An investigation of computer anxiety by gender and grade

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Abstract

Many tests have been constructed to assess computer anxiety. This has lead to the construct being conceptualised in some cases as a multidimensional, with a confusing array of dimensions, and also, implicitly, as unidimensional. The present study has used the computer-anxiety index (CAIN), a scale previously developed by Simonson, Maurer, Montag-Torardi, and Whitaker [Simonson, M. R., Maurer, M., Montag-Torardi, A., & Whitaker, M. (1987). Development of a standardised test of computer literacy and a computer anxiety index. Journal of Educational Computing Research 3(2), 231–247] to test its unidimensionality with the view to arrive at a scale that provides a unidimensional measure, hence avoiding the conceptual confusion of multidimensionality. Rasch analysis [Rasch, G. (1980). Probabilistic models for some intelligence and attainment tests. Chicago: The University of Chicago Press (expanded edition, original work published 1960).], a technique that has been adopted in international educational measurement studies such as the Third International Mathematics and Science Study (TIMSS) and the Program for International Assessment (PISA), was used to analyse the responses from 910 grade 7, 9 and 11 male and female students. The response patterns obtained conformed to the strict requirements the Rasch model and confirmed the assumption that all 26 items of the Computer-Opinion Survey measured a single underlying trait. This result differed somewhat from that of a previous investigation by King and Bond [King, J., & Bond, T. (1996). A Rasch analysis of a measure of computer anxiety. Journal of Educational Computing Research 14(1), 49–65.] where for the lowest age group alone, six of the items were rejected. An investigation of the grade facet indicated that grades 7 and 9 were measurably different in computer anxiety from grade 11, and that grades 7 and 9 were the same within error. Investigation of the gender facet revealed a small measurable difference in computer anxiety between males and females, with males being more anxious than females. There was a significant interaction between gender and grade with a

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1. Introduction

Computers are fast becoming an essential tool in the areas of work, school and leisure. Computer use is a part of the school curriculum that aims to increase students’ computer literacy and provide students with the skills to enhance learning, and to access information. Due to the increasing importance of attaining at least a rudimentary level of computer literacy in today’s technological society, it is desirable to minimise students’ computer anxiety levels (Bowers & Bowers, 1996; Brosnan, 1998; Goss, 1996; Hemby, 1998; Presno, 1998) as high computer anxiety is considered to reduce a person’s effectiveness when utilising a computer (Rozell & Gardner, 1999; Shelley, 1998). This is increasingly important as sources of information are now universally available via computers on the Internet. Not only students, but people re-training in the workforce need to develop computer skills unencumbered by the emotional constraints that can accompany the attainment of those skills. Delveccio (1995) reported on a study by Deakin University that found one in 10 young people suffer from computer anxiety even though over 50% had computers at the time of the survey. Other reports suggest that feelings of anxiety toward computers and computer use is common, affecting 30–40% of the population (Tseng, Tiplady, Macleod, & Wright, 1996).

Anxiety can generate a range of emotional responses and two different methods can be used to identify these responses. The first involves detecting actual physiological changes in the subject. The second method requires the subject to complete self-report tests, a procedure more practical than the former in educational environments. These tests generally use a Likert scale format and record persons’ perceived feelings, attitudes and reactions as opposed to how their bodies are actually responding.

Psychologists have classified general anxiety into two areas. One domain is trait anxiety, and the other is state anxiety (Biggs & Moore, 1993). Trait anxiety can be described as “a general readiness to react with anxiety in many situations” (Biggs & Moore, 1993, p. 243). State anxiety refers to “anxiety actually experienced in a particular situation” (Biggs et al., 1993, p. 243). Examples of state anxiety would be maths and test anxiety (Hunsley, 1987). Computer anxiety as state anxiety can generally be defined as “the fear or apprehension felt by individuals when they use computers, or when they consider the possibility of computer utilisation” (Simonson, Maurer, Montag-Toradi, & Whitaker, 1987, p. 238).

