Industrial psychology students' attitudes towards statistics

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ABSTRACT

Orientation: The attitude of students toward statistics may influence their enrolment, achievement and motivation in the subject of research and Industrial Psychology.

Research purpose: The aims of this study were to determine the reliability and validity of the survey of attitudes toward statistics (SATS-36) for a South African sample and to determine whether biographical variables influence students' attitudes.

Motivation for study: Students could be better prepared for, and guided through, a course in statistics if more is known about their attitudes towards statistics.

Research design, approach and method: A cross-sectional survey design was used and the SATS-36 was administered to a sample of convenience consisting of 235 students enrolled in Industrial and Organisational Psychology at a large tertiary institution in South Africa.

Main findings: Results revealed that even though students perceive statistics to be technical, complicated and difficult to master, they are interested in the subject and believe statistics to be of value. The degree to which students perceived themselves to be competent in mathematics was related to the degree to which they felt confident in their own ability to master statistics. Males displayed slightly more positive feelings toward statistics than females. Older students perceived statistics to be less difficult than younger students and also displayed slightly more positive feelings concerning statistics.

Practical implications: It seems that in preparing students for statistics, their perception regarding their mathematical competence could be managed as well.

Contribution: This study provides the first preliminary evidence for the reliability and validity of the SATS-36 for a sample of South African students.

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INTRODUCTION

Statistics is a methodological discipline that offers other fields of study a coherent set of ideas and tools for dealing with data. The discipline does not exist for itself, but rather provides means for dealing with data that take into account the omnipresence of variability (Cobb & Moore, 1997). Florence Nightingale went so far as to say that statistics can be viewed as the most important science in the whole world (Ridgway, Nicholson & McCusker, 2007), the reason being that the practical application of every other science depends on statistics and it is therefore the one science essential to all political and social administration as well as education (Ridgway, Nicholson & McCusker, 2007). Consequently, statistics is near-universally recognised as an important component of almost all studies at tertiary level.

The objective of a statistics course is to equip students with basic statistical skills in order to appreciate the value of statistics in their professional and personal lives (North & Zewotir, 2006). A baseline comprehension of statistics equips students to understand previous and current research, generate some of their own research, evaluate practices and draw informed conclusions regarding studies that were undertaken (Quinn, 2006). At undergraduate level, the ability to evaluate empirical evidence in published material (Mulhern & Wylie, 2004) and at postgraduate level, the ability to undertake empirical work, is central to any professional training.

However, for most students, statistics is seen only as a professional tool rather than a central skill (Petocz & Reid, 2005) and their statistics education as part of their degree does not set out to prepare them as statistics consultants. It rather prepares them to recognise when a statistician is needed and to be able to better use a statisticians' consultancy services in their profession (North & Zewotir, 2006). As a result of this, statistics represents a new way of thinking for most students and is also seen as a somewhat unexpected component of their studies and future professions (Petocz & Reid, 2005). Most students find the completion of statistics as part of their education quite daunting (Laher, Israel & Pitman, 2007).

The perceptions and attitudes of students regarding statistics might therefore pose some challenges for everyone teaching statistics, also in the field of Industrial Psychology in South Africa. Investigating students' attitudes towards statistics might aid those teaching statistics to better prepare and guide students through this compulsory statistical education. It can also equip teachers to influence students' perceptions of the role of statistics in their future careers.

Students' attitudes toward statistics

The preparedness of students to undertake courses in statistics can, apart from mathematical aptitude and pedagogic approaches, also be viewed in terms of affective and attitudinal factors (Mulhern & Wylie, 2004). Attitude toward statistics can be defined as 'a disposition to respond favourably or

unfavourably to objects, situations or people related to statistics learning' (Chiesi & Primi, 2009, p. 309). Although some students reveal a positive attitude toward statistics (Mills, 2004; Waters, Martelli, Zakrajsek & Popovich, 1989), evidence reveals that unfavourable responses far outweigh any favourable responses.

