Rasch and Confirmatory Factor Analysis of the Trait Emotional Intelligence Questionnaire Short Form

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Funding: NHS Education Scotland/Scottish Government Health Directorate Delivery Group. Supporting the development of the evidence base for Recruitment, Selection and Retention of nursing and midwifery students in Scotland. Funding £24,411

Conflict of interest: No conflict of interest was declared by the authors in relation to the study itself. Note that Roger Watson is *JAN* Editor-in-Chief but, in line with usual practice, this paper was subjected to double blind peer review and was edited by another editor.

ABSTRACT

Aim. To examine the construct validity of the Trait Emotional Intelligence Questionnaire Short form.

Background

Emotional intelligence involves the identification and regulation of our own emotions and the emotions of others. It is therefore a potentially useful construct in the investigation of recruitment and retention in nursing and many questionnaires have been constructed to measure it.

Design

Secondary analysis of existing dataset of responses to Trait Emotional Intelligence Questionnaire Short form using concurrent application of Rasch analysis and confirmatory factor analysis.

Method

First year undergraduate nursing and computing students completed Trait Emotional Intelligence Questionnaire-Short Form in September 2013. Responses were analysed by synthesising results of Rasch analysis and confirmatory factor analysis.

Results

Participants (N=938) completed Trait Emotional Intelligence Questionnaire Short form. Rasch analysis showed the majority of the Trait Emotional Intelligence Questionnaire-Short Form items made a unique contribution to the latent trait of

emotional intelligence. Five items did not fit the model and differential item functioning (gender) accounted for this misfit. Confirmatory factor analysis revealed a four-factor structure consisting of: self-confidence, empathy, uncertainty and social connection. All five misfitting items from the Rasch analysis belonged to the 'social connection' factor.

Conclusions

The concurrent use of Rasch and factor analysis allowed for novel interpretation of Trait Emotional Intelligence Questionnaire Short form. Much of the response variation in Trait Emotional Intelligence Questionnaire Short form can be accounted for by the social connection factor. Implications for practice are discussed.

Key words: Emotional Intelligence; Nursing; Gender; Recruitment; Retention; Rasch Analysis; Factor Analysis; Trait Emotional Intelligence Questionnaire Short form; TEIQue-SF

Summary Statement

Why is this research or review needed? □

- Emotional Intelligence is a potentially useful construct to understand in recruitment, retention and development of nurses.

- The 130-item Trait Emotional Intelligence Questionnaire is a well-validated measure of emotional intelligence.

- The 30 item short form needs further testing as it claims to measure both a single latent trait *and* a factor structure.

What are the key findings? □

- Concurrent Rasch analysis and Confirmatory Factor Analysis revealed neither a latent trait nor the specified *a priori* factor structure.

- Both analyses independently revealed five misfitting items interpreted here as the 'social connection' factor within Trait Emotional Intelligence Questionnaire – Short Form.

- The social connection factor accounted for the gender difference in emotional intelligence scores in adult nurses.

How should the findings be used to influence policy/practice/ research/education?

- Combining factor analysis with Rasch analysis on the same dataset revealed an interpretation that could not have been reached by using either method in isolation.

- The relationship between 'Social Connection' and subsequent performance should be examined empirically.

- Caution should be exercised in using any psychometrics for nursing recruitment without understanding their properties as applied to local datasets.

INTRODUCTION

Emotional intelligence (EI) is increasingly referred to in the nursing literature, yet there is no single agreed definition of what EI is (Petrides & Sevdalis 2010). The most commonly encountered definition is based on Salovey and Mayer's (1990) conceptualisation of EI as an ability, a form of intelligence. Such a conceptualisation focuses on the individual's ability to perceive and manage their own and other's emotions, using this information as the basis for action, in accordance with their development of a four branch hierarchical model (Salovey and Mayer 1990, Mayer & Salovey 1993, Mayer & Salovey 1995, Mayer & Geher 1996, Mayer et al 2000). In contrast, Petrides and colleagues (cf Petrides & Furnham 2001, Petrides et al 2007a, 2007b) base their understanding of EI in personality theories, conceptualising EI as a lower order personality trait. There therefore exist competing models of EI for which there are a range of validated measures developed by theorists on all sides of the debate (Bar-On 2006, Petrides 2009, Schutte *et al.* 2009, Mayer et al 2000).

Background

In nursing, EI has been linked to the development of desirable nursing attributes such as compassion and caring (Bulmer Smith *et al.* 2009, Quoidbach & Hansenne 2009, Rego *et al.* 2010). There is also evidence that EI is associated with student nurse performance (Beauvais et al 2011), perceived competency (Por et al 2011) and Grade Point Average (Codier & Odell 2014). Several studies have found significant associations between single factors of the EI measure used (rather than total EI score) and the student nurse variables explored (Montes-Borges & Augusto 2007, Augusto Landa et al 2009) leading to the conclusion that the factor structure of the measures used is an important consideration as when total EI might not be significantly

associated with the variables explored, single factors might offer deeper insights into the relationship between EI and desired nursing attributes.

In the student selection literature ability emotional intelligence scores have been found to be predictive of performance in clinical practice and interpersonal skills workshops (Zysberg et al 2011). Jones-Schenk and Harper (2014) found that candidates who had higher EI were more likely to successfully complete a Baccaleaureate Nursing Program than their counterparts with lower EI levels as measured on the Emotional Quotient Inventory (EQ-i). However, a comparison of the use of multiple mini interviews and scores on Bar-On's EQ-I measure in the recruitment of medical students concluded that the EQ-I was not sufficiently discriminating to use as the basis of student selection (Yen et al 2011).

There is therefore only limited evidence to link EI of students on entry to nursing programmes with their subsequent performance and retention, and ultimately successful achievement of clinical and academic competence required for registration as a nurse. Therefore the identification and impact of high EI at the point of nursing student selection is useful to explore, particularly in light of recent criticisms of nursing care in the UK (Francis 2013), and may lead to the identification of EI as a suitable criterion for inclusion in the selection process for nursing students.

Snowden *et al.* (2015) conducted the first phase of a longitudinal repeated measures study designed to examine the impact of EI on the performance and retention of a large cohort of student nurses and midwives (n=870) in Scotland. This longitudinal study is hereby referred to as the EI Impact Study. The EI Impact Study sample

additionally included computer students as a small control group (n=68) to test the differences in EI scores hypothesised between the groups. The paper presented here entails secondary analysis of EI data collected in Snowden *et al.'s* (2015) primary research.

Two measures of emotional intelligence were used in the original study: the Trait and Emotional Intelligence Questionnaire (short form) (TEIQue-SF, Petrides 2006), and Schutte's Emotional Intelligence Scale (SEIS, Schutte *et al.* 1998). The two measures were chosen because they have been validated across a range of populations (Cooper & Petrides 2010, Kim *et al.* 2010, Mikolajczak *et al.* 2007, Ng *et al.* 2009). Theoretically, they measure different concepts of emotional intelligence, thereby potentially providing a more robust measurement profile than would be obtained by using either measure alone.