In the literature, computer anxiety is sometimes subsumed under the more general definition of computer attitude (Simonson et al., 1987), a practice that does little to assist in its measurement. It is recognised by at least some researchers that computer
anxiety and a person’s attitudes toward computers are different conditions (Kernan & Howard, 1990; Rosen, Sears, & Weil, 1987).

2. Aspects of computer anxiety

2.1. Tests

One test of computer anxiety that has been utilized in a number of studies is the Computer Attitude Scale (CAS) developed by Loyd and Gressard (1984). This scale assumes that there are three factors that underlie the concept of computer anxiety. These factors include: anxiety towards computers, computer liking, and computer confidence. Loyd and Loyd (1985) added an additional sub-scale labelled computer usefulness.

Kluever, Lam, Hoffman, Green, and Swearingen (1994) investigated the reliability of the CAS developed by Loyd and Loyd (1985). They also tested its factorial validity and fit to a unidimensional model. The factors they identified were congruent with the factors identified by Loyd and Loyd (1985). However, they suggested that some items did not fit a unidimensional model. After further analyses they concluded that some question revisions should be considered.

The CAS (Loyd & Gressard, 1984) was examined again by Bandalos and Benson (1990) in a separate study. They tested for invariance in the grouping conditions of males/females and graduates/undergraduates. They revised the CAS so that it consisted of only 23 items that portrayed the three factors of Computer Liking, Computer Confidence, and Computer Achievement. Not all of the factor analyses of the scale led to common factors. The three factors were found to be invariant over both conditions. The dimensions of Computer Liking and Computer Confidence differed to those described by Loyd and Gressard (1984). Bandalos and Benson (1990) insinuated that there could be “some inconsistency in the hypothesised dimensionality of the construct, computer anxiety”, the reason being that not all of the factor analyses of the scale led to common factors. They also mentioned that for a scale to demonstrate construct validity, it is necessary to compare computer anxiety scores across groups. This suggestion has been followed through with the present study.

Another test of computer anxiety, the Computer-Anxiety Scale Short Form (CAS-SF), was developed by Campbell and Dobson (1987). This scale however was based on the CAS developed by Newman and Clure (1984). It gave rise to two major factors revealed from a factor analysis of the 30 item CAS: fears related to computer-usage skills and self-concept based on computer-usage skills. However, they suggested that the validity of the computer anxiety scale was difficult to establish. They maintained that it was possible that the scale could be measuring confidence based on computer anxiety, rather than computer anxiety itself.

Simonson et al. (1987) created a test of computer literacy named the Computer-Opinion Survey. From this survey, scores could be calculated to formulate a Computer-Anxiety Index (CAIN) according to the authors. The 26 items were chosen from a pool of items that presumed to indicate how anxious a person felt about
computers. While the items cover aspects such as computer liking, computer achievement, computer confidence and the necessity for computers, the author’s use of the CAIN appeared to assume that the test was unidimensional. It was because of this apparent assumption of unidimensionality that the authors of the present study applied Rasch analysis to the responses of students to the Computer Opinion Survey to test its unidimensionality. A comparison study of the CAIN with three other instruments (Gardner, Discenza, & Dukes, 1993) revealed that all of the measures involved were basically equal in terms of reliability and validity, and that deriving improved scales was unproductive. The CAIN achieved a 66% (fairly easy) rating in readability suggesting that the CAIN is an appropriate test for grade 11 students and above, rather than lower grades.

2.2. Experience

King (1993) queried the CAIN scores obtained from the Computer-Opinion Survey (Simonson et al., 1987) in a school investigation. The study examined computer usage and computer anxiety within a group of 11–12 year-old elementary school students. The three classroom groups (of roughly 30 in number) had been exposed to a larger than usual number of microcomputers over nine months (King, 1993). The Computer Opinion Survey was administered both at the commencement and at the end of a nine-month period, and it was hypothesised that anxiety levels would decrease. Results of a repeated-measures ANOVA indicated a significant increase in computer anxiety scores on the CAIN. This was contrary to the expected results, namely, the more computer experience a person has, the less computer anxious they are likely to be. Interviews conducted with six purported high-anxiety students revealed that these students felt more dissatisfaction with computer access and with the lack of game playing rather than more fear about computers (King, 1993). These results challenged the validity of the Computer Opinion Survey at the high-anxiety end of the scale. King hypothesised that the test could also be measuring frustration. The results of this study prompted a more detailed investigation of the measurement characteristics of the Computer-Anxiety Index (CAIN).