Students often view statistics as one of the biggest hurdles they face as graduate students. In this regard, Birenbaum and Eylath (1994) are of the opinion that statistics-related courses are considered by many students as the most dreadful courses in the curriculum and their experience of these courses can be rather onerous and anxiety-laden (Piotrowski, Bagui & Hemasinha, 2002). Evidence of this can also be traced to the titles of some statistics references such as 'Statistics without tears' (Rowntree, 1981) or some subtitles that read 'Those of you who approach statistics with fear and foreboding...' (Clegg, 1982, p. 9). Courses in statistics are often described by students as difficult, boring, a waste of time and not relevant (Hollis, 1997). Research has shown that students' attitudes toward these courses include anxiety, cynicism, fear and contempt (Hopkins, Hopkins & Glass, 1996). Onwuegbuzie (2004) found that as many as 80% of graduate students experience anxiety over learning statistics.
Students' attitudes toward statistics may create a major obstacle for effective learning (Mills, 2004; Onwuegbuzie & Seaman, 1995) and as a result, teaching statistics and even research methods can become a major pedagogic challenge (Mulhern & Wylie, 2004). Onwuegbuzie (2000) also expressed the concern that non-cognitive issues like students' attitudes, feelings, beliefs and perceptions may counteract the learning environment which statistics instructors are attempting to create. Earlier authors have even gone so far as to suggest that the first goal in teaching statistics should be to reduce the fear of statistics (Blalock, 1987). Garfield and Ben-Zvi (2007), in a review of a number of studies regarding how students learn statistics, suggested that teachers need to cultivate more positive beliefs about the value of statistics and statistical literacy. Teachers should also be aware that students come to statistics courses with a variety of perspectives regarding their own ability or lack of ability to succeed in the course (Garfield & Ben-Zvi, 2007). Schau (2003) found that students' attitude toward statistics were positively related to their achievement in statistics. Hilton, Schau and Olsen (2004) believed that evidence is slowly growing to support the belief that students' attitudes toward statistics affects their course enrolment, persistence, achievement and the general climate in the class. Since students' attitudes toward statistics are important, we must be able to assess them.

The assessment of attitude toward statistics

Attitudes towards statistics is most often described as a multidimensional concept that consists of affective (emotions and the motivation related to classes and assessments), cognitive (beliefs and knowledge about the ability required to learn statistics and about the discipline) and behavioural (action tendencies in studying and performance in examinations) components (Schau, Stevens, Dauphinee & Del Vecchio, 1995).

Schau *et al*. (1995) developed an instrument, the Survey of Attitude Toward Statistics (SATS-28 item version), designed to measure attitudes toward statistics based on four facets – namely, affect (positive and negative feelings concerning statistics), cognitive competence (students' attitudes about their own intellectual knowledge and skills when applied to statistics), value (attitudes about the usefulness, relevance and worth of statistics in one's personal and professional life) and difficulty (attitudes about the difficulty of statistics as a subject). The SATS-28 item version has been proven to be valid and reliable for American (Mills, 2004; Schau *et al*., 1995) and Italian samples (Chiesi & Primi, 2009). The 28-item version was extended to a 36-item version to include two additional components – namely, interest (level of individual interest in the topic of statistics) and effort (amount of work needed to learn statistics) (Schau 2003). The SATS-36 item version has been used with a European sample (Tempelaar, Gijselaers & Van der Loeff, 2006). No records could, however, be found of this measurement being used in a South African sample.

Variables related to attitude toward statistics

Previous studies have shown that attitudes toward statistics are related to previous math experience (Brown & Brown, 1995; Onwuegbuzie, 2000; Schau, 2003), level of statistics course (Waters *et al*., 1989), previous statistics experience (Sutarso, 1992 cited in Mills, 2004) and grade–point average (Ware & Chastain, 1989 cited in Mills, 2004). Mills (2004) reviewed previous studies on the influence of gender on attitudes toward statistics and reported that they yielded mixed results. He found that males were less likely than females to report that they were scared of statistics, could not learn it and they did not feel confident mastering statistical material (Mills, 2004). In a sample of European students, Tempelaar, Gijselaers and Van der Loeff (2006) found that males scored higher on positive affect toward statistics, cognitive competence applied to statistics and difficulty of the subject, but scored lower than females on general interest in the subject and the degree of effort they were planning to expend on statistics. No gender differences were found regarding the value of statistics for their personal and professional lives.

