Computer Anxiety, Self-Efficacy, Computer Experience: An investigation throughout a Computer Science degree

Eileen Doyle¹, Ioanna Stamouli ², and Meriel Huggard ³

Abstract - Considerable research has focused on the relationship between computer experience, computer anxiety and self-efficacy. These factors have been used both individually and in combination as predictors in the social sciences and business studies [1, 7, 17]. However, very few studies investigate their effects in the area of computer science. This study focuses on capturing these factors across the four years of a computer science course at Trinity College, Dublin. It shows that as computer experience increases self-efficacy also increases while computer anxiety decreases with increasing experience.

Index Terms – Computer Anxiety, Computer Experience, Computer Science, Self-efficacy.

INTRODUCTION

Many students are reluctant to use computers and consider working with them a daunting prospect [21]. Self-efficacy [2], computer anxiety [1], and computer experience [9, 16] have been shown to affect how students approach the use of computers during the course of their studies. These factors have been widely investigated, both individually and collectively, in relation to students of social science, health and business studies [1, 7, 17], however very few studies exist in the field of computer science [19]. This study investigates whether computer science students are affected by the same factors as their counterparts in other disciplines.

The study presented herein primarily focuses on changes in the three factors under consideration across all years of a degree programme. The initial hypothesis was that as students progress with their studies they should feel more confident, less anxious and give a higher rating of their computer experience.

The student sample for this study was drawn from the entire population of the four-year computer science degree programme in Trinity College, Dublin. A questionnaire was designed that incorporated extant measures of computer anxiety, self-efficacy and computer experience. This survey was administered to 163 Computer Science students and this study reports on the findings.

In the following sections the three chosen factors are defined and the rational behind their choice is discussed. The experimental design and methodology are then presented. The paper concludes with a detailed analysis and evaluation of the data.

Computer Anxiety

Computer anxiety has been explored in great depth as a factor in many research studies [1, 4, 7]. This can be defined in terms of a psychological response (e.g. computer phobia [19]) or in terms of a cognitive reaction (e.g. apprehension of computer technology [15]). The definition that was found to be most relevant for this study includes both of these characteristics: Computer Anxiety is the “negative emotions and cognitions evoked in actual or imaginary interaction with computer-based technology” [4]. Individuals who suffer from computer anxiety usually display negative behaviour and physiological reactions to computers. These behaviour reactions include (1) avoidance of computer usage; (2) negative comments about computers; (3) employing extreme care with computers and (4) using the computer for the minimal amount of time [4]. Some of the physiological reactions include sweaty palms, shortness of breath and dizziness [3]. Computer anxiety affects the general usage and the performance of tasks involving the computer.

Self-efficacy

The second factor under investigation in this study is self-efficacy. This is defined as an individual’s judgment of their capability to use a computer [8]. Each student’s belief in their own efficacy is not concerned with past experience; rather it is focused on their individual capability to perform tasks in the future. Those with a strong belief in their efficacy view difficult tasks as a challenge that they can master, rather than as an obstacle that must be avoided [2]. While those with weak judgment of their own efficacy tend to avoid difficult tasks as they view them as a threat [2].

Computer Experience

Like Computer Anxiety, there is little agreement in the literature on a precise definition of computer experience [9]. Some researchers define it by the number of years of computer experience, while others state that it the number of hour’s usage per week. One of the more comprehensive definitions states that

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computer experience consists of three components: amount of computer use, opportunities to use computers and diversity of experience [16]. This definition captures a greater breath of computer experience than some of the other measures and so was chosen for inclusion in this study.

**Relationship between factors**

Studies that investigate the relationship between self-efficacy and computer anxiety, from fields as diverse as health science [22] and education [15], have revealed that there is a significant correlation between these two factors. This finding is complemented by strong evidence of an association between high computer anxiety and low self-efficacy [5, 15]. This is not an unexpected outcome since as an individual becomes more confident in their ability to complete computer tasks their level of anxiety about doing those tasks decreases. This boost in confidence may be due to an increase in computer experience, for example that gained through education and training [10].

However there is a conflict in the evidence in relation to computer anxiety and computer experience [5, 15]. Some researchers argue that increased experience leads to a decrease in computer anxiety while others state that experience exacerbates an individual’s level of anxiety [4].

Thus, based on these studies it is evident that relationships exist between all three of the factors under consideration. However, the precise nature of these relationships differs depending on the student groups under consideration (e.g. health science, education) and so the results can not be generalised to other student populations (e.g. computer science).