Schutte was an early proponent of the existence of emotional intelligence (Schutte *et al.* 1998), grounding her understanding of EI in Salovey and Mayer's concept. Schutte's measure sees EI as an 'ability', and therefore capable of change over time (Qualter *et al.* 2010). Emotional intelligence can be learned and nurtured on this view. This was considered important in a repeated measure longitudinal study to establish what, if anything supported changes associated with this measure (Lund & Lund 2015). Petrides' TEIQue-SF by contrast conceptualises emotional intelligence as a reasonably stable multifactorial aspect of personality (Petrides 2011). Conceptualised as a 'constellation of emotional self perceptions located at the lower end of personality hierarchies' (Petrides & Sevdalis 2010: 526) trait EI has been critiqued as simply a reworking of personality theory. However, there is a growing body of work

supporting the concept of trait EI as distinct from the Big Five personality traits (Siegling et al 2015, Russo *et al.* 2012, Petrides et al 2007a, Petrides et al 2007b, Saklofske et al 2003). Again, repeated measures can establish the validity of this claim of EI as trait, and establish any relationship between this measure and subsequent performance. Whilst both measures require further validation, space prevents further discussion of Schutte's measure here, although we propose to test reliability of both the measures in the EI Impact Study.

In summary, all measures of EI are 'young' and will therefore benefit from further analysis and validation. This study focuses on the brief, easily applicable and popular measure, the TEIQue-SF. It does this by exploring its psychometric properties in a large cohort of students using Rasch analysis (Bond & Fox, 2007) and Confirmatory Factor Analysis (Randall & Engelhard, 2010).

Competing Claims for the TEIQue-SF

The TEIQue-SF is a 30-item trait emotional intelligence measure (Table 1) based on 15 facets and four factors (Well-being, sociability, self control & emotionality) identified by Petrides from his larger 130-item TEIQue (Freudenthaler *et al.* 2008). The four factor structure has been replicated in the long form TEIQue by Freudenthaler *et al.* (2008). To construct the short form of the measure, two items from each of the facets were selected based on their correlation with the corresponding facet, resulting in a global EI score.

Petrides (2006) has claimed that the short form principally measures a single global trait of emotional intelligence, but also claims that it measures the same four factors

present in the 130 item long form of the TEIQue. According to Petrides the items are associated with the factors as follows:

> Well-being: 5, 20, 9, 24, 12, and 27
>
> Self-control: 4, 19, 7, 22, 15, and 30
>
> Emotionality: 1, 16, 2, 17, 8, 23, 13, and 28
>
> Sociability: 6, 21, 10, 25, 11, and 26
>
> Note that items 3, 18, 14, and 29 contribute only to the global trait EI score.
>
> (Petrides 2006)

Petrides (2006) calls this an *a priori* factor structure and does not expect it to be replicable in a factor analysis. He does not expand on this but in a separate and subsequent paper he presents more compelling evidence that the short form measures a single global trait (Cooper & Petrides 2010), and is most useful as a quick measure of EI (the TEIQue-SF takes 7 minutes as opposed to 25 for the longer version). So, whilst it is clear that Petrides favours the single global trait interpretation of the TEIQue-SF he nevertheless claims it can also be legitimately used to construct an *a priori* four-factor structure of emotional intelligence. On the face of it these claims do not seem to be entirely consistent with each other. To understand the relationship between the two claims better, and the relevance for the EI Impact Study (Snowden *et al.* 2015) in particular, a concurrent combination of Rasch analysis and Confirmatory Factor Analysis (CFA) was used to examine the evidence for a) a unidimensional latent trait of emotional intelligence and b) a coherent factor structure in the TEIQue-SF.

THE STUDY

Aim

To examine further the psychometric properties of the Trait Emotional Intelligence Questionnaire-Short Form (TEIQue-SF), by re-examining its construct validity.

Objectives

1. Test the degree to which the TEIQue-SF measures a latent trait.
2. Test for the presence of a four-factor structure in TEIQue-SF.

Design

Secondary analysis of an existing dataset of responses to TEIQue-SF using concurrent application of Rasch analysis and Confirmatory Factor Analysis.

Participants

First year nursing, midwifery and computer students in two Scottish Universities who had been asked to participate in the EI Impact Study (Snowden *et al.* 2015) during their first week of university in September 2013. The sample consisted of 938 students (149 males, 785 females, 4 not reported) with mean age 25.39 (SD 8.25) years. The majority (n=586) were adult nursing students, with 122 mental health nurses, 28 children's nurses, 46 learning disability nurses, 88 midwives, and 68 computing students.

Data Collection

All students completed demographic data and the 30-item TEIQue-SF (Table 1). Once consent had been obtained, students were given unlimited time to complete the demographics and questionnaire on paper copies. Responses were transcribed by a

research assistant into an excel database and then coded for further analysis in SPSS, AMOS and WINSTEPS by the authors AS and RW.

Ethics

Permission to undertake the study was granted by the University of the West of Scotland and Edinburgh Napier University ethics committees in 2013.

Data analysis

Rationale

The reason for using both Rasch analysis and CFA in this study is that they have different approaches to the issue of fit (Kreiner & Christensen, 2013). Fit in this case broadly refers to the relationship between actual responses to the questionnaire and the theoretical model under study. Rasch analysis presumes all items in a questionnaire are measuring the same latent trait and tests the data against that assumption (Bond & Fox, 2007). Factor analysis by contrast looks for patterns in responses and then seeks to explain them (Kääriäinen 2011). Only the covariance of items is important in analysing their relationship to the latent trait, or sub-dimensions thereof; items are all assumed to be equally likely to be endorsed by respondents. The 'best fitting' factor structure then requires interpretation.

Whilst the differences should not be overplayed (Kreiner & Christensen, 2013), Rasch and CFA target different types of departure from the model under study and thus result in different conclusions concerning fit. The main justification for combining

them here was therefore to offset the inherent limitations in using either alone. For example it can't be assumed that all items are equally likely to be endorsed, thereby jeopardising the assumptions underpinning CFA. Where there is questionable confidence about the items under study and dimensionality needs to be examined alongside evidence of local dependence, confirmatory factor analysis alone is insufficient according to Christensen (2012). Christensen (2012) goes on to recommend a combination of Rasch and confirmatory factor analysis, a position also taken by Waugh and Chapman (2005) and Yu *et al.* (2007). For a succinct summary of the strengths and limitations of combining the two approaches including further references please see Engelhard (2012) and Saltzberger (2012).

Rasch analysis

TEIQue-SF was scored as described in Table 1. For objective 1 Rasch analysis (Bond & Fox, 2007) was then used to test the degree to which the TEIQue- SF was measuring a single latent trait. There are three key parameters in the Rasch model: *Difficulty Logit*, which is related to the item in the questionnaire, *Ability Logit*, which is related to the participants who answered the questionnaire, and *Rasch – Andrich Threshold*, which is related to the categories of values of the items (Soflano *et al.* 2014). Rasch analysis envisages a particular relationship between a participant's score on an item and their position along the latent trait (Watson *et al.* 2011) and uses an iterative algorithm to test the data obtained against these expectations. For a mathematical description of the algorithm used to calculate the specific values please see Soflano *et al*. (2014). The key output of this analysis relevant to objective 1 is 'item location', 'unidimensionality' and 'item invariance'.

Item location expresses the likelihood of positively endorsing a particular item. For example, in a mathematical test, the most difficult item to positively endorse should be the one that only those students who are very good at mathematics will be able to answer correctly. The most difficult item would be located at the top of the scale. The output of the Rasch analysis specifies which items are likely to be the most difficult to positively endorse and locates them higher in the scale. The units of measurement are logits (Linacre, 2006). In this analysis the 'difficult' items are those most likely to be positively endorsed by those with higher emotional intelligence. The output places all the items on a continuum of 'difficulty'.

To check whether that continuum makes sense (ie. measures emotional intelligence) Rasch analysis also tests for unidimensionality. This test checks whether the data form a single factor. In other words it tests that the questionnaire is only measuring one latent trait (emotional intelligence), as opposed to measuring other traits. This is achieved by calculating 'item fit' as measured using the mean-square residual fit statistic (MSR). The ideal value is 1, but variation from this is reasonable, and in a sample this size a range of 0.7-1.3 would indicate acceptable fit to the Rasch model (Bond & Fox, 2007). Each item's 'infit mean square' (Table 3) therefore shows how well the item fits or not with the latent trait under study.

Finally, the check for item invariance tests whether certain groups in the data set are responding in different ways. Item invariance is assessed here by the (DIF) statistic using the Mantel-Haenszel (MH) approach (Linacre 2011). DIF tests for difference in response patterns according to various characteristics of the respondents. For example it is known that females tend to score higher on EI measures than males (Fernández-

Berrocal, Cabello, Castillo *et al.* 2012). Testing for DIF according to gender will show if and how this is the case in this dataset and what items if any may be particularly prone to differences according to gender.

In this study using the Rasch Rating Scale Model (Bond & Fox 2007), item location, item fit and item invariance were examined (Williams *et al.* 2012) in WINSTEPS (version 3.81.0). Item location is described by each item's difficulty logit value. Item fit is calculated as infit mean square. Differential item functioning (DIF) was assessed according to age, gender and programme of study.

Confirmatory factor analysis

To answer objective 2 an alternative analysis was applied, as exemplified recently by (Shenkin *et al.* 2014) based on classical test theory, whereby only the covariance of items is important in analysing their relationship to the latent trait, or sub-dimensions thereof; items are all assumed to be equally likely to be endorsed by respondents.

The presence of a four-factor structure in TEIQue-SF was assessed using factor analysis in both exploratory and confirmatory modes. Exploratory factor analysis (EFA) is used to explore multivariate data to reduce large numbers of items to fewer underlying dimensions and confirmatory factor analysis (CFA) is used to test the fit of data to an hypothesised model. Here we used principal components analysis (PCA) as the exploratory method. Although not strictly EFA (Watson & Thompson 2006), PCA is a widely applied and understood method of exploring multivariate data providing results that are, essentially the same. PCA is carried out using structural equation modelling whereby putative models are described mathematically and then

tested for how well they fit the data. CFA outcomes are judged by a series of fit indices that should exceed 0.9 and by the root mean error of approximation (RMSEA), which should be below 0.06 (Byrne 2010). The Chi-square difference between the model and the data is routinely reported and it should be small and non-significant (but is also sample size dependent). It should, however, decrease in better fitting models.

Therefore, the data were first analysed using principal components analysis (PCA). Items 3, 18, 14 & 29 were omitted from the PCA because Petrides (2006) considered them a 'general' factor as described in the introduction and therefore not specifically associated with any particular factor. The remaining 26 items were entered into SPSS for Windows version 20.0. To decide how many components to rotate by Varimax rotation, a combination of eigenvalues > 1, the scree slope methods and Monte Carlo parallel analysis for PCA was used (http://www.softpedia.com/get/Others/Home-Education/Monte-Carlo-PCA-for-Parallel-Analysis.shtml; retrieved 18 November 2008). The confirmatory approach was carried out in AMOS version 20.0. To achieve better fit, the modification indices were inspected to see if any error terms could be correlated.

RESULTS

Female mental health nursing students had the highest mean (SD) TEIQue-SF score 5.42 (0.6), female computing students the lowest 4.71 (0.78). Further details are in Table 2. For comparison, mean scores in other studies are around 5 for males and 5.2 for females (Cooper & Petrides 2009).

Objective 1: measurement of a latent trait.

Table 3 shows how responses fit the Rasch model. In relation to item difficulty item 11 shows the highest value (0.7 logits) and item 13 the lowest (-1.24 logits). Item 11 can therefore be thought of as representing the most complex aspect of emotional intelligence in this set of items. Likewise item 13 can be thought of as the most straightforward item to endorse. However, these conclusions are only credible for those items demonstrating unidimensionality, as tested by the infit mean square in the next column of Table 3. In this analysis items 5, 12, 13, 16 & 28 are a poor fit to the Rasch model because they have an infit mean square of greater than 1.3. This is best illustrated in the bubbleplot in Figure 1. Each bubble represents an item according to three parameters: their location, infit mean square and standard error. The size of the bubble represents standard error (the smaller the better), infit mean square is represented on the horizontal axis and item location (difficulty) is represented on the vertical axis. The dotted line has been added at 1.3 to indicate the cutoff for acceptable fit in this sample. This illustrates that the items beyond this line do not appear be measuring the same trait as the rest of the items because there is more misfit than would reasonably be expected in a sample this size.

Some of the variance in the responses to the TEIQue-SF questions is a product of differential item functioning (DIF), indicated as either present or not in Table 3. It is important to note that DIF is not problematic in itself but rather helps understand the construct under study (Linacre 2009). It is helpful conceptually here as all the items 5, 12, 13, 16 & 28 demonstrate DIF in the same direction in relation to gender. Figure 2 shows the mean response to each item categorised by gender. If there were no differential item functioning the lines would be equivalent. Where there is a

difference it means the items in question are being answered differently by different groups. Females answered all items 5, 12, 13, 16 & 28 more positively than males. This will be returned to in the discussion.

Objective 2: presence of a four-factor structure

The results of the principal components analysis is shown in Table 4 and, based on that structure, the confirmed structure, shown in Table 5 and Figure 3, was relatively simple (high and low loadings of items, respectively, on the putative factors and *vice versa*) and interpretable. It showed a better fit than the Petrides' original structure. Table 6 shows the correlation between the error variances that were required to obtain the fit shown in Table 7 which compares the fit indices of the original structure and that obtained in the present paper.

Figure 3 shows a diagrammatic representation of structural equations representing the hypothesised model of the relationship between variables in the TEIQ-SF. Squares represent the TEIQ variables and ovals represent first-order latent variables. Standardised regression weights between factors are shown. Broken arrows represent error variance. Standardised regression weights of TEIQ items on first-order factors are shown in Table 4. Intercorrelated error variances are shown in Table 5. Fit indices are in Table 6.

In common with the suggestion by Petrides (2006) a four-factor structure was supported for the TEIQue-SF in the present study. However, the structure obtained here differed from the originally suggested structure, which was: Well-being, Self-control, Emotionality, Sociability. In fact, using structured equation modelling, Petrides' (2006) *a priori* structure could not be confirmed. Once the error terms were

relaxed the structural equation model fitted well. The four factors suggested here are:

- *Self-confidence* (eg 'Others admire me for being relaxed') items 30, 15, 19, 24, 27, 21, 9, 6;
- *Social Connection* (eg 'I find it difficult to bond well even with those close to me') items 12, 5, 28, 13, 16;
- *Uncertainty* (eg 'I tend to change my mind frequently') items 7, 10, 22, 25, 8, 4, 2;
- *Empathy* (eg 'I'm normally able to get 'into someone's shoes' and experience their emotions') items 11, 26, 17, 1, 23.

DISCUSSION

Construct validity is the degree to which a test measures what it claims to measure (Cronbach & Meehl 1955). The aim of this analysis of construct validity was to further examine the claims made for the psychometric properties of the Trait Emotional Intelligence Questionnaire-Short Form through concurrent use of Rasch and Confirmatory Factor Analysis. The key finding was that the five items making up the 'social connection' factor in the CFA were exactly those five items identified as misfitting the Rasch analysis.

These question/ items are:

5. I generally don't find life enjoyable.

12. On the whole I have a gloomy perspective on most things.

13. Those close to me often complain I don't treat them right.

16. I often find it difficult to show my affection to those close to me.

28. I find it difficult to bond well even with those close to me.

According to the Rasch analysis these five items appear to be measuring something other than emotional intelligence. To examine further the impact of this factor on TEIQue-SF total scores two new variables were constructed. The first consisted of mean social connection score and the second consisted of mean score for all TEIQue-SF items except these five items. Mean scores for these variables alongside original TEIQue-SF totals are in Table 7 for comparison. This table shows that high scores on the social connection factor are associated with high total TEIQue-SF scores, as would be expected. What is more interesting is that the difference between total TEIQue-SF scores in males and females without the social connection factor narrows. In the adult nursing sample (the largest single cohort n=585) the difference in TEIQue-SF scores is eliminated altogether (without social connection factor the TEIQue-SF means are females 5.14; males 5.15 whereas using the full TEIQue-SF mean scores gives females 6.22; males 5.78). In other words the differential item functioning by gender in the social connection factor accounts for all the difference in total TEIQue-SF scores in the adult nursing sample. This 'social connection' factor largely accounts for the gender difference in total responses to the TEIQue-SF. The practical and psychometric implications of this finding are now examined in more detail.

First, the discovery that these five items may explain the gender effect in the TEIQue-SF has implications for the use of this measure for selection of nursing students, as it is probable that if selecting on the basis of high EI using this measure, females would perform better than males and hence be disproportionately recruited. Second and

relatedly, scrutiny of the content of the items constituting the social connection factor indicates that they describe ability to connect socially with others and to inspire hope; two key features of the caring nurse-patient relationship. Further understanding of the impact of EI, and in particular the social connection factor, on student progression and completion of nursing and midwifery education will enhance knowledge about whether this factor might best be omitted when using the TEIQue-SF for selection purposes or whether it identifies a key quality or skill that nursing students must possess. This will be monitored throughout the longitudinal EI study.

Third, in relation to psychometrics this analysis has shown that a combination of multivariate techniques applied for the first time to these data have provided new insight into the structure of the TEIQue-SF and, possibly, into the structure and nature of emotional intelligence. No single analysis can detect all possible sources of variance (Randall & Engelhard 2010, Risjord *et al.* 2001) and this paper has demonstrated the utility of using different methods on the same dataset. Whilst alternative factorial techniques for simultaneous testing for the presence of a general trait and multi factorial structure exist such as bifactor analysis (Reise 2012) it is unlikely they would have discovered the important element of misfit that has been revealed here. Likewise, with the Rasch analysis simply identifying misfit would not have identified the underlying factor.

There is increasing credibility in combining Rasch analysis with factor analysis to study dimensionality (Engelhard 2012). In this study, synthesising results from CFA and Rasch analysis has provided evidence to support inferences regarding different elements of invariance and thus offered complementary explanations to better support

a new theoretical understanding of TEIQue-SF.

Limitations

The main limitation is that this paper described a secondary analysis. We did not have the opportunity to select a wider sample. It is therefore unclear whether the outcome described here would hold in a different country or in a different sample of professionals. From an analytic perspective space prevented detailed analysis of the Rasch results. For example we have not been able to discuss the significance of the social connection items being the easiest items to endorse and hence the largest contributors to the overall TEIQue-SF score. Rasch analysis starts with the assumption that the questionnaire items measure a single latent trait and that there is a hierarchy of responses which means that those who score highly in this questionnaire are more 'emotionally intelligent' than those who have low scores. Nor have we examined the threshold properties of the Likert categories. These will be described in subsequent papers.

CONCLUSION

The original factor structure of the TEIQue-SF suggested by Petrides (2006) was at best only partially supported by our factor analysis. Rasch analysis identified the presence of five misfitting items. This means that the single factor interpretation of the TEIQue-SF may have an alternative interpretation. In this study it displayed a secondary factor described here as 'social connection', which explained a considerable amount of response variance. It accounted for the differential item functioning according to gender in the TEIQue-SF in the largest subsample of adult nurses (n=586).

The impact of EI at entry to nursing and midwifery education on subsequent progression and successful completion remains to be tested and is the focus of an on-going longitudinal study from which the secondary data analysed here was drawn (Snowden *et al.* 2015). This longitudinal EI Impact Study offers the opportunity to examine in detail the impact of scoring high or low on social connection on the progression of these students. Such knowledge will enable educators to understand whether this factor should be omitted altogether or if it has a diagnostic function, highlighting students who may require increased support throughout their programme, as might be hypothesised given the relational nature of nursing.

Author Contributions:

All authors have agreed on the final version and meet at least one of the following criteria (recommended by the ICMJE*):

1) substantial contributions to conception and design, acquisition of data, or analysis and interpretation of data;

2) drafting the article or revising it critically for important intellectual content.

* http://www.icmje.org/recommendations/

References

Augusto-Landa, J.M., Lopez-Zafra, E., del Carmen Aguilar-Luzon, M. and Salguero de Ugarte, M.F. (2009) Predictive validity of Perceived Emotional Intelligence on nursing students' self-concept *Nurse Education Today* 29: 801-808

Bar-On, R. (2006). The Bar-On model of emotional-social intelligence (ESI). *Psicothema*, *18 Suppl*, 13–25.

Beauvais, A.M., Brady, N., O'Shea, E.R. and Quinn Griffin, M.T. (2011) Emotional intelligence and nursing performance among nursing students *Nurse Education Today* 31: 396-401

Bond, T. G., & Fox, C. M. (2007). *Applying the Rasch Model. Fundamental Measurement in the Human Sciences* (2nd ed.). New York, NY: Routeledge.