Age appeared to be an influencing factor based on the time that had elapsed since previous mathematical or statistical experience (Onwuegbuzie, DaRos & Ryan, 1997; Onwuegbuzie, 2000). Baloglu (2003) also found that although older students showed more positive attitudes towards the usefulness of statistics, they tended to have higher levels of statistics anxiety.

The aim of this paper is to (1) determine the validity and reliability of the SATS-36 item version as an instrument to measure attitude toward statistics in a South African sample, (2) determine the general attitude of students towards statistics and (3) determine whether the variables of prior math experience, level of statistics course (academic year), gender and age influence students' attitudes towards statistics.

RESEARCH DESIGN

Research approach

A cross-sectional survey design, that was quantitative in nature, was used. The survey design enables indirect observation through the use of structured interviews and questionnaires and getting a broad overview of a sample of a larger population (Mouton, 2001). The cross-sectional design allowed for a larger number of students to be included in the study and was appropriate to use in gathering information regarding their attitudes toward statistics by means of a questionnaire at a specific point in time.

Research method

Participants

The characteristics of the participants are described in Table 1. The participants were 235 undergraduate (n = 111), honours (n = 107) and masters (n = 17) students enrolled in Industrial and Organisational Psychology at a large tertiary institution in South Africa. Females comprised 72.8% of the sample. More than half of the participants (52.8%) were black, whereas the remaining participants were white (30.2%), asian (10.6%) or coloured (5.1%). The average age of the sample was 31 years and the ages ranged from 19 to 58 years.

Measuring instruments

The SATS-36 (Schau, 2003) was used to measure students' attitudes toward statistics. The SATS-36 uses a 7-point Likert scale (1 = strongly disagree, 4 = neither disagree nor agree, 7

TABLE 1
Characteristics of the participants

Item	Category	Frequency	%
Academic year	Second year	111	47.2
	Honours level	107	45.5
	Masters level	17	7.2
Gender	Males	63	26.8
	Females	171	72.8
Race	White	71	30.2
	Black	124	52.8
	Asian	25	10.6
	Coloured	12	5.1
Age	19–31	135	57.4
	32–45	81	34.5
	46–59	17	7.2

= strongly agree) and contains six subscales. Affect measures students' feeling concerning statistics (e.g. 'I am scared by statistics'). This subscale consists of six items and internal reliability (alpha coefficient) has been shown to range between 0.80 and 0.89. Cognitive competence investigates students' attitudes about their intellectual knowledge and skills when applied to statistics (e.g. 'I can learn statistics'). The subscale has six items and reliability ranged between 0.77 and 0.88. Value is a measurement of students' attitudes about the usefulness, relevance, and worth of statistics in their personal and professional life (e.g. 'Statistics is irrelevant in my life'). This is measured by nine items and Cronbach alpha coefficients ranged between 0.74 and 0.90. Difficulty relates to students' attitudes about the difficulty of statistics as a subject (e.g. 'Statistics is highly technical'). Seven items are included in this subscale and reliability coefficients ranged between 0.64 and 0.81. Four new items measure students' level of individual interest in statistics (interest) (e.g. 'I am interested in using statistics') and another four items measures effort (the amount of work the student expends to learn statistics) (e.g. 'I plan to work hard in my statistics course) (Dauphinee, Schau & Stevens, 1997; Hilton *et al*., 2004; Schau *et al*., 1995). The SATS therefore yielded good internal consistency. Schau *et al*. (1995) confirmed the four-factor structure of the 28-item version through confirmatory factor analysis. The estimated correlations among the four factors of the 28-item version were significant, except for the correlation between value and difficulty (Schau *et al*., 1995). Convergent validity was proven with the attitude towards statistics (ATS) scale of Wise (1985).