**METHODOLOGY**

The underlying methodology for the three factors under consideration may be measured through the use of validated questionnaires. The next section discusses these questionnaires and their measurements.

**Sample and procedure**

This study was conducted within the Department of Computer Science at Trinity College, Dublin. The statistical sample consisted of 163 participants, comprising 32 female and 131 male students drawn from all four years of the computer science degree. Each student’s participation was purely voluntary and they were assured anonymity. The questionnaire, which is described in more detail in the following section, was administered to the students within the first week of the first term of the academic year. It was felt that it was essential to capture the students’ initial conceptions and beliefs prior to their involvement in the learning process. This was done to insure that their responses where not influenced by any temporary difficulties they may have been experiencing with individual course modules.

**Questionnaire**

The students’ level of computer and software experience, computer anxiety and self-efficacy were assessed using a multi-part questionnaire.

The first section of the questionnaire measured computer anxiety and was adapted from the Computer Anxiety Rating Scale (CARS) [13]. The CARS contains 10 statements which are anxiety laden while the remaining 9 statements are non-anxiety laden statements. Non anxious items are reverse scored before calculating the level of computer anxiety. It was necessary to review and change some of the questions to adjust their relevance for computer science students. Individual scores lie in a range between 19 (low anxiety level) and 95 (high anxiety level).

The self-efficacy questionnaire [19] used in this study was initially designed for the C++ programming language. Students rate their current self-efficacy on a Likert-type scale. Due to the fact that students in Trinity College are taught Java, the original questions were adapted to reflect self-efficacy in this language. The survey consists of 32 questions and the measured level of self-efficacy for an individual can lie between 32 (low self-efficacy level) and 224 (high self-efficacy level).

The final section of the questionnaire was related to computer experience. Three existing surveys [12, 14, 18] were combined to form this section. These surveys were not designed specifically for computer science students therefore

**Relationship between factors and grade**

Computer anxiety research reports that students who perform badly in course assessments or exams have a higher level of computer anxiety than those who succeed [1]. Similarly in relation to self-efficacy it has been observed that increased performance on computer related tasks is directly correlated to a higher level of self-efficacy [10]. Therefore, it may be hypothesised that, for computer science students, low levels of self-efficacy and experience, and high levels of computer anxiety are predictors of a decreased level of performance.

![Figure 1: Predicted Inter-Dependence Between Variables](image)
it was necessary to adjust some of the questions to make them more relevant to the sample population. An additional question was included in this section to determine the amount of time the students use a computer each week.

**RESULTS**

This section presents a statistical analysis of the data collected along with a discussion and evaluation of the main findings. The data was analysed to look at the factors both individually and in combination so that the research questions which guided the study could be addressed. It was anticipated that computer science students would experience a low level of computer anxiety, if any, and that first year students would suffer from the greatest level of anxiety. In order to address this, computer anxiety was measured across the four years of the population. In Figure 2 we observe that most students, independent of their year of study, fall under the category ‘slightly anxious’ which indicates that their level of computer anxiety is relatively low.

![Figure 2: Level of Computer Anxiety over Four Years](image)

The interesting observations on Figure 2 relate to the results of first and fourth year students. The majority of first years rate themselves as only “slightly anxious”; this is better than anticipated prior to administration of the questionnaire. The first year students have a high degree of confidence in their computer abilities. This may be due to the fact that during their second level education their main computer experience is limited to the use of office-type applications. The fourth year students display a wider range in their level of anxiety. This was not as expected: it was predicted that fourth year students would fall into the “mostly not anxious” or “slightly anxious” level due to the fact that they had been working closely with computers for the previous three years. One possible explanation is that the fourth year students are just commencing their final year at university. As a consequence, they are likely to feel anxious about doing well and achieving a good final grade for their degree. Another explanation may be that the fourth year students know more about computer science and therefore are more aware of the limitations of their knowledge.

The next sets of results are for self-efficacy and computer anxiety. Firstly, we examine the level of self-efficacy across the four years of study. It was expected that the first year students have a lower belief in their programming abilities. This is partially due to the fact that programming is not compulsory for second level students in Ireland, so most first year students would have little or no programming experience. Figure 3 presents the distribution across the seven levels of self-efficacy for each year. The first year students have lower levels of self-efficacy; this is as initially expected. However, a closer examination of Figure 3 reveals that the fourth year students have a wider variation in their self-efficacy levels than those in their second or third years. This may be attributed to the fact that they are about to commence their first major individual programming project and hence they may be experiencing some self-doubt.

![Figure 3: Level of Self-Efficacy over Four Years](image)

To further investigate the relationship between computer anxiety and self-efficacy, scatter plots were generated and Pearson’s correlation coefficients calculated. The circles in Figure 4 indicate the expected levels of computer anxiety versus self-efficacy for the four years of the course as proposed in our initial hypothesis. Figure 4 illustrates that first year students have a medium level of computer anxiety with low self-efficacy. The corresponding Pearson correlation coefficients (see Table 1) do not show a statistically significant relationship between the two factors for first year students. The correlation coefficients for the other three years indicate that there is a significant negative relationship between the factors. Moreover, this relationship increases in strength with the year of study. Therefore, as the level of self-efficacy increases the level of computer anxiety decreases.

In the computer usage and software experience section of the questionnaire, the majority of students from each year were observed to have “average experience” except for the second year students who were more confident and rated their ability as “very experienced”. The fact that both first year and fourth year students rated themselves similarly might be
explained by the different meanings that students were giving to the term “experience”. The fourth year students are close to completing their computer science degree and so should rate their experience more highly. However, given that this is the last year of their degree course they may be more aware of the deficiencies in their knowledge and capabilities.

A relationship was expected to exist between self-efficacy and computer experience [5, 10, 15, 22]. Table 1 displays the correlation coefficients for these factors. This confirms the existence of a significant positive relationship, which demonstrates that as the level of computer experience increases so does the level of self-efficacy. Thus the students’ level of belief in their abilities is increases as they progress with their course of study.

**RECOMMENDATIONS**

If our hypothesis is correct then the next issue to be addressed is the methods by which self-efficacy, anxiety and experience levels can be improved.

Computer Anxiety

Recommendations for the alleviation of computer anxiety include special seminars, additional classes, individual counselling and group therapy [6]. However, most educators do not have the resources to implement these suggestions in their classrooms.

Bower & Bower [6] propose a more practical solution which is attainable by educators. The first step of this solution is to identify class members who suffer from computer anxiety. Then the educator can reassure these students that, regardless of their previous experience, they will be provided with the necessary resources to complete course assignments. Additionally, it is recommended that educator’s make the first assignment straight forward and provide sufficient time for its completion. This will assist students in gaining confidence with the course material.

Another alternative is to pair students with high anxiety to students with low anxiety [6]. This enables students to learn from their peers and increase their confidence in the presence of a friend rather than an educator.

Self-Efficacy and Experience

It is widely recognised that the level of self-efficacy and experience can be altered through education and training [5, 9, 20]. Educators can add supplementary practical classes to their courses or include additional practical assignments to assist students in increasing their levels of self-efficacy and experience.

**CONCLUSION**

This study investigated whether CS students in Trinity College students suffer from computer anxiety and low self efficacy. The computer experience of the students was also examined since literature in this field indicated there is a relationship between these three factors. The study was conducted with CS students from all four years and the findings revealed that student suffer from higher than expected levels of computer anxiety. Additionally, low self-efficacy levels are very common among first and fourth year students. Based on the results a negative relationship was observed between computer anxiety and experience which means that as computer experience increases, the student’s level of anxiety decreases. Also a statistically significant positive correlation was identified between experience and self efficacy, which denotes that when the former increases the students become more self confident and their level of self-efficacy increases.

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**TABLE I**

**PEARSON’S CORRELATION COEFFICIENTS**

<table>
<thead>
<tr>
<th>Pearson Correlation</th>
<th>Computer Anxiety Vs Self-efficacy</th>
<th>Computer Anxiety Vs Experience</th>
<th>Self-efficacy Vs Experience</th>
</tr>
</thead>
<tbody>
<tr>
<td>First Year</td>
<td>-0.262</td>
<td>-0.598**</td>
<td>0.519**</td>
</tr>
<tr>
<td>Second Year</td>
<td>-0.546**</td>
<td>-0.513**</td>
<td>0.565**</td>
</tr>
<tr>
<td>Third Year</td>
<td>-0.614**</td>
<td>-0.606**</td>
<td>0.534**</td>
</tr>
<tr>
<td>Fourth Year</td>
<td>-0.725**</td>
<td>-0.708**</td>
<td>0.612**</td>
</tr>
</tbody>
</table>

**Correlation is significant at the 0.01 level (2-tailed)**
Self-efficacy and computer anxiety are dependent on the current mood of the participant. To capture a more accurate picture of the evolution of student beliefs it would be necessary to administer the questionnaire periodically over the academic year. It would also be informative to carry out a longitudinal study which follows a class throughout the four years of their degree course.

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REFERENCES