A study by Rosen et al. (1987) assessed attitudes with the computer anxiety rating scale (CARS), and their results also indicated that computer interaction did not necessarily reduce anxiety. They reported that a number of students became more anxious and recorded more negative attitudes after working with computers. Colley, Gale, and Harris (1994) examined the effects of prior experience upon computer anxiety, confidence and liking and found that experience at home was associated with lower anxiety for both males and females.

McInerney, McInerney and Sinclair (cited in Bezzina & Butcher, 1991) concluded that “Increased computer experience alone will not reduce computer anxiety” (p. 688). They also stipulated that for some people, more computer experience can worsen anxiety. Studies by King (1993) and Goss (1996) supported this assertion.

It appears that the type and/or quality of experience is an important factor in the prediction of computer anxiety. As Goss stated “Computer anxiety is created; it is not a birth defect waiting to be healed”.
2.3. Age

Loyd and Gressard (1984) reported some significant age effects in their study of 354 high school and college students. They concluded that older students were more confident users of computers and did not find any clear trend with age. Rosen et al. (1987) found that “older students were more computer anxious, but did not have more negative attitudes than did younger students” (p. 167).

A study by Krendl and Boihier (1992) examined a group of students from fourth through to tenth grade and concluded that “age is an additional factor that consistently shapes individuals’ perceptions of and attribution’s about computers.” (p. 225). They reported that the perceived difficulty of using computers remained stable, suggesting that age may not be a factor in predicting computer anxiety. Other researchers (Harris & Grandgenett, 1996; Kubeck, Miller-Albrecht, & Murphy, 1999) also found that age was a negligible variable in their studies.

The findings from age-related computer anxiety studies suggest that it is difficult to isolate whether age or experience is the major contributing factor that influences the level of computer anxiety.

2.4. Gender

There is a voluminous amount of literature relating to gender and computer usage and the findings are somewhat conflicting. One group of research findings revealed that males have more positive attitudes and less computer anxiety than females (Anderson, 1987; Chambers & Clarke, 1987; Colley et al., 1994; Hattie & Fitzgerald, 1987; Krendl & Broihier, 1992; Okebukola, 1993). However, in another collection of studies, females were found to have more positive attitudes and less anxiety than males (Lever, Sherrod, & Bransford, 1989; Loyd, Loyd, & Gresssard, 1987; Siann, Macleod, Glissow, & Durndell, 1990; Swadener & Jarrett, 1987). Other studies found negligible differences (Chen, 1986; Colley et al., 1994; Collis, 1985; Collis & Williams, 1987; Kay, 1992; Scott & Rockwell, 1997).

It appears that considerable doubt remains regarding the relative differences in computer anxiety between males and females. Kay (1992) suggested that the conflicting results were due to inconsistencies in the empirical methods used to collect data and made a number of suggestions in relation to research methodology, including the improvement of construct and scale development.

The present study has attempted to clarify the conceptual inconsistencies in multidimensional descriptions of computer anxiety in previous studies that not only vary markedly in the number of dimensions described, but also in the nature of those dimensions. The unidimensional nature of the construct for a wider age range of grade 7, 9 and 11 students is examined. Rasch analysis, a technique that has been adopted in international educational measurement studies such as the Third International Mathematics and Science Study (TIMSS) and the Program for International Assessment (PISA), was seen to provide an appropriate measurement model to accomplish this as it statistically models the complete set of relationships between all data points.
3. Methodology

3.1. Subjects

The data used in this study were collected from 372 grade seven, 314 grade nine and 224 grade eleven students from a stratified sample of government and private primary schools and high schools in a large regional city in Australia. The age range of students varied from 12 to 16 years. Stratification of the sample was done by obtaining a random proportional sample of schools and then a random proportional sample of classes within the selected schools to ensure that a wide variety of students of different ability levels from different types of schools were involved. Given the sample size and the sampling strategy, the group can be reasonably described as being representative of the population of grade 7–11 students—which exceeds the requirement of the Rasch model.