Statistical analysis

Confirmatory factor analysis was used to determine the validity of the SATS-36 for the specific sample of this study. Cronbach alpha coefficients were determined to indicate the reliability of the sub-factors of the survey. Descriptive statistics were calculated to determine the students' attitudes towards statistics. Skewness and kurtosis were used to determine if the data are normally distributed (zskewness = S-0/SEskewness < 1.96 = normally distributed; zkurtosis = K-0/SEkurtosis < 1.96 = normally distributed). Based on the values of skewness and kurtosis displayed in Table 4, it could be seen that only cognitive competence and difficulty are normally distributed. Therefore, since most of the data are not normally distributed, non-parametric statistics were used for the rest of the analyses. Spearman correlations were used to test for the relationships between attitudes and prior math experience. Effect sizes were used to decide on the practical significance of the findings, where 0.10 was regarded as a small effect, 0.30 as a medium effect and 0.50 as a large effect (Cohen, 1988). The Mann–Whitney non-parametric t-test was used to determine the significance of difference between the level of statistics course (academic year), gender and age. Effect sizes were determined for the Mann–Whitney test by calculating $r = Z/\sqrt{N}$. This is a standardised measure of the size of the effect that is observed,

TABLE 2
Fit indices for the confirmatory factor analysis models of the SATS-36

Fit indices and other measures	Model Factors					
	Single		Basic 6		Final 6	
Scaled* model Chi-Square	1632.4		1142.7		587	
Degrees of Freedom for above	594		579		404	
Normed Chi-Square	2.75	N	1.97	A	1.45	A
Comparitive Fit Index (CFI)	0.598	N	0.782	N	0.923	A
RMSEA	0.086	N	0.065	N	0.044	A
90% lower limit	0.081	N	0.059	N	0.036	A
90% upper limit	0.091	N	0.07	N	0.051	A

A = Acceptable; N = Not acceptable, *Satorra-Bentler Type.

where r = 0.00 – 0.29 denotes a small effect; r = 0.30 – 0.49 denotes a medium effect; and r = > 0.50 denotes a large effect (Field, 2005).

RESULTS

Reliability and validity of the measuring instrument

No previous South African studies could be found that used SATS-36. Therefore, before the data was analysed and interpreted, the reliability and validity of the measuring instrument was determined for the specific sample used in this study.

The first step in the confirmatory factor analysis was to determine whether a single factor model could possibly fit the data satisfactorily. The fit indices, as shown in Table 2, indicated that a single latent factor model could not describe the data adequately.

Secondly, the basic six-factor model was fitted which resulted in an improvement of all the fit indices considered. The Normed chi-square was acceptable, but none of the other indices conformed to the generally prescribed limits. All possible covariances between the six latent factors were introduced and used in all subsequent analyses.

Thirdly, a series of steps were followed for improving the overall fit of the model as portrayed by the indices listed in Table 2. At each possible alteration to the model, only a single change was made, the model was rerun and again inspected for possible changes. Some of the steps used included the following:

The use of Wald indices for reducing the number of non significant parameters in a given model.

La Grange multipliers were calculated for the purpose of adding new paths between latent factors and items, such as moving an item from one factor to another or for the introduction of covariance terms between the error terms of items which may indicate a common cause.

Steps 1 and 2 were reiterated until a satisfactory model was obtained. Values of 0.90 and higher signify acceptable fit for GFI, TLI and CFI, whereas values of 0.08 and lower indicate acceptable fit for RMSEA (Byrne, 2001). From Table 3 it can also be seen that items 21, 24, 27, 30 and 36 were deleted. These items had lower R^2-values compared to other items and deleting them improved the model significantly.

The suggested (basic) and developed (final) measurement models are given in Table 3. All six factors had acceptable Cronbach alpha levels above 0.70, except for Difficulty (0.66).

Attitudes towards statistics

Descriptive statistics were used to describe the attitudes of the students towards statistics. These descriptive statistics are shown in Table 4.

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TABLE 3
Revised factor structure of the SATS-36

Factor	No	Description	Original Factor	Factor Loading	Item *R2* (%)	Covariance with	Cronbach Alpha
[F1] Affect – students' feelings concerning statistics	3	I will like statistics	[F1]	0.754	56.8	-	
	4 *	I will feel insecure when I have to do statistics problems	[F1]	0.52	27.1	5	
	15 *	I will get frustrated going over statistics tests in class	[F1]	0.578	33.4	18	
	18 *	I will be under stress during statistics class	[F1]	0.71	50.5	15	
	19	I will enjoy taking statistics courses	[F1]	0.767	58.8	20, 29	0.801
[F2] Cognitive Competence – students' attitudes about their intellectual knowledge and skills when applied to statistics	5 *	I will have trouble understanding statistics because of how I think	[F2]	0.523	27.4	4, 11	
	11 *	I will have no idea of what's going on in this statistics course	[F2]	0.6	36.1	5	
	26 *	I will make a lot of math errors in statistics	[F2]	0.679	46.1	-	
	31	I can learn statistics	[F2]	0.587	34.5	14, 32	
	32	I will understand statistics equations	[F2]	0.607	36.8	6, 31	
	35 *	I will find it difficult to understand statistical concepts	[F2]	0.728	53	28	0.798
[F3] Value – students' attitudes about the usefulness, relevance, and worth of statistics in personal and professional life	7 *	Statistics is worthless	[F3]	0.564	31.8	17	
	9	Statistics should be a required part of my professional training	[F3]	0.698	48.7	10, 16, 33	
	10	Statistical skills will make me more employable	[F3]	0.53	28.1	9	
	13 *	Statistics is not useful to the typical professional	[F3]	0.652	42.6	-	
	16 *	Statistical thinking is not applicable in my life outside my job	[F3]	0.754	56.9	9	
	17	I use statistics in my everyday life	[F3]	0.517	26.7	7	
	21 *	Statistics conclusions are rarely presented in everyday life	[F3]	**Deleted**	-	-	
	25 *	I will have no application for statistics in my profession	[F3]	0.664	44.1	-	
	33 *	Statistics is irrelevant in my life	[F3]	0.64	41	9, 20	0.828
[F4] Difficulty – students' attitudes about the difficulty of statistics as a subject	6	Statistics formulas are easy to understand	[F4]	0.606	36.8	32	
	8 *	Statistics is a complicated subject	[F4]	0.511	26.1	-	
	22	Statistics is a subject quickly learned by most people	[F4]	0.353	12.4	-	
	24 *	Learning statistics requires a great deal of discipline	[F4]	**Deleted**	-		
	28 *	I am scared by statistics	[F1]	0.778	60.6	35	
	30 *	Statistics involves massive computations	[F4]	**Deleted**	-	-	
	34 *	Statistics is highly technical	[F4]	0.35	12.2	-	
	36 *	Most people have to learn a new way of thinking to do statistics	[F4]	**Deleted**	-	-	0.662
[F5] Interest – students' level of individual interest in statistics	12	I am interested in being able to communicate statistical information to others	[F5]	0.695	48.3	23	
	20	I am interested in using statistics	[F5]	0.768	59	19, 33	
	23	I am interested in understanding statistical information	[F5]	0.663	43.9	12	
	29	I am interested in learning statistics	[F5]	0.732	53.6	19	0.827
[F6] Effort - amount of work the student expends to learn statistics	1	I plan to complete all of my statistics assignments	[F6]	0.779	60.7	-	
	2	I plan to work hard in my statistics course	[F6]	0.927	85.9	-	
	14	I plan to study hard for every statistics test	[F6]	0.77	59.3	31	
	27	I plan to attend every statistics class session	[F6]	**Deleted**	-	-	0.853

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

TABLE 4
Descriptive statistics of students' attitudes toward statistics

	N	Mode	s.d.	Skewness	Kurtosis
Affect	234	4.6	1.32	-0.45	0.17
Cognitive Competence	232	5.33	1.16	-0.19	-0.62
Value	234	4.88	1.12	-0.62	0.25
Difficulty	233	3.4	1.13	-0.13	-0.65
Interest	231	7	1.26	-1.03	1.09
Effort	235	7	0.98	-2.32	7.85

s.d. = standard deviation
Higher value = more positive attitude

Students displayed a high level of interest in statistics (the modal score for the sub-factor of interest is 7.00, indicating that most students strongly agreed with statements like 'I am interested in learning statistics' or 'I am interested in using statistics'). Students acknowledged that they were prepared to expend a high amount of work in order to learn statistics (the modal score for the subfactor of effort is 7.00, indicating that most students strongly agreed with statements like 'I plan to work hard in my statistics course' or 'I plan to complete all of my statistics assignments'). Students were slightly more positive in rating their confidence in their own intellectual knowledge and skills when applied to statistics (the modal score for the subfactor cognitive competence is 5.33, indicating that most students agree with statements like 'I can learn statistics' or 'I will understand statistics equations'). They tended to be somewhat neutral in their response when rating the feelings they harbour regarding statistics (the modal score for affect is 4.6, indicating that students neither disagreed, nor agreed, or slightly agreed with statements like 'I will like statistics' or 'I will enjoy taking statistics courses'), as well as rating statements about the usefulness, relevance and worth of statistics in their personal and professional life (the modal score for value is 4.88, indicating that most students neither agreed nor disagreed or slightly disagreed with statements like 'Statistics is not useful to the typical professional' or 'Statistics is irrelevant in my life'). They were, however, in agreement that statistics could be viewed as difficult and were slightly more negative when rating the difficulty of statistics as a subject (the modal score for difficulty is 3.40, indicating that students slightly disagreed with statements like 'Statistics formulas are easy to understand' or slightly agreed with statements like 'Statistics is a complicated subject').

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TABLE 5
Correlations between prior math or statistics experience and students' attitudes toward statistics

		Affect	Cognitive Competence	Value	Difficulty	Interest	Effort
Number of years high school mathematics taken	*r*	0.052	0.157*+	0.039	0.122	-0.06	0.055
	p	0.443	0.019	0.565	0.07	0.377	0.411
	N	223	221	223	222	220	224
Number of previous math or statistics courses taken at university	*r*	0.028	0.035	0.039	0.089	-0.023	0.05
	p	0.687	0.615	0.568	0.198	0.743	0.467
	N	212	212	212	211	210	213

*Correlation is significant at the 0.05 level (2-tailed); +Small effect

TABLE 6
Correlations between mathematics achievement and how good students believed they are at mathematics, and students' attitudes toward statistics

		Affect	Cognitive Competence	Value	Difficulty	Interest	Effort
How well students did at mathematics in high school	*r*	0.182**+	0.311**++	0.139*+	0.168**+	0.106	0.11
	p	0.005	0	0.033	0.01	0.107	0.094
	N	234	232	234	233	231	235
How good students believe they are at mathematics	*r*	0.261**+	0.406**++	0.210**+	0.243**+	0.162*+	0.182**+
	p	0	0	0.001	0	0.014	0.005
	N	234	232	234	233	231	235

*Correlation is significant at the 0.05 level (2-tailed); **Correlation is significant at the 0.01 level (2-tailed); +Small effect; ++Medium effect; +++Large effect

Variables that influence students' attitudes toward statistics

Differences regarding students' attitudes towards statistics in terms of their prior maths experience, levels of statistics course (academic year of study), gender and age were determined.

Students were asked the number of years they had studied mathematics at high school and how many previous mathematics or statistics courses they had completed at university. The correlations between these questions and student's attitudes toward statistics are shown in Table 5.

From Table 5 it can be seen that no significant correlations were obtained between attitudes toward statistics and the number of years that students had studied mathematics at high school or the number of previous mathematics or statistics courses they had taken at university. An exception was a practically significant relationship of small effect between the number of years high school mathematics taken and the degree to which students believed that they had the knowledge and skills required to succeed at statistics (cognitive competence).

Students were also asked how well they did at mathematics in high school and how good they believed they were at mathematics. Correlations between these questions and students' attitudes are displayed in Table 6.

Table 6 indicates that the proficiency of students at mathematics in high school had a practically significant relationship of small effect with affect, value and difficulty and a practically significant relationship of medium effect with cognitive competence. No statistically significant correlations were found between how well students did at mathematics in high school and their interest in statistics or the effort they were planning to extend to master statistics. In addition, there was a practically significant correlation of small effect between students' perception of their competence regarding mathematics on the one hand, and affect, value, difficulty, interest and effort on the other hand. There was also a practically significant correlation of medium effect between students' perception of their mathematic competence and their perception of their statistics competence (cognitive competence).

Differences between the levels of statistics course (academic year) and students' attitudes regarding statistics were calculated by means of the Mann–Whitney test. Results revealed that there were no significant difference between the attitudes of postgraduate students (honours and masters') and undergraduate students toward statistics. Results are presented in Table 7.

Gender and age differences with regard to attitude toward statistics are given in Table 8.

No significant differences were found between males and females regarding their attitudes towards statistics, except for their feelings concerning statistics (affect). Males displayed somewhat more positive feelings towards statistics, but the difference is of small effect (r = 0.10). The youngest 15.5% of students (19–22 years of age) differed significantly with regard to their feelings toward statistics from the oldest 15.5% of students (41–58 years of age). They felt less positive regarding statistics, but the difference was of small effect (r = -0.26). The younger students also regarded statistics to be somewhat more difficult (r = -0.34) than the older students. The difference is of medium effect.

DISCUSSION

The aim of this paper were to determine the validity and reliability of the SATS-36 item version as an instrument to measure attitude toward statistics in a South African sample, to determine the general attitude of students towards statistics and to determine whether the variables of prior math experience, level of statistics course (academic year), gender and age influence students' attitudes towards statistics.

The overall findings of the present study provide evidence for the validity and reliability of the SATS-36 item version for a South African sample. A one-factor structure model did not fit the data well. This is in line with suggestions from the developer of the survey (Schau, 2008). The six-factor structure was confirmed and all the sub-factors, except for difficulty, displayed acceptable levels of internal consistency. This result is in accordance with previous results which also showed the reliability coefficients of difficulty ranging between 0.64 and 0.81 (Dauphinee *et al*., 1997; Hilton *et al*., 2004; Schau *et al*., 1995). It therefore seems that presenters of statistics courses in South Africa can use the SATS-36 as a measure of students' attitude toward statistics in future.

Results from this study indicated that students have more positive attitudes about statistics than negative attitudes – a finding that coincides with research by Mills (2004) (in a sample of 203 undergraduate students enrolled for an introductory statistics course in the College of Business of which 89.1% participants were pursuing a Bachelor's degree) and Waters *et*

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TABLE 7
Differences between attitudes toward statistics of postgraduate and undergraduate students

Factor		*N*	Mean Rank	Sum of Ranks	Mann–Whitney *U*	*p* (2-tailed)
Affect	Undergraduate	111	115.95	12870	6654	0.74
	Postgraduate	123	118.9	14625		
	Total	**234**				
Cognitive Competence	Undergraduate	108	109.16	11789	5903	0.12
	Postgraduate	124	122.9	15239		
	Total	**232**				
Value	Undergraduate	110	114.38	12581.5	6476.5	0.51
	Postgraduate	124	120.27	14913.5		
	Total	**234**				
Difficulty	Undergraduate	109	113.23	12342	6347	0.42
	Postgraduate	124	120.31	14919		
	Total	**233**				
Interest	Undergraduate	108	116.27	12557.5	6612.5	0.95
	Postgraduate	123	115.76	14238.5		
	Total	**231**				
Effort	Undergraduate	111	120.46	13371.5	6608.5	0.57
	Postgraduate	124	115.79	14358.5		
	Total	**235**				

al. (1989) (in a sample of 237 students enrolled in a freshman-level introductory statistics course taught in the Psychology department of a Midwestern university). However, these results contrast with those of Birenbaum and Eylath (1994) (in a sample of graduate level students in the educational sciences) and Onwuegbuzie (2004) (in a sample of 135 graduate students enrolled in three sections of a required introductory-level educational research course at a university in the south-eastern part of the USA) in which students displayed much more negative attitudes towards statistics. It seems that further research is required regarding the external factors that influences students' attitudes in order to shed more light on these inconsistent results.

The students in the current study displayed a high level of interest in statistics (this is in line with research by Tempelaar *et al*. (2006) in a sample of European first year students enrolled for a course in Quantitative Methods (QM) that forms part of both Economics and Business first-year programs). They displayed an interest in learning, understanding and using statistics, as well as being able to communicate statistical information. Students were somewhat neutral with regard to statistics being of value in their personal and professional life. Nevertheless, they agreed that statistics should be a required part of their professional training, that statistics will have some application in their profession and also that statistical skills will make them more employable. They even agreed to some extent that they can use statistics in their everyday life. Similar results regarding the value students attach to statistics were found by Schau (2003) in a sample of undergraduate students enrolled for an introductory statistics course offered by the Mathematics and Statistