

Predictive validity of general intelligence and Big Five measures for adult basic education and training outcomes



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This study explored whether scores on intelligence tests and personality questionnaires can predict performance in an adult basic education and training (ABET) programme. Participants in ABET programmes often have limited English reading skills, which make the use of conventional assessment tools problematic. A proposed solution is to utilise instruments that make limited demands on the use of language. Raven's Progressive Matrices (RPM), a well-established intelligence test, and the Five Factor-Nonverbal Personality Questionnaire (FF-NPQ) are both instruments that do not require any reading. The performance of 82 participants in the practical and academic components of an ABET programme was correlated with the RPM and the five traits of the FF-NPQ, namely, Extraversion, Conscientiousness, Openness to Experience, Neuroticism and Agreeableness. The RPM correlated significantly with both the practical ($r = 0.47$) and academic components ($r = 0.35$). The Agreeableness scale of the FF-NPQ correlated significantly with the practical component ($r = 0.34$). No

personality scale correlated significantly with the academic component. The results show that non-verbal intelligence tests and personality inventories can be potentially useful in the prediction of performance in an ABET programme.

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The importance of measures of general intelligence in the prediction of academic and work-related achievement is well documented (Gottfredson, 1998; Kuncel, Hezlett & Ones, 2004; Schmidt & Hunter, 2004). Similarly, there is a growing body of evidence that supports the importance of measures of personality traits in the prediction of academic and work-related achievement (cf. Barrick, Mount & Judge, 2001; De Bruin, 2002; De Fruyt & Mervielde, 1996; De Raad & Schouwenburg, 1996; Johnson, 2003; Salgado, 2003; Van der Walt, Meiring, Rothmann & Barrick, 2002). Much of this research, however, has focused on participants with a reasonably high level of formal education. Less is known about the relationships between intelligence, personality traits and achievement among individuals with limited formal education. In view of this, the relationships between measures of general intelligence, personality traits, and practical and academic training achievement of people with limited formal education are investigated in this study.

In the following discussion, the evidence that supports the use of general intelligence and personality traits in the prediction of achievement, is briefly examined. Thereafter, some of the difficulties encountered in the measurement of general intelligence and personality traits among individuals with limited formal education is explored.

Meta-analyses of job selection studies provide strong empirical evidence in support of general intelligence measures in the prediction of work-related achievement (Hunter & Hunter, 1984; Schmidt & Hunter, 1998). By statistically combining the results of studies done in the 85 years preceding 1998, Schmidt and Hunter (1998) estimated the validity coefficient of measures of general intelligence in the prediction of overall job performance as 0.51, and in the prediction of job training performance as 0.56. These estimates were based on data of over 32 000 employees in some five hundred diverse jobs. Schmidt and Hunter also demonstrated that, apart from work sample measures (validity for overall job performance = 0.54), general intelligence measures have the highest validity of 19 different predictors of work-related performance. It is important to note, however, that work sample tests are much more expensive than general intelligence tests and that work sample tests have only slightly better validity than general intelligence tests.

On a more specific level, Hunter and Hunter (1984) demonstrated that the validity coefficients of general intelligence measures decrease as jobs become less complex: 0.58 for professional-managerial jobs, 0.56 for high-level, complex technical jobs, 0.51 for medium-complexity jobs, 0.40 for semi-skilled jobs, and 0.23 for completely

unskilled jobs. These correlation coefficients show that intelligence tests retain predictive validity even for completely unskilled jobs. On the basis of these results and the cost-effectiveness of general intelligence tests, Schmidt and Hunter (1998) regarded such tests as the primary measures for job selection. In support of the validity of measures of general intelligence, Murray (1998) and Judge, Higgins, Thoresen and Barrick (1999) showed that general intelligence predicts later occupational outcomes, such as income and occupational level.

Meta-analyses of the role of personality traits in the prediction of work-related outcomes have focused on the so-called Big Five personality factors, namely, Extraversion, Neuroticism, Openness to Experience, Conscientiousness and Agreeableness (cf. Barrick & Mount, 1991; Judge, Heller & Mount, 2002; Salgado, 2003; Tett, Jackson & Rothstein, 1991). Barrick and Mount's (1991) influential meta-analysis of 117 studies indicated that Extraversion, Openness to Experience and Agreeableness predict success in work achievement, including work competence, personnel data and training achievement. Conscientiousness was the only trait that showed a positive relationship to all three of these aspects of work achievement. Balk and Dudzik (2001), as well as Schouwenburg and Kossowska (1996) also highlighted the positive role of Conscientiousness as a predictor of work-related achievement. Salgado's (2003) recent meta-analysis of European and American studies confirmed the relationship of Conscientiousness with work-related achievement, and showed that Neuroticism is also a valid predictor of all three work-achievement criteria. In South Africa, van der Walt et al. (2002) found that Extraversion, Neuroticism and Conscientiousness were valid predictors of success in different occupations.

In the South African context, the use of intelligence and personality tests in the prediction of work-related performance among individuals with limited formal education present significant difficulties. Specifically, psychologists wishing to assess the intelligence or personality traits of individuals in adult basic education and training (ABET) courses are presented with two challenges: first, it can be expected that some participants in such courses will have an indigenous African language as their first language. However, in contrast to Afrikaans and English, very few suitable tests for adults are available in indigenous African languages. Second, many participants in ABET courses may have poorly developed English reading skills.

From this it follows that psychologists working in an ABET context may need tests that require a very basic reading ability or tests that rely on non-verbal content. Non-verbal tests of intelligence or personality, however, are not necessarily without comprehension problems. It can easily be demonstrated, for instance, that a pictorial item in a personality test may contain content that is unfamiliar or ambiguous to the respondents. Such content is clearly unsuitable, even though it does not require any reading ability.

In this study, we examined the use of non-verbal tests of intelligence and personality, namely, Raven's Progressive Matrices (RPM) (Raven, Raven & Court, 1995) and

the Five Factor-Nonverbal Personality Questionnaire (FF-NPQ) (Paunonen, Ashton & Jackson, 2001), respectively, in the prediction of academic and practical performance in an ABET course in Domestic Services.

METHOD

Participants

The study involved eighty-two participants (46 coloured and 36 black participants; 79 female and 3 male participants). They were all enrolled for an ABET course, namely, the National Certificate in Domestic Services, on Level 1 of the National Qualifications Framework (NQF). Forty-five of these participants' first language was Afrikaans, one English, two seSotho, and thirty-four isiXhosa. The level of their formal education ranged between Grade 9 and Grade 12.

Instruments

In view of the difficulties encountered in the measurement of general intelligence and personality traits among individuals with limited formal education or where no tests are available in participants' preferred language, it was decided to use the FF-NPQ (Paunonen et al. 2001) and the Standard RPM (Raven et al. 1995). Both these tests make limited demands on the participants' reading ability in English.

The FF-NPQ consists of 60 pictorial items. Respondents have to indicate to what degree their behaviour would correspond with the behaviour portrayed in the pictures. Paunonen et al. (2001, p. 3) explained the purpose of the FF-NPQ as follows:

This new questionnaire is intended to provide efficient and psychometrically sound personality assessments in certain cross-cultural contexts without requiring the translation of verbal items. It is also intended for use in some within-culture assessment situations where, for example, language or reading comprehension is a problem.

Regarding the cross-cultural use of the FF-NPQ, Paunonen and Ashton (2002) pointed out that caution should be exercised when personality measures that are developed in one culture, are used in another culture. They explained that the meaning of personality items may differ for individuals from different cultures and that scores on personality measures are not necessarily comparable across cultures. In terms of the FF-NPQ, it is possible that some of the non-verbal items represent behaviours that are irrelevant in certain cultures. In this regard, Paunonen and Ashton (2002) emphasised that many of the non-verbal items have culture-specific content and that some of the items are most relevant to Western, educated, middle-class respondents. In view of this, they do not regard the FF-NPQ as a culture-free test or even a culture-reduced test. During a pilot study conducted by the third author of this article, two items with ambiguous content were identified. The content of these items was briefly discussed

during the actual data collection in the hope that every participant would attach the same meaning to the same item.

Cronbach's coefficient alpha for the participants' FF-NPQ scores were as follows: Neuroticism, $\alpha = 0.78$, Openness to Experience, $\alpha = 0.65$, Conscientiousness, $\alpha = 0.73$, Agreeableness, $\alpha = 0.58$, and Extraversion, $\alpha = 0.72$. These coefficients show that the reliabilities of four of the scales could be described as satisfactory for research purposes, but that the reliability of the Agreeableness scale could best be described as unsatisfactory. The effect of the relatively low reliability was that the correlations of the Agreeableness scale with the criterion variables were underestimated. Hence, a statistical correction for the lack of reliability was necessary to obtain a clear picture of the true relations between the Agreeableness scale and the criterion variables.

The mean of the five reliability coefficients was 0.69, which compares well with those obtained in Germany (0.69), Norway (0.71), Poland (0.68) and Russia (0.72) (Paunonen et al., 2001).

The RPM measures intelligence in a manner designed to reduce the influence of verbal ability, cultural meanings and educational qualifications on test scores. There are three forms of the RPM available, differing in level of difficulty. The Coloured Matrices are the most basic of the three, followed by the Standard Progressive Matrices and the Advanced Matrices, respectively. The Standard Progressive Matrices, consisting of 60 items, were used in this study. The items are non-verbal, and require testees to perceive relationships in shapes and figures. Jensen (1980, p. 648) described the usefulness of this instrument as follows: 'One of its chief values is for screening illiterate, semi-literate, bilingual, and otherwise educationally disadvantaged or socially depressed populations for potential academic talent.'

The RPM has often been used in cross-cultural intelligence studies worldwide (Anastasi & Urbina, 1997). Cronbach's coefficient alpha for the RPM was 0.90, which can be described as very satisfactory.

The ABET course consisted of two components, namely, practical and academic. Two different sets of test results were therefore obtained for each participant. With regard to the practical component, the average of all the evaluations on the completion of various practical tasks served as the practical mark. A mean score for the academic component was obtained by averaging test and examination marks.

Procedure

All participants completed the FF-NPQ, the RPM, and a biographical questionnaire over two days, in small group settings. Participation was voluntary. Participants agreed that the results could be used for research purposes. In return for their participation, participants received feedback on the results.

RESULTS

Relationships between the personality traits, the RPM and the ABET practical component

The observed correlations between scores for the practical component, the five personality traits, and the RPM, respectively, were as follows: Openness to Experience ($r = 0.13$, $p = 0.12$), Conscientiousness ($r = 0.16$, $p = 0.07$), Extraversion ($r = -0.11$, $p = 0.16$), Agreeableness ($r = 0.34$, $p = 0.001$), Neuroticism ($r = 0.20$, $p = 0.04$), and the RPM ($r = 0.47$, $p < 0.001$) (see Table 1). Agreeableness correlated the strongest with performance in the practical component. When corrected for measurement error in Agreeableness, this correlation increased to 0.45, suggesting that Agreeableness and performance in the practical component shared approximately 20% of their variance.

Table 1. Correlation matrix of the ABET components, RPM and FF-NPQ scales

	Practical	Academic	RPM	E	A	C	O	N
Academic	0.45*							
RPM	0.47*	0.35*						
E	-0.11	-0.01	-0.15					
A	0.34*	-0.05	0.20*	-0.09				
C	0.16	0.03	0.00	0.21*	0.26*			
O	0.13	-0.09	0.07	0.30*	0.40*	0.54*		
N	0.20*	0.06	0.23*	0.01	-0.22*	0.17	-0.03	
Mean	88.17	88.95	33.24	50.59	62.72	65.10	59.68	48.98
SD	4.51	5.31	11.96	11.80	8.72	10.26	9.60	13.66
Reliability			0.90	0.72	0.58	0.73	0.65	0.78

Notes: $n = 82$; RPM = Raven's Progressive Matrices; E = Extraversion; A = Agreeableness; C = Conscientiousness; O = Openness to Experience; N = Neuroticism; * $p < 0.05$

Further inspection of Table 1 shows that the RPM was significantly correlated with the following personality traits: Agreeableness ($r = 0.20$, $p = 0.04$) and Neuroticism ($r = 0.23$, $p = 0.02$). These findings suggest that the more intelligent participants were more agreeable and neurotic than the less intelligent participants. Taken together, the five personality traits significantly explained approximately 15% of the variance in the RPM [$R^2 = 0.15$, $F(5, 76) = 2.66$, $p = 0.03$].

A hierarchical multiple regression analysis was performed with the practical component as dependent variable and the RPM and the five personality traits as independent

variables. The RPM was entered into the regression equation first, followed by the five personality traits as a single block. The results are summarised in Table 2.

Table 2. Proportion of variance in the practical component explained by the RPM and FF-NPQ scales

Model	R^2	Adjusted R^2	R^2 change	F change	$df1$	$df2$	Sig. F change
1	0.22	0.21	0.22	23.05	1	80	0.000
2	0.32	0.27	0.10	2.14	5	75	0.070

Notes: For Model 1, the predictor was the RPM score. For Model 2, the five FF-NPQ scales (as a single block) were added as predictors.