Bulmer Smith, K., Profetto-McGrath, J. and Cummings, G.G. (2009) Emotional intelligence and nursing: an integrative literature review *International Journal of Nursing Studies* 46: 1624-1636

Byrne, B. M. (2010). Structural Equation Modeling With AMOS. *Routledge Academic*, (1), 416. Retrieved from http://www.psypress.com/structural-equation-modeling-with-amos-9780805863734

Christensen, K. B. (2012). Rasch vs. FA. *Rasch Measurement Transactions*. Retrieved April 25, 2015, from http://www.rasch.org/rmt/rmt263a.htm

Codier, E. and Odell, E. (2014) Measured emotional intelligence ability and grade point average in nursing students *Nurse Education Today* 34: 608-612

Cooper, A., & Petrides, K. V. (2010). A psychometric analysis of the Trait Emotional Intelligence Questionnaire-Short Form (TEIQue-SF) using item response theory. *Journal of Personality Assessment*, *92*(5), 449–57. doi:10.1080/00223891.2010.497426

Cronbach, L., & Meehl, P. (1955). Construct validity in psychological tests. *Psychological Bulletin*, *129*(1), 3–9. doi:10.1037/h0040957

Engelhard, G. (2012). Rasch Measurement Theory and Factor Analysis. *Transactions of the Rasch Measurement SIG*, *26*(3), 1375.

Fernández-Berrocal, P., Cabello, R., Castillo, R., & Extremera, N. (2012). Gender Differences in Emotional Intelligence: the Mediating Effects of Age. *Behavioural Psychology*, *20*(1), 77–89.

Francis, R. (2013). *Report of the Mid Staffordshire NHS Foundation Trust Public Inquiry Executive summary*. London.

Freudenthaler, H. H., Neubauer, A. C., Gabler, P., Scherl, W. G., & Rindermann, H. (2008). Testing and validating the trait emotional intelligence questionnaire

(TEIQue) in a German-speaking sample. *Personality and Individual Differences*, *45*(7), 673–678. doi:10.1016/j.paid.2008.07.014

Jones-Shenk, J. and Harper, M.G. (2014) Emotional intelligence: an admission criterion alternative to cumulative grade point averages for prelicensure students *Nurse Education Today* 34: 413-420

Kääriäinen, M., Kanste, O., & Elo, S. (2011). Testing and verifying nursing theory by confirmatory factor analysis. *Journal of Advanced Nursing*, *67*(5), 1163–72. Retrieved from http://onlinelibrary.wiley.com/doi/10.1111/j.1365-2648.2010.05561.x/full

Kim, D.-H., Wang, C., & Ng, K.-M. (2010). A Rasch rating scale modeling of the Schutte Self-Report Emotional Intelligence scale in a sample of international students. *Assessment*, *17*(4), 484–96. doi:10.1177/1073191110376593

Kreiner, S., & Christensen, K. B. (2013). Assessment of item correlation in Rasch models. In *Advances in Latent Variables - Methods, Models and Applications* (pp. 1–6). Brescia - Department of Economics and Management. Retrieved from http://meetings.sis-statistica.org/index.php/sis2013/ALV/paper/viewFile/2558/458

Linacre, J. M. (2011). *A users guide to WINSTEPS*. Chicago. Retrieved from http://ifile.hkedcity.net/1/001/950/public/Secondary/EI0020070012/winsteps.pdf

Linacre, J. M. (2006). (2006). WINSTEPS Rasch measurement computer program. Chicago: Winsteps.com.

Lund, A., & Lund, M. (2015). One-way repeated measures ANOVA in SPSS Statistics. *Laerd Statistics*. Retrieved from https://statistics.laerd.com/premium/rma/repeated-measures-anova-in-spss.php

Mayer, J.D., Caruso, D.R. and Salovey, P. (2000) Emotional intelligence meets traditional standards for an intelligence *Intelligence* 27(4): 267-298

Mayer, J.D. and Geher, G. (1996) Emotional Intelligence and the identification of emotion *Intelligence* 22: 89-113

Mayer, J.D. and Salovey, P. (1995) Emotional intelligence and teh construction and regulation of feelings *Applied and Preventive Psychology* 4: 197-208

Mayer, J.D. and Salovey, P. (1993) The intelligence of emotional intelligence *Intelligence* 17: 433-442

Mikolajczak, M., Luminet, O., Leroy, C., & Roy, E. (2007). Psychometric properties of the Trait Emotional Intelligence Questionnaire: factor structure, reliability, construct, and incremental validity in a French-speaking population. *Journal of Personality Assessment*, *88*(3), 338–53. doi:10.1080/00223890701333431

Montes Borges, B. and Augusto, J.-M. (2007) Exploring the relationship between perceived emotional intelligence, coping, social support and mental health in nursing students *Journal of Psychiatric and Mental Health Nursing* 14: 163-171

Ng, K.-M., Kim, D.-H., & Bodenhorn, N. (2009). Factor Structure Analysis of the Schutte Self-Report Emotional Intelligence Scale on International Students. *Educational and Psychological Measurement*, *70*(4), 695–709. doi:10.1177/0013164409355691

Petrides, K. (2011). Ability and trait emotional intelligence. In T. Chamorro-Premuzic, A. Furnham, & S. von Stumm (Eds.), *The Wiley-Blackwell handbook of individual …*. New York: Wiley. Retrieved from http://onlinelibrary.wiley.com/doi/10.1002/9781444343120.ch25/summary

Petrides, K.V. and Sevdalis, N. (2010) Emotional intelligence and nursing: Comment on Bulmer-Smith, Profetto-McGrath, and Cummings (2009) *International Journal of Nursing Studies* 47: 526-528

Petrides, K. V. (2009). Psychometric Properties of the Trait Emotional Intelligence Questionnaire (TEIQue). In J. D. A. Parker, D. H. Saklofske, & C. Stough (Eds.), . Boston, MA: Springer US. doi:10.1007/978-0-387-88370-0

Petrides, K.V., Pita, R. and Kokkinaki, F. (2007a) The location of trait emotional intelligence in personality factor space *British Journal of Psychology* 98: 273-289

Petrides, K. V., Pérez-González, J. C., & Furnham, A. (2007b) On the criterion and incremental validity of trait emotional intelligence *Cognition & Emotion* 21: 26-55 doi:10.1080/02699930601038912

Petrides, K.V. (2006). Deriving Factor Scores from the TEIQue-SF. Webnote #2. Retrieved from http://www.psychometriclab.com/Webnote_2.pdf

Por, J., Barriball, L., Fitzpatrick, J. and Roberts, J. (2011) Emotional intelligence: its relationship to stress, coping, well-being and professional performance in nursing students *Nurse Education Today* 31: 855-860

Qualter, P., Ireland, J., & Gardner, K. (2010). Exploratory and confirmatory factor analysis of the Schutte Self-Report Emotional Intelligence Scale (SSREI) in a sample of male offenders. *British Journal of Forensic …*, *12*(2), 43–52. Retrieved from http://www.emeraldinsight.com/journals.htm?articleid=1928353&show=abstract

Quoidbach, J., & Hansenne, M. (2009). The Impact of Trait Emotional Intelligence on Nursing Team Performance and Cohesiveness. *Journal of Professional Nursing*, *25*(1), 23–29.

Randall, J., & Engelhard, G. (2010). Using Confirmatory Factor Analysis and Rasch Measurement Theory to Assess Measurement Invariance in a High Stakes Reading Assessment. *Applied Measurement in Education, 23*, 286–306.

Rego, A., Godinho, L., McQueen, A., & Cunha, M. P. (2010). Emotional intelligence and caring behaviour in nursing. *The Service Industries Journal*.

Reise, S. P. (2012). The Rediscovery of Bifactor Measurement Models. *Multivariate Behavioral Research*.

Risjord, M., Moloney, M., & Dunbar, S. (2001). Methodological Triangulation in Nursing Research. *Philosophy of the Social Sciences*, *31*(1), 40–59. doi:10.1177/004839310103100103

Russo, P. M., Mancini, G., Trombini, E., Baldaro, B., Mavroveli, S., & Petrides, K. V. (2012) Trait emotional intelligence and the Big Five: A study on Italian children and preadolescents *Journal of Psychoeducational Assessment* 30: 274-283 doi:10.1177/0734282911426412

Saklofske, D.H., Austin, E.J. and Minski, P.S. (2003) Factor structure and validity of a trait emotional intelligence measure *Personality and Individual Differences* 34(4): 707-721

Salovey, P.. & Mayer, J. D. (1990). Emotional intelligence. *Imagination, Cognition and Personality*, *9*, 185–211.

Saltzberger, T. (2012). The Rasch model and factor analysis: Complementary or mutually exclusive? *Rasch Measurement Transactions*, *26*(3), 1376–8. Retrieved from http://www.rasch.org/rmt/rmt263a.htm

Schutte, N. S., Malouff, J. M., & Bhullar, N. (2009). The Assessing Emotions Scale. In J. D. A. Parker, D. H. Saklofske, & C. Stough (Eds.), . Boston, MA: Springer US. doi:10.1007/978-0-387-88370-0

Schutte, N. S., Malouff, J. M., Hall, L. E., Haggerty, D. J., Cooper, J. T., Golden, C. J., & Dornheim, L. (1998). Development and validation of a measure of emotional intelligence. *Personality and Individual Differences*, *25*(2), 167–177. doi:10.1016/S0191-8869(98)00001-4

Seigling, A.B., Furnham, A. and Petrides, K.V. (2015) Trait emotional intellignece and personality:gender-invariant linkages across different measures of the Big Five *Journal of Psychoeducational Assessment* 33(1): 57-67

Shenkin, S. D., Watson, R., Laidlaw, K., Starr, J. M., & Deary, I. J. (2014). The attitudes to ageing questionnaire: Mokken scaling analysis. *PLoS ONE*, *9*(6).

Snowden, A., Stenhouse, R., Young, J., Carver, F., Carver, H., & Brown, N. (2015). Emotional Intelligence, Recruitment and Retention in Nursing. *Nurse Education Today*, *35*(1), 152–8. Retrieved from http://www.sciencedirect.com/science/article/pii/S0260691714003025

Snowden, A., Young, J., Stenhouse, R., Carver, H., Carver, F., & Brown, N. (2014). Tracking the Impact of Emotional Intelligence of Student Progression. In *International Research in Nursing Conference*. Glasgow. Retrieved from

http://www.rcn.org.uk/__data/assets/pdf_file/0007/552886/Programme_at_a_glance_552886_10.0114_v.2.pdf

Soflano, M., Snowden, A., & Connolly, T. M. (2014). The Visualisation of Rasch Model Analysis. In *European Conference in the Applications of Enabling Technologies 2014*.

Watson, R., & Thompson, D. R. (2006). Use of factor analysis in Journal of Advanced Nursing: Literature review. *Journal of Advanced Nursing*.

Watson, R., Van Der Ark, L. A., Lin, L.-C., Fieo, R., Deary, I. J., & Meijer, R. R. (2011). Item response theory: How Mokken scaling can be used in clinical practice. *Journal of Clinical Nursing*. doi:10.1111/j.1365-2702.2011.03893.x

Waugh, R. F., & Chapman, E. S. (2005). An analysis of dimensionality using factor analysis (true-score theory) and rasch measurement: What is the difference? Which method is better? *Journal of Applied Measurement*, *6*(1), 80–99.

Williams, B., Onsman, A., & Brown, T. (2012). A Rasch and factor analysis of a Paramedic Graduate Attribute scale. *Evaluation & the Health Professions*, *35*(2), 148–68. doi:10.1177/0163278711407314

Yen, W., Hovey, R., Hodwitz, K. and Zhang, S. (2011) An exploration of the relationship between emotional intelligence (EI) and Multiple Mini-Interviews (MMI) *Advances in Health Sciences Education* 16: 59-67

Yu, C. H., Popp, S. O., Digangi, S., & Jannasch-Pennell, A. (2007). Assessing unidimensionality : A comparison of Rasch Modeling , Parallel Analysis , and TETRAD. *Practical Assessment, Research, and Evaluation*, *12*(14), 1–19

Zysberg, L., Levy, A. and Zisberg, A. (2011) Emotional intelligence in applicant selection for care-related academic programs *Journal of Psychoeducational Assessment* 29(1): 27-38

Rasch and CFA TEIQ-SF

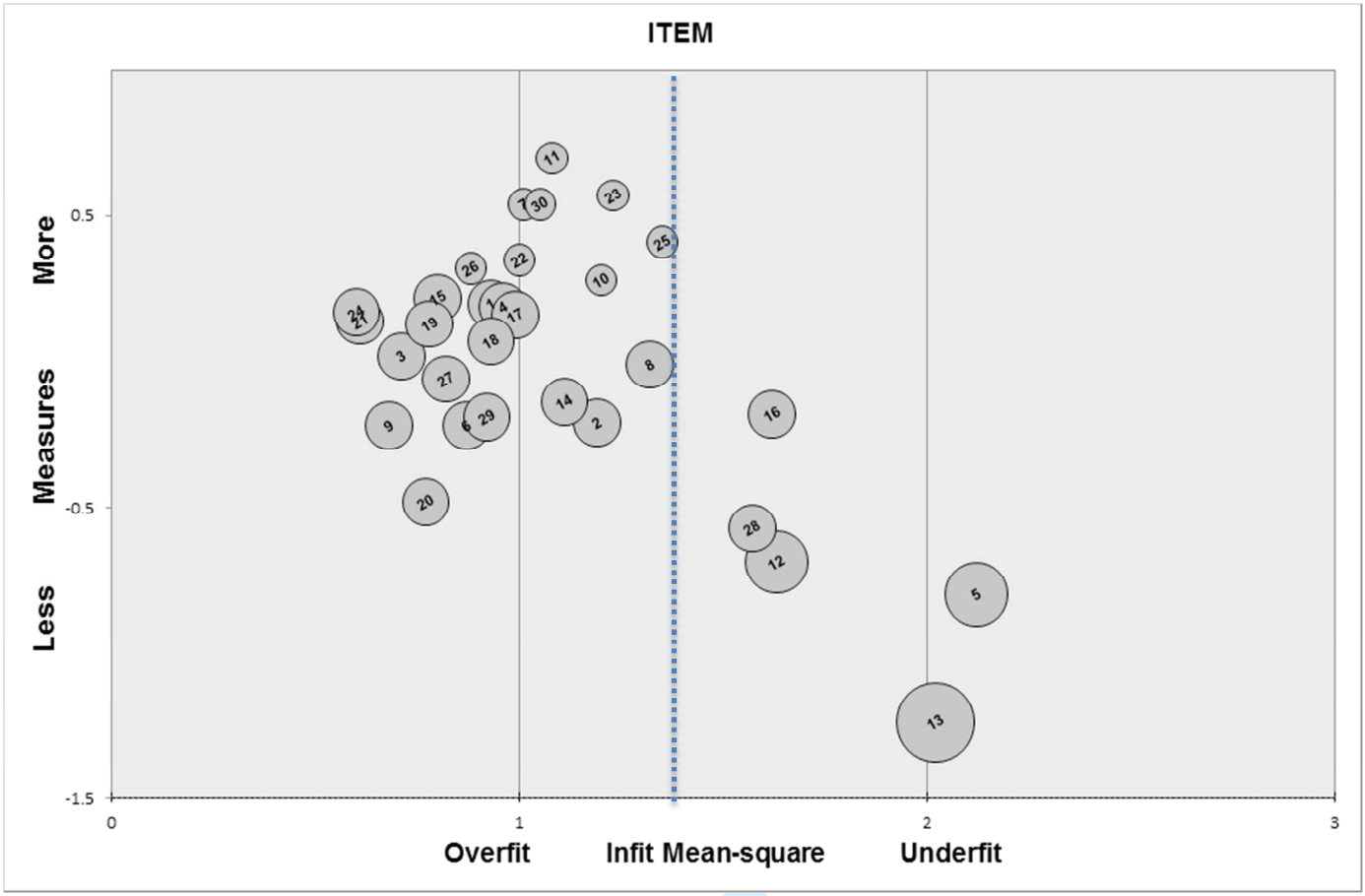

Figure 1 Bubbleplot of TEIQue SF items. Dotted line represents infit mean square of 1.3. Misfitting items are to the right of this line

*Figure 2. DIF by Gender (1=female, 2=male, *=total) Note large differences in response in same direction for items 5, 12, 13, 28 in particular. Females found these items 'easier'.*

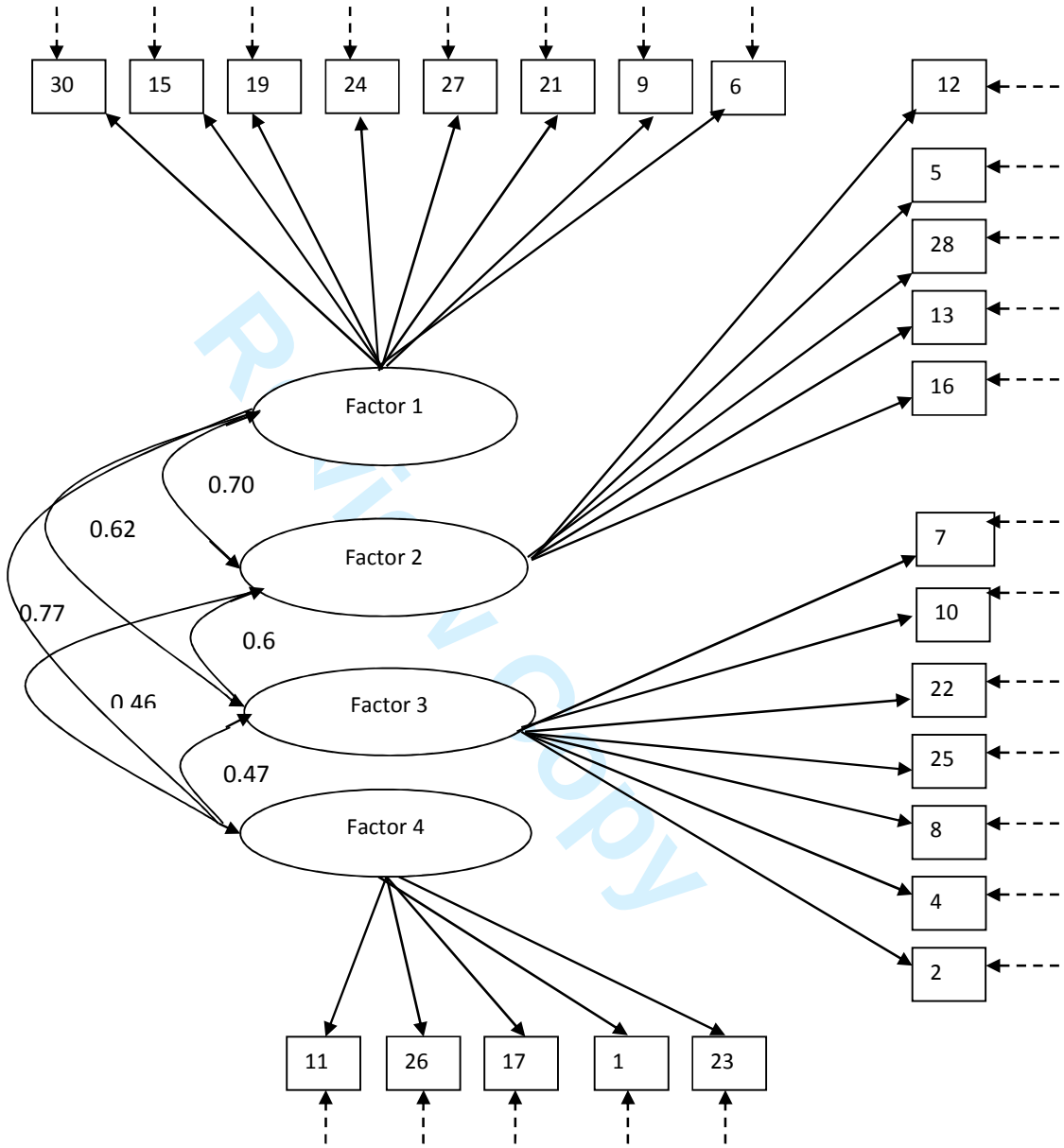

Figure 3. Confirmatory Factor Analysis TEIQue-SF

TEIQue-SF

Instructions: Please answer each statement below by putting a circle around the number that best reflects your degree of agreement or disagreement with that statement. Do not think too long about the exact meaning of the statements. Work quickly and try to answer as accurately as possible. There are no right or wrong answers. There are seven possible responses to each statement ranging from 'Completely Disagree' (number 1) to 'Completely Agree' (number 7).

1 . . . . . 2 . . . . . 3 . . . . . 4 . . . . . 5 . . . . . 6 7
Completely Disagree **Completely Agree**

1. Expressing my emotions with words is not a problem for me.	1	2	3	4	5	6	7
2. I often find it difficult to see things from another person's viewpoint.	1	2	3	4	5	6	7
3. On the whole, I'm a highly motivated person.	1	2	3	4	5	6	7
4. I usually find it difficult to regulate my emotions.	1	2	3	4	5	6	7
5. I generally don't find life enjoyable.	1	2	3	4	5	6	7
6. I can deal effectively with people.	1	2	3	4	5	6	7
7. I tend to change my mind frequently.	1	2	3	4	5	6	7
8. Many times, I can't figure out what emotion I'm feeling.	1	2	3	4	5	6	7
9. I feel that I have a number of good qualities.	1	2	3	4	5	6	7
10. I often find it difficult to stand up for my rights.	1	2	3	4	5	6	7
11. I'm usually able to influence the way other people feel.	1	2	3	4	5	6	7
12. On the whole, I have a gloomy perspective on most things.	1	2	3	4	5	6	7
13. Those close to me often complain that I don't treat them right.	1	2	3	4	5	6	7
14. I often find it difficult to adjust my life according to the circumstances.	1	2	3	4	5	6	7
15. On the whole, I'm able to deal with stress.	1	2	3	4	5	6	7
16. I often find it difficult to show my affection to those close to me.	1	2	3	4	5	6	7
17. I'm normally able to "get into someone's shoes" and experience their emotions.	1	2	3	4	5	6	7
18. I normally find it difficult to keep myself motivated.	1	2	3	4	5	6	7
19. I'm usually able to find ways to control my emotions when I want to.	1	2	3	4	5	6	7
20. On the whole, I'm pleased with my life.	1	2	3	4	5	6	7
21. I would describe myself as a good negotiator.	1	2	3	4	5	6	7
22. I tend to get involved in things I later wish I could get out of.	1	2	3	4	5	6	7
23. I often pause and think about my feelings.	1	2	3	4	5	6	7
24. I believe I'm full of personal strengths.	1	2	3	4	5	6	7
25. I tend to "back down" even if I know I'm right.	1	2	3	4	5	6	7
26. I don't seem to have any power at all over other people's feelings.	1	2	3	4	5	6	7
27. I generally believe that things will work out fine in my life.	1	2	3	4	5	6	7
28. I find it difficult to bond well even with those close to me.	1	2	3	4	5	6	7
29. Generally, I'm able to adapt to new environments.	1	2	3	4	5	6	7
30. Others admire me for being relaxed.	1	2	3	4	5	6	7

Items 2,4,5,7,8,10,12,13,14,16,18,22,25,26,28 are reverse scored.*

Table 1. TEIQue-SF items and scoring (reproduction permission to be sought)

TEIQue-SF Programme	Gender	Mean	N	Std. Deviation
Adult	female	5.32	532	0.61
	male	5.26	53	0.75
	Total	5.32	585	0.62
Mental health	female	5.42	94	0.60
	male	5.17	29	0.44
	Total	5.36	123	0.58
Learning disability	female	5.11	25	0.62
	male	5.38	4	0.61
	Total	5.14	29	0.61
Children's	female	5.14	47	0.53
	Total	5.14	47	0.53
Midwifery	female	5.38	82	0.66
	Total	5.38	82	0.66
Computing	female	4.71	5	0.78
	male	4.74	63	0.75
	Total	4.74	68	0.75
Total	female	5.32	785	0.61
	male	5.02	149	0.73
	Total	5.27	934	0.64

Table 2. Mean TEIQue-SF scores by programme and gender

ITEM	ITEM LOCATION	STANDARD ERROR	INFIT MSQ	DIF Gender	DIF Profession	DIF Age
TEIQ_1	0.2	0.03	0.93			
TEIQ_2	-0.21	0.03	1.19			
TEIQ_3	0.02	0.03	0.71			
TEIQ_4	0.19	0.03	0.96			
TEIQ_5	**-0.8**	**0.04**	**2.12**	**x**	**x**	**x**
TEIQ_6	-0.22	0.03	0.87			
TEIQ_7	0.54	0.02	1.02			
TEIQ_8	*-0.01*	*0.03*	*1.32*			
TEIQ_9	*-0.22*	*0.03*	*0.68*			
TEIQ_10	0.28	0.02	1.20			
TEIQ_11	0.7	0.02	1.08			
TEIQ_12	**-0.69**	**0.04**	**1.63**	**x**		
TEIQ_13	**-1.24**	**0.05**	**2.02**	**x**	**x**	**x**
TEIQ_14	-0.14	0.03	1.11			
TEIQ_15	0.22	0.03	0.80			
TEIQ_16	**-0.18**	**0.03**	**1.62**			
TEIQ_17	0.16	0.03	0.99			
TEIQ_18	0.07	0.03	0.93			
TEIQ_19	0.13	0.03	0.78			
TEIQ_20	-0.48	0.03	0.77			
TEIQ_21	*0.14*	*0.03*	*0.61*			
TEIQ_22	0.35	0.02	1.00			
TEIQ_23	0.57	0.02	1.23			
TEIQ_24	*0.17*	*0.03*	*0.60*			
TEIQ_25	*0.41*	*0.02*	*1.35*			
TEIQ_26	0.32	0.02	0.88			
TEIQ_27	-0.06	0.03	0.82			
TEIQ_28	**-0.57**	**0.03**	**1.57**	**x**	**x**	
TEIQ_29	-0.19	0.03	0.92			
TEIQ_30	0.54	0.02	1.05			

Table 3. Item location, error, fit and DIF
Emboldened items show misfit and DIF across one or more measure. Italicised items show misfit

Item	Factors				Unique
	1	2	3	4	variance
30		424			180
15		555			308
19		537			288
24		595			354
27		564			318
21		597			356
9		579			335
6		526			277
12			662		439
5			569		324
28			599		359
13			469		220
16			443		249
7				574	330
10				425	180
22				532	283
25				277	180
8				590	348
4				507	257
2				399	159
11					271 074
26					426 182
17					583 233
1					496 246
23					264 070

*For clarity, for regression weights and unique variances only the places after the decimal point are shown.

Table 4 Standardised regression weights of TEIQue-SF items on first-order factors and squared multiple correlations of error variances*

Original	Present	
Fit index	Structure	Structure
GFI	0.857	0.924 (0.911)
AGFI	0.828	0.907 (0.893)
CFI	0.737	0.856 (0.818)
RMSEA	0.071	0.052 (0.058)
Chi-Square	1666.4	928.1 (1103.9)
Degrees of freedom ($p<0.001$)	293	266 (269)

GFI=goodness of fit index; AGFI=adjusted goodness of fit index; CFI=comparative fit index; RMSEA=root mean square error of approximation

Table 5 Fit indices for confirmatory factor analysis of the TEIQue-SF scale (values prior to restriction imposed on the model are shown in brackets)

Mean Programme	Gender	TEIQue-SF Total	Social Connection factor	TEIQue-SF without social connection factor
adult	female	5.32	6.22	5.14
	male	5.26	5.78	5.15
	Total	5.32	6.18	5.14
mental health	female	5.42	6.27	5.26
	male	5.17	5.85	5.03
	Total	5.36	6.17	5.20
learning disability	female	5.11	5.77	4.97
	male	5.38	6.05	5.25
	Total	5.14	5.81	5.01
children's	female	5.14	6.05	4.96
	Total	5.14	6.05	4.96
midwifery	female	5.38	6.31	5.20
	Total	5.38	6.31	5.20
computing	female	4.71	5.32	4.59
	male	4.74	5.14	4.66
	Total	4.74	5.15	4.65
Total	female	5.32	6.21	5.14
	male	5.02	5.53	4.92
	Total	5.27	6.10	5.11

Table 6. Mean scores by gender for total TEIQue-SF, social connection factor and TEIQue-SF score without social connection factor.