence in their ability to do mathematics and tend to take the minimum number of required mathematics courses which has greatly limited their career choice of opinions [33]. The findings of [34] also revealed that the correlation between mathematics anxiety and academic achievement is negatively significant. Some other studies have shown that mathematics anxiety influences negative attitude towards computers [35,36]; which in turn is likely to have great implications on computer programming achievement. Students who are more relaxed when faced with programming related activities perform better than those with...
relatively high programming anxiety in any programming course. Thus, there is every reason to believe that anxiety level (whether computer anxiety, programming anxiety or mathematics anxiety) ought to be minimal in order to obtain a good programming achievement.

Several researches have been conducted to show that older students are more likely to adapt and function effectively in any school settings than the younger students. [37] specifically discovered in his study of computer engineers that there was no difference in job performance as age increases. A more comprehensive study on age and the attributes of successful students in an introductory programming class, showed that higher levels of performance is obtained with increasing age and an intention to major in computing [38].

A number of studies have considered gender as an independent factor influencing computer – related variables. Significantly, some studies revealed that boys are more interested and confident in working with computers than the girls [39,40,41,42,43].

Studies that collectively looked at the predictive abilities of mathematics ability, computer and programming anxieties, age and gender on Basic programming achievement generally and especially among Nigerian subjects seems to be very rare in literature. Given the level of demand for indigenous programmers and software developers in Nigeria, a study like this becomes imperative as it would provide the empirical data needed to suggest strategies for boosting software development activities among Nigerian computer majors. It is on this note, that this study seeks to establish the relationship between the following six variables (mathematics ability, computer anxiety, mathematics anxiety, programming anxiety, age and gender) and achievement in Basic programming.

Purpose of the Study

This study will determine:
1. The relationship between mathematics ability, computer anxiety, mathematics anxiety, programming anxiety, age, gender and achievement in Basic programming.
2. The composite effect of the six predictor variables (mathematics ability, computer anxiety, mathematics anxiety, programming anxiety, age and gender) on the academic achievement of NCE Computer / Mathematics students in Basic programming.
3. The relative effect of the six predictor variables (mathematics ability, computer anxiety, mathematics anxiety, programming anxiety, age and gender) on the academic achievement of NCE Computer / Mathematics students in Basic programming.

Research Questions

The following research questions were answered:
1. Do each of the six predictor variables; gender, age, mathematics ability, mathematics anxiety, computer anxiety and programming anxiety relate significantly with the performance of NCE computer / mathematics students in Basic programming?
2. What is the composite effect of the six predictor variables; gender, age, mathematics ability, mathematics anxiety, computer anxiety and programming anxiety on the performance of NCE computer / mathematics students in Basic programming?
3. What are the relative effects of the six predictor variables; gender, age, mathematics ability, mathematics anxiety, computer anxiety and programming anxiety on the performance of NCE computer / mathematics students in Basic programming?

Method

The study adopted a survey design with all undergraduate computer/mathematics students of the Federal colleges of education in Lagos and Ogun states of Nigeria as population for the study. The sampling procedure was purposive as students who had offered the Basic programming course in the Nigeria Colleges of Education curriculum were eligible to participate in the study. Three instruments were administered on one hundred and sixty computer/mathematics students of Federal College of Education (Technical), Akoka, Lagos state; Nigeria and Federal College of Education, Osiele, Abeokuta, Ogun state, Nigeria. The instruments included the Computer programming anxiety rating scale, computer anxiety rating scale and mathematics anxiety rating scale. To determine the mathematics ability of students, their first semester scores in a course titled “Algebra” (MAT 111) was used while their second semester scores in the Basic Programming course (CSC 125) was used for their achievement in Basic programming. The student background questionnaire was used to elicit information on age and gender of the respondents. The computer programming anxiety scale was originally designed and validated by [44]. The scale has 19 items. The respondents were given instructions to rate their anxiety levels when faced with computer related tasks. The questionnaire was designed using a five-point Likert-scale using the following response format: Never true (0), seldom true (1), sometimes true (2), often true (3), always true (4). The reliability coefficient using cronbach alpha was found to be 0.82. The computer anxiety rating scale was originally designed and validated by [30]. The scale has 19 items. The respondents were given instructions to rate their anxiety levels when faced with computer related tasks. The questionnaire was designed using a four-point Likert-scale using the following response format: strongly agree (SA), agree (A), disagree (D) and strongly disagreed (SD). The reliability coefficient using cronbach alpha was found to be 0.82. The mathematics anxiety rating scale was originally designed and validated by [45]. The scale has 14 items. The respondents were given instructions to rate their anxiety levels when faced with mathematical concepts. The questionnaire was designed using a four-point Likert-scale using the following response format: strongly agree (SA), agree (A), disagree (D) and strongly disagreed (SD). The reliability coefficient using cronbach alpha was found to be 0.82. The resulting data were analysed with the aid of Statistical Package for Social Sciences (SPSS) version 17.0 software using correlation and multiple regression.
Result

To answer research question one, a correlation matrix (Table 1) showing the correlation coefficient between the performance of NCE computer / mathematics students in Basic programming and the six predictor variables is presented.

Table 1: Correlation Matrix Showing Relationship Between Performance in Basic Programming and Predictor Variables.

<table>
<thead>
<tr>
<th></th>
<th>Gender</th>
<th>Age</th>
<th>MA</th>
<th>MARS</th>
<th>CARS</th>
<th>CPA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender</td>
<td>1.000</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age</td>
<td>-0.148</td>
<td>1.000</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MA</td>
<td>-0.30</td>
<td>-0.077</td>
<td>1.000</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MARS</td>
<td>-0.078</td>
<td>-0.015</td>
<td>0.096</td>
<td>1.000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CARS</td>
<td>0.017</td>
<td>0.072</td>
<td>0.043</td>
<td>0.272</td>
<td>1.000</td>
<td></td>
</tr>
<tr>
<td>CPARS</td>
<td>0.129</td>
<td>-0.126</td>
<td>-0.103</td>
<td>-0.082</td>
<td>-0.076</td>
<td>1.000</td>
</tr>
<tr>
<td>CPA</td>
<td>0.077</td>
<td>-0.082</td>
<td>0.450</td>
<td>** 0.100</td>
<td>0.123</td>
<td>-0.144</td>
</tr>
</tbody>
</table>

KEY: MA = Mathematics ability; MARS = Mathematics Anxiety Rating Scale; CARS = Computer Anxiety Rating Scale; CPARS = Computer Programming Anxiety Rating Scale; CPA = Computer Programming Achievement

** = Correlation is significant at the 0.01 level (2-tailed)
*  = Correlation is significant at the 0.05 level (2 tailed)

The results showed that not all the six predictor variables (gender, age, mathematics ability, mathematics anxiety, computer anxiety and computer programming anxiety) related positively with the performance of NCE computer / mathematics students in Basic programming. The predictor variables which related positively are gender, mathematics ability, mathematics anxiety, computer anxiety, and computer programming anxiety while age and computer programming related negatively. The relationship between mathematics ability and the performance of NCE computer / mathematics student in Basic programming is statistically significant at an alpha level of 0.01.

Table 2: Multiple Regression of the Predictor Variables on the Performance of NCE Computer / Mathematics Students in Basic Programming.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Multiple Regression (R)</td>
<td>0.488</td>
</tr>
<tr>
<td>R – Square</td>
<td>0.238</td>
</tr>
<tr>
<td>Adjusted R – square</td>
<td>0.208</td>
</tr>
<tr>
<td>Std. Error of Estimate</td>
<td>11.648</td>
</tr>
</tbody>
</table>

Predictors: (Constant), Gender, age, MA, MARS, CARS and CPARS.

Table 2 above presents the multiple regression of the predictor variables on the performance of NCE computer / mathematics students in Basic programming. The multiple regression correlation coefficient (R) showing the linear relationship between the six predictor variables (gender, age, mathematics ability, mathematics anxiety, computer anxiety, and computer programming anxiety) and the students’ performance in Basic programming is 0.488. The adjusted R square value is 0.208. This implies that the variation in the performance of NCE computer / mathematics students in Basic programing accounted for by the stated predictor variables is 20.8%.

Table 3: Multiple Regression ANOVA

<table>
<thead>
<tr>
<th>Model</th>
<th>Sum of squares</th>
<th>Df</th>
<th>Mean square</th>
<th>F</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Regression</td>
<td>6405.220</td>
<td>6</td>
<td>1067.537</td>
<td>7.869</td>
<td>0.000*</td>
</tr>
<tr>
<td>Residu</td>
<td>20485.767</td>
<td>151</td>
<td>135.667</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>26890.987</td>
<td>157</td>
<td>177.187</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

a. Predictors: (Constant), Gender, age, MA, MARS, CARS and CPARS.
b. Dependent variable: CPA

Table 3, above shows the Multiple Regression ANOVA of the predictor variables on the performance of NCE Computer / Mathematics students in Basic programming. Further verification using multiple regression ANOVA however produced F-ratio =7.869, p<0.05. This implies that there is a significant linear relationship between the above stated predictor variables and the performance of NCE Computer / Mathematics students in Basic programing.
The result showed that the combined effect of the six predictor variables (gender, age, mathematics ability, mathematics anxiety, computer anxiety and computer programming anxiety) on students’ computer programming achievement is 20.8% and the relationship is significant.

The results also revealed that only one of the predictor variables (that is, mathematics ability), have positive “significant” relationship with the performance of NCE Computer / Mathematics students in Basic programming. This result is consistent with the findings [8] where it was discovered that students who have good background in mathematics are more likely to succeed in programming subject. This result also supports the findings of [2 and 5] where success in Mathematics was found to be a good predictor of success in computer science. Moreover, other researchers suggested that mathematics background related significantly to students’ performance in College computer science courses [10,11,12,13]. The reason why good mathematics ability encourages good performance in programming could be as a result of the fact that both Mathematics and Programming involves the ability to understand abstract concepts in solving problems. [46] stated that:

“In solving problem through programming, the students are required to develop the abstract representation of the problems and express them in a logical structure and detailed realization in programming language”.

### Conclusion

The relationship between mathematics ability and the performance of NCE computer / mathematics students in Basic programming is statistically significant. The composite effect of the six predictor variables on the performance of NCE computer / mathematics students in Basic programming is 20.8%. Only one of the six predictor variables (mathematics ability) has significant relative effect on the performance of NCE computer / mathematics students in Basic programming.

### Recommendations

College computer science students should be motivated to improve in their mathematics ability and develop more positive attitude towards mathematics, since good mathematics ability enhances good academic achievement in computer programming.

### Discussion of Findings

Table 4 above shows the relative effects of the predictor variables on the performance of NCE Computer / Mathematics students in Basic programming in the order of absolute magnitudes as indicated by standardized Beta (B) weights. Mathematics Ability (MA) contributed most and directly to the performance of NCE computer / mathematics students in Basic programming (B = 0.430; t = 5.973; p < 0.05). The contributions of other predictor variables to the performance of NCE Computer / Mathematics students in Basic programming are: computer anxiety (B = 0.093; t = 1.247; p > 0.05), mathematics anxiety (B = 0.031; t = 0.422; p > 0.05), Age (B = -0.058; t = -0.794; p > 0.05), Gender (B=0.108; t = 1.484; p > 0.05), and computer programming anxiety (B = -0.113; t = -1.554; p > 0.05). This implies that only the Mathematics ability in table 4 above have significant relative effect on the performance of NCE Computer / Mathematics students in Basic programming.

### References

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