With the RPM as the only predictor, $R^2 = 0.22$, $F(1, 80) = 23.05$, $p < 0.001$. With the five personality traits added, $R^2 = 0.32$, $F(6, 75) = 88.01$, $p < 0.001$. The five personality traits jointly explained a further 10% of the variance in the practical component, but this change was statistically non-significant [R^2 change = 0.10, $F(5, 75) = 2.14$, $p = 0.07$]. The standardised and unstandardised regression weights, t -values, p -levels and semi-partial correlations of the predictor variables with the practical component are summarised in Table 3. Inspection of this table shows that when all the other predictor variables were controlled, Agreeableness appears to have a potentially meaningful relationship with the practical component ($\beta = 0.29$, semi-partial $r = 0.24$, $t = 2.52$, $p = 0.01$).

Table 3. Regression weights, t-tests and effect sizes in the prediction of the practical component

	Unstandardised Coefficients		Standardised Coefficients	t	p	Correlations		
	B	Std. Error	β			Zero-order	Partial	Part
RPM	0.14	0.04	0.38	3.64	0.00	0.47	0.39	0.35
E	-0.01	0.04	-0.04	-0.36	0.72	-0.11	-0.04	-0.03
A	0.15	0.06	0.29	2.52	0.01	0.34	0.28	0.24
C	0.04	0.05	0.09	0.77	0.44	0.16	0.09	0.07
O	-0.02	0.06	-0.04	-0.34	0.74	0.13	-0.04	-0.03
N	0.05	0.04	0.16	1.52	0.13	0.20	0.17	0.15

Notes: RPM = Raven’s Progressive Matrices; E = Extraversion; A = Agreeableness; C = Conscientiousness; O = Openness to Experience; N = Neuroticism

The hierarchical multiple regression analysis was repeated with the RPM and Agreeableness as the only predictor variables [$R^2 = 0.29$, $F(2, 79) = 15.76$, $p < 0.001$]. The addition of Agreeableness to the regression equation was statistically significant [R^2 change = 0.06, $F(1, 79) = 6.79$, $p = 0.01$]. Note that without Extraversion, Neuroticism, Conscientiousness and Openness to Experience, only 3% less of the variance in the practical component was explained.

Relationships between the personality traits, the RPM and the ABET academic component

The correlations between scores for the academic component, the five personality traits, and the RPM, respectively, were as follows: Openness to Experience ($r = -0.09$, $p = 0.21$), Conscientiousness ($r = 0.03$, $p = 0.40$), Extraversion ($r = -0.01$, $p = 0.48$), Agreeableness ($r = -0.05$, $p = 0.32$), Neuroticism ($r = 0.06$, $p = 0.31$) and the RPM ($r = 0.35$, $p = 0.001$) (see Table 1). The correlations between the personality traits and the academic component were all low and non-significant, but the RPM, as with the practical component, showed a meaningful and moderately strong relationship with the academic component.

A hierarchical multiple regression analysis was performed with the academic component as dependent variable and the RPM and the five personality traits as independent or predictor variables. The RPM was again entered into the regression equation first, followed by the five personality traits as a single block. The results are summarised in Table 4.

Table 4. Proportion of variance in the academic component explained by RPM and FF-NPQ scales

Model	R^2	Adjusted R^2	R^2 change	F change	df^1	df^2	Sig. F change
1	0.12	0.11	0.12	11.33	1	80	0.001
2	0.17	0.10	0.05	0.83	5	75	0.536

Notes: For Model 1, the predictor was the RPM score. For Model 2, the five FF-NPQ scales (as a single block) were added as predictors.

With the RPM as the only predictor, $R^2 = 0.12$, $F(1, 80) = 11.33$, $p < 0.001$. With the five personality traits added, $R^2 = 0.17$, $F(6, 75) = 2.56$, $p = 0.03$. The five personality traits together explained a further 5% of the variance in the academic component, but this change was statistically non-significant [R^2 change = 0.05, $F(5, 75) = 0.83$, $p = 0.54$]. The standardised and unstandardised regression weights, t -values, p -levels, and semi-partial correlations of the predictor variables are summarised in Table 5. Inspection of this table shows that no individual predictor, apart from the RPM, was significantly related to the academic component when all the other predictor variables were controlled. Hence, no further analyses were made.

Table 5. Regression weights, t-tests and effect sizes in the prediction of the academic component

	Unstandardised Coefficients		Standardised Coefficients	<i>t</i>	<i>p</i>	Correlations		
	<i>b</i>	Std. Error	β			Zero-order	Partial	Part
RPM	0.19	0.05	0.42	3.70	0.00	0.35	0.39	0.39
E	0.03	0.05	0.07	0.60	0.55	-0.01	0.01	0.06
A	-0.07	0.08	-0.12	-0.96	0.34	-0.05	-0.11	-0.10
C	0.08	0.07	0.16	1.22	0.23	0.03	0.14	0.13
O	-0.10	0.08	-0.18	-1.29	0.20	-0.09	-0.15	-0.14
N	-0.04	0.05	-0.10	-0.87	0.34	0.06	-0.10	-0.09

Notes: RPM = Raven’s Progressive Matrices; E = Extraversion; A = Agreeableness; C = Conscientiousness; O = Openness to Experience; N = Neuroticism

DISCUSSION

The goal of this study was to investigate the relationships between general intelligence, personality traits, and the practical and academic training achievement of students in an ABET course. The RPM and the FF-NPQ were used as non-verbal tests of intelligence and personality.

The predictive validity of the RPM for the practical component ($r = 0.47$) is better than what was reported by Schmidt and Hunter (1998) for semi-skilled ($r = 0.40$) and unskilled workers ($r = 0.23$). This finding is noteworthy in view of the relatively restricted range of scores obtained for the practical component, namely, between 77% and 92%. These results suggest that general intelligence measures may be useful in the prediction of success in the practical component of an ABET course in domestic management.

On the FF-NPQ, Agreeableness showed the strongest correlation with performance in the practical component. Barrick, Mitchell and Stewart (2003) pointed out that Agreeableness is most likely to co-vary with performance in jobs that require co-operation. In this regard, one might imagine that friendly and co-operative domestic workers will be rated more highly than argumentative, defensive and unco-operative workers. The role of Agreeableness in training achievement could possibly also be explained in terms of its relationship to teamwork (Barrick et al., 2001; Hough, 1992). While in training, the ABET students often worked in small groups and, consequently, the specific trait could possibly have contributed to positive results. In this regard, Mount, Barrick and Stewart (1998) also reported that Agreeableness was the most important personality predictor of performance in jobs involving interactions with others in teams.

A surprising finding was that performance in the practical component correlated positively with scores for the Neuroticism scale. This indicates that individuals who are more prone to the experience of negative emotions, such as anxiety and depression, performed better. Previous research has indicated contradictory findings (Barrick et al., 2001; Barrick et al., 2003; Salgado, 2003). These contradictory findings call for further research.

The results of this study differ from those of, among others, Barrick and Mount (1991), Salgado (2003), and Balk and Dudzik (2001), in that Agreeableness was the only meaningful predictor of success. The variations in results could possibly be explained by the differences between the current and previous studies with regard to (a) the type of training programme, and (b) the degree of difficulty of the programme. The type of training programme demands certain traits to be more important than others for success. For example, at university level it is often expected of students to engage in self-study. Conscientiousness, as represented by, among other things, orderliness, the ability to work systematically and endurance (De Raad & Schouwenburg, 1996), will probably play a more important role in success in higher education courses than in ABET courses, which are more structured and directed by a facilitator.

With regards to the degree of difficulty of the programme, Spurgeon and Barwell (1991, p. 588) maintained:

Although some degree of intellectual ability is essential for each job area, it is a necessary but not sufficient characteristic. Beyond a certain level, increased intellectual ability does not necessarily produce enhanced job performance . . . Personality factors appear to be more predictive . . .

Spurgeon and Barwell's comment could possibly contribute to an explanation of why other research that focused on university students found significant relationships between other personality factors and academic success. Bearing the National Qualifications Framework (NQF) in mind, the degree of difficulty of the ABET course (NQF-level 1) is assumed to be much lower than undergraduate university courses (NQF-level 5). It thus seems possible that different personality traits may be useful in different environments and that they may have low validity in some environments.

In this study, no significant correlations between the personality traits and the academic component of the ABET course were found. However, the RPM correlated meaningfully with the academic component ($r = 0.35$). These results suggest that general intelligence measures may, as with the practical component, be useful in the prediction of success in the academic component of an ABET course in domestic management. This finding is supported by other research (cf. Kunzel et al., 2004; Viswesvaran & Ones, 2002).

Regardless of the differences between the current and previous studies, the results are encouraging in that they suggest that standard psychometric tools, specifically

non-verbal general intelligence tests and non-verbal personality questionnaires, hold promise for the prediction of semi-skilled or unskilled workers' work-related performance.

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