Testing was undertaken with class groups in these schools. One of the researchers and a research assistant shared the task of visiting the classes chosen and provided the identical instructions to each group. Students were advised that they were being asked to provide their opinions about computers and that they could ask the researcher if they had a query about any of the questions. The researchers then provided explanations for any questions that arose.

3.2. Instrument

The Computer-Opinion Survey (Montag, Simonson, & Maurer, 1984) was used to assess computer anxiety in this study. It can be described as a 26 prompt Likert-style test. Students were required to read the assertions, then circle the scale number that indicated the degree to which they either agreed or disagreed with the prompt. For example, for the prompt: “I will probably never use a computer”, the student would then respond by circling either: 1 = Strongly agree; 2 = Agree; 3 = Slightly agree; 4 = Slightly disagree; 5 = Disagree; 6 = Strongly disagree. A Computer Anxiety Index (CAIN) score can be calculated by summing the scores for each item, after the scores of negatively worded questions have been reversed.

3.3. Software

The Rasch measurement model (Rasch, 1980) was used to analyse the Likert data obtained. This was done using the ConQuest computer program (Wu, Adams, & Wilson, 1998). The Rasch model (often, but a little misleadingly, referred to as a one parameter Item-Response Theory model) is used to estimate the probability that any person will choose any particular response in a survey item. This is done, in this case, by estimating the difference between the anxiety level of a person and the extent of anxiety detected by an item (Weitzman, 1996). The Rasch model can be described as “a mathematical formulation that predicts the probabilities of the responses of a sample of subjects, who vary in the exhibition of a trait, to a test that has items of varying endorsability designed to detect the presence of that trait”
The Rasch analysis allows the students’ response patterns for each item to be compared with their responses for all other items. This aims to ascertain the extent to which the item measures the same variable as the other items (Van Alphen, Halfens, Hasman, & Imbos, 1994). It is a central measurement principle that measures of an attribute should be derived only from items that measure the same construct. Indeed, proponents of the Rasch model routinely assert that it is the only currently available psychometric technique capable of producing the interval scale measures that are central to scientific measurement (Bond & Fox, 2001). The complete reliance on the Rasch model for producing the comparisons central to the TIMMS and PISA international assessments is exactly due to this fundamental measurement property.

Items not fitting the model (say, at the level of \( p < 0.05 \); Adams & Khoo, 1993), are routinely excluded from the calculation of person anxiety measures. Reasons for aberrant response patterns might include guessing, inattention, the nature of individual items (poorly worded, detection of other traits, etc.), carelessness, or student misunderstanding.

The Rasch model can be directly applied to the CAIN because the CAIN is assumed to detect a single unidimensional construct (computer anxiety), and trait estimates or scores are computed by adding all of the subjects’ responses to obtain a single total score. A factor-analytical model might be more appropriate with an instrument such as the CAS (Bandalos & Benson, 1990) because of the CAS’s explicitly multi-dimensional nature, comprising computer liking, computer confidence and computer achievement. (King & Bond, 1996; Sax, 1989).

ConQuest allows within a single computer program a variety of Rasch-based models. The model chosen as appropriate for this analysis was the many-facets Rasch model (Linacre, 1989) in which the measurement of other facets of interest, additional to students and test items, were grade level and gender. The many-facets Rasch model allows for the simultaneous estimation of facet values in order that they may be considered individually.

### 4. Results

The Rasch model locates both person estimates of computer anxiety and estimates of test-item difficulties, as well as facet values, along the same single scale. These estimates are recorded as logits (log odds units). Fig. 1, which was adapted from the ConQuest output, shows the wide-ranging variation in the computer anxiety estimates for the combined grade seven, nine and eleven sample. Persons (identified by Xs) located at the bottom of the scale in the negative logit range, have less computer anxiety. Items (indicated by item number and difficulty threshold, e.g. 3.1) at the same low level are ones this sample found “easy to endorse”. The persons (identified by Xs) located at the higher end of the scale are measured as having high anxiety. The items at the top of the scale in the positive logit range, (e.g. 1.2, 14.3) are those that this sample found “most difficult to endorse”.
Fig. 1. CAIN facets. A map of item response model parameter estimates. Each ‘X’ represents 4.9 cases.
The distribution of students (X) along the logit scale (Fig. 1) indicates that most of the sample is located around the middle to low anxiety level. There appear to be few very anxious students, and few students with very low levels of anxiety. This is similar to the results for the King and Bond study (1996).

The Rasch analysis performed on the data for the three grades combined determined that while all items fitted the Rasch model strict requirements for measurement, there was, as expected, some variation between items, with some exhibiting a better fit than others (Table 1). Fit indices are based on the deviations between the model’s expectations and the actual person and item responses. The mean-square of

<table>
<thead>
<tr>
<th>Item</th>
<th>Estimate (logits)(^a)</th>
<th>Error</th>
<th>Unweighted fit(^c)</th>
<th>Weighted fit(^d)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>MNSQ</td>
<td>r(^e)</td>
</tr>
<tr>
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<td>0.369</td>
<td>0.032</td>
<td>0.95</td>
<td>-0.3</td>
</tr>
<tr>
<td>2</td>
<td>0.207</td>
<td>0.031</td>
<td>0.98</td>
<td>-0.1</td>
</tr>
<tr>
<td>3</td>
<td>0.021</td>
<td>0.029</td>
<td>1.09</td>
<td>0.7</td>
</tr>
<tr>
<td>4</td>
<td>-0.121</td>
<td>0.028</td>
<td>1.03</td>
<td>0.3</td>
</tr>
<tr>
<td>5</td>
<td>0.068</td>
<td>0.030</td>
<td>1.10</td>
<td>0.7</td>
</tr>
<tr>
<td>6</td>
<td>0.265</td>
<td>0.031</td>
<td>0.91</td>
<td>-0.6</td>
</tr>
<tr>
<td>7</td>
<td>0.113</td>
<td>0.031</td>
<td>1.07</td>
<td>0.5</td>
</tr>
<tr>
<td>8</td>
<td>0.032</td>
<td>0.031</td>
<td>0.89</td>
<td>-0.7</td>
</tr>
<tr>
<td>9</td>
<td>0.209</td>
<td>0.034</td>
<td>0.98</td>
<td>-0.1</td>
</tr>
<tr>
<td>10</td>
<td>-0.261</td>
<td>0.028</td>
<td>0.90</td>
<td>-0.7</td>
</tr>
<tr>
<td>11</td>
<td>-0.067</td>
<td>0.029</td>
<td>0.95</td>
<td>-0.3</td>
</tr>
<tr>
<td>12</td>
<td>0.032</td>
<td>0.030</td>
<td>0.99</td>
<td>-0.0</td>
</tr>
<tr>
<td>13</td>
<td>0.253</td>
<td>0.033</td>
<td>0.79</td>
<td>-1.4</td>
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<tr>
<td>14</td>
<td>-0.134</td>
<td>0.029</td>
<td>1.06</td>
<td>0.4</td>
</tr>
<tr>
<td>15</td>
<td>-0.328</td>
<td>0.027</td>
<td>1.04</td>
<td>0.3</td>
</tr>
<tr>
<td>16</td>
<td>0.097</td>
<td>0.031</td>
<td>0.85</td>
<td>-1.1</td>
</tr>
<tr>
<td>17</td>
<td>0.010</td>
<td>0.029</td>
<td>0.89</td>
<td>-0.8</td>
</tr>
<tr>
<td>18</td>
<td>0.048</td>
<td>0.030</td>
<td>0.85</td>
<td>-1.0</td>
</tr>
<tr>
<td>19</td>
<td>-0.171</td>
<td>0.028</td>
<td>1.27</td>
<td>1.8</td>
</tr>
<tr>
<td>20</td>
<td>0.167</td>
<td>0.032</td>
<td>1.07</td>
<td>0.5</td>
</tr>
<tr>
<td>21</td>
<td>0.084</td>
<td>0.032</td>
<td>1.09</td>
<td>0.6</td>
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<td>22</td>
<td>0.120</td>
<td>0.031</td>
<td>0.90</td>
<td>-0.7</td>
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<td>23</td>
<td>-0.255</td>
<td>0.028</td>
<td>1.14</td>
<td>1.0</td>
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<td>24</td>
<td>0.093</td>
<td>0.031</td>
<td>1.05</td>
<td>0.4</td>
</tr>
<tr>
<td>25</td>
<td>-0.912</td>
<td>0.025</td>
<td>1.27</td>
<td>1.8</td>
</tr>
<tr>
<td>26</td>
<td>0.060(^b)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

\(\text{a}\) A logit is a logarithmic scale unit representing a linear, interval measurement such that any difference in item difficulty or student anxiety maintains its value anywhere along the common scale.

\(\text{b}\) Indicates a constrained parameter in the ConQuest estimation procedure.

\(\text{c}\) Unweighted (outfit) statistics monitor responses of clients towards the extremes of the scale more closely.

\(\text{d}\) Weighted (infit) statistics for any item derive most information from the responses of clients close to this item.

\(\text{e}\) Standardised fit statistics have a \(t\)-distribution, so values outside the range –2 to +2 are problematic.
item residuals are calculated, with a range of 0.7–1.3 is usually taken as an acceptable
range, with items lying in that range accepted as conforming to the model (Adams &
Khoo, 1993).

The Rasch analysis detected that two of the items were close to the limits of the
acceptable range. Question 25, with an unweighted mean-square index of 1.27, and a
weighted fit of 1.29 was the most poorly fitting item. Interestingly, this item “I some-
times feel that computers are smarter than I am” was also the most poorly fitting item
in the King and Bond (1996) study and was one of the six items rejected as misfitting in
that study, because its mean-square fit value was well outside the acceptable range.

5. Grade

The facets analysis obtained from the ConQuest program allowed for a compar-
ison of the anxiety estimates of the three grades. Values for facet estimates may be
interpolated on the same logit scale as used for Fig. 1. An analysis of this grade facet
revealed that the differences in computer anxiety estimates for grades 11, 9 and 7
were small with regard to mean levels of anxiety (Table 2). Grade 11 (−0.021 logits)
was the least anxious grade overall. Error estimates indicate that the computer
anxiety levels for grades 7 and 9 are not measurably different, whereas the anxiety
estimates for both grades 7 and 9 are measurably greater than that of the grade 11
group.

Table 2
Grade parameter estimates

<table>
<thead>
<tr>
<th>Grade</th>
<th>Anxiety estimate</th>
<th>Error estimate</th>
<th>Unweighted fit</th>
<th>Weighted fit</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>MNSQ</td>
<td>t</td>
</tr>
<tr>
<td>11</td>
<td>−0.021</td>
<td>0.010</td>
<td>1.03</td>
<td>0.3</td>
</tr>
<tr>
<td>9</td>
<td>0.019</td>
<td>0.010</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>0.002</td>
<td>0.009</td>
<td>1.00</td>
<td>0.0</td>
</tr>
</tbody>
</table>

a Indicates a constrained parameter in the ConQuest estimation procedure.

Table 3
Gender parameter estimates

<table>
<thead>
<tr>
<th>Gender</th>
<th>Anxiety estimate</th>
<th>Error estimate</th>
<th>Unweighted fit</th>
<th>Weighted fit</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>MNSQ</td>
<td>t</td>
</tr>
<tr>
<td>Males</td>
<td>0.064</td>
<td>0.008</td>
<td>1.01</td>
<td>0.1</td>
</tr>
<tr>
<td>Females</td>
<td>−0.064a</td>
<td>0.008</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

a Indicates a constrained parameter in the ConQuest estimation procedure.
5.1. Gender

ConQuest analysis also calculated results for the gender facet. Table 3 reveals that there was a small but measurable difference between males and females with the males having a higher anxiety level.

5.2. Gender and grade

The possibility of an interaction between grade and gender was also estimated using the ConQuest program (Table 4). The data indicates that females are measurably more computer anxious at the grade 7 level, that there is no measurable gender difference at the grade 9 level and that males are measurably more anxious at the grade 11 level. This could suggest a changeover period around grade 9 above which grade the females become measurably less anxious about using computers compared to males.

6. Discussion

Analysis of the Computer-Opinion Survey responses using Rasch analysis has revealed that within the fit range specified, all of the items in the Computer-Opinion Survey were measuring the same single unidimensional construct for grades 7, 9, and 11 taken together. Hence it can be treated as a unidimensional test for this age range. This reveals the benefit of having a larger appropriate sample for determining a test’s measurement characteristics. While the responses of the grade 7 students from the King and Bond (1996) study, taken on their own, raised doubts about the dimensionality of the CAIN, the patterns of this much larger sample are much more congruent with the unidimensionality premise that always underlies the summation of scores to yield a single computer anxiety index for each respondent.

Table 4

<table>
<thead>
<tr>
<th>Gender</th>
<th>Grade</th>
<th>Anxiety estimate</th>
<th>Error estimate</th>
<th>Unweighted fit</th>
<th>Weighted fit</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>MNSQ</td>
<td>MNSQ</td>
</tr>
<tr>
<td>Male</td>
<td>11</td>
<td>0.071</td>
<td>0.010</td>
<td>1.03 0.3</td>
<td>1.03 0.5</td>
</tr>
<tr>
<td>Female</td>
<td>11</td>
<td>−0.071a</td>
<td></td>
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<td></td>
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<tr>
<td>Female</td>
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<td>0.009a</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>7</td>
<td>−0.062</td>
<td>0.009</td>
<td>1.00 0.0</td>
<td>1.03 0.4</td>
</tr>
<tr>
<td>Female</td>
<td>7</td>
<td>0.062a</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

a Indicates a constrained parameter in the ConQuest estimation procedure.
Item 25, and to a lesser extent item 19, are the only items for which fit results are marginal. That is, high anxiety students and students with low anxiety were more inclined to respond to these items in a less differentiated manner that was the case for other items. The marginal status of item 25 in this study is in agreement with the King and Bond (1996) finding where item 25 was the most misfitting item. There it was hypothesised that low-anxiety students might presume computers are smarter than they are, and are consequently attracted to them because of their capacity to do tasks. High anxiety students however may also agree that computers are smarter than they are, and as a consequence become fearful of them. Unlike the King and Bond survey, this study found item 19 “I am usually uncomfortable when I have to use computers”, just inside the acceptable fit range. This could be indicative of the ambiguous nature of the question. Is the question asking about the person's mental state or about their physical comfort? A less ambiguous prompt might focus on the former.

It was interesting to note that Item 1 “Having a computer available to me would improve my productivity” was well within the acceptable mean-square fit range. It was hypothesised in the previous study that grade 7 children did not view computers as a productivity tool. Because many primary school children use computers for games, King and Bond (1996) suggested that the question was rejected in their study because this attitude was widely held within the sample. Another reason for the rejection in the grade 7 sample could be that the younger students, unlike grade 9 and 11 students, may have had trouble understanding the word ‘productivity’. The reason that the higher age groups appeared to understand this difficult wording might also be applied to other questions that were rejected in the King and Bond (1996) study.

Fig. 1 indicates that the CAIN cannot be measuring the anxiety levels of the low anxiety students very well. This is apparent because there are no questions at a similar position on the logit scale discriminating between the low anxious students on the lower end of the scale. Most of the questions are located where they measure those students with a moderate level of anxiety. This is evident because most of the questions are located quite close to the zero mark on the logit scale. This in itself is not problematic, as it is the students with higher anxiety that one would normally wish to identify. Additional questions would need to be added to the test to better measure the degree of anxiety on the lower extreme of the scale. In principle, a greater spread of item difficulty estimates would improve the utility of the measure, as the range of the CAIN appears quite restricted.

Examination of the gender facet alone revealed that there was a small measurable difference between males and females. The fact that this difference is small supports the literature, where there is no clear indication of gender differences in this area.

The literature has suggested that older students are more computer anxious, yet do not have more negative attitudes than younger students (Rosen et al., 1987). When comparing gender and grade together, the males were the higher anxiety group in grade eleven and the females were the higher anxiety group in grade 7. These results suggest a changeover period at year nine where there were no measurable gender differences. This could occur because games become a less prominent part of computer usage in schools by grade 11 and computer game usage is an area
that is generally dominated by males. Females tend to be the more serious users of computers in this age range, whereas evidence exists that some males are affected by their construction of the computer as a toy for game playing. This difference in construction of the computer as a toy by males and as a tool by females may also help to explain the crossover in anxiety levels from year 7 to 11.

The changeover might also happen because more females than males generally choose subjects at and beyond grade 9 where computers are an integral part of the curriculum; for example typing or business studies. Gilroy and Desai (1986) found that exposure and experience is necessary to instil confidence. The familiarity and positive experience gained as a result of computer usage such as word processing could be a contributory factor to the lessening of anxiety amongst females.

An additional reason to explain the differences in grade 11 could be that computers are now being used as a communication tool. Many computer users now frequent communication facilities such as chat-rooms located on the Internet. Females are often considered to be better communicators than males, and the computer, seen in this communications context, could help females view the computer as less of a threat. The more that anxious females see computers as a method of communication and not merely as a computational tool, the less likely they may construct the computer as masculine.

Another possible reason for the difference in year 11 could be the phenomenon of these older males to consider it ‘uncool’ to participate in academic subjects. As computers become more a part of school subjects, perhaps they are shunned as work tools by lower ability males. By the time these students reach a higher grade, they may consequently feel more anxiety when using computers. Anxiousness of computers on the part of some males may be as a result of impending academic activity.

Age and experience appear to be inextricably linked when describing the profile of a computer anxious person. In the case of this study, grade 11 had the lowest anxiety, followed by grade 7, and then by grade 9. This finding conflicts with the assumption that computer anxiety becomes less apparent with age. However, the experience of the students in the three grade groups was not quantified. But given the size and diversity of each grade sample, it would not be unreasonable to claim that their computer experience increased with grade.

7. Conclusions

There are many different tests of computer anxiety. For results to be considered acceptable, it is important to properly conceptualise the construct and consider the age range of the sample under consideration. The present study has attempted to clarify the conceptual inconsistencies in multi-dimensional descriptions of computer anxiety in previous studies that vary markedly, not only in the number of dimensions described, but also in the nature of those dimensions.

The results from this study indicate that the 26-item CAIN developed by Simonson et al. (1987) is a unidimensional test of computer anxiety across a sample of grades 7, 9 and 11. By verifying the unidimensionality of this scale for the age range
involved, the confusion of the variable descriptions of multidimensional scales is
avoided, and adherence to an important measurement principle is affirmed. The
modified 20-item CAIN recommended by King and Bond (1996) might remain more
suited for students at the lower end of this range.

The small but measurable difference found between males and females across
the age range suggests that gender is not an important variable in considering
differences in computer anxiety. It could be argued that gender differences will cease
to be measurable as computers are more and more perceived by females as a com-
munications device.

The change in computer anxiety between grade 7 and 11 is interesting and may
deserve more fine-grained attention through qualitative studies to determine the
nature of this reversal. On the other hand, while the many-facets Rasch model is
able to both model and measure such group differences with considerable precision,
experience suggests that such small differences may have little or no meaning in
educational practice.

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**Vitae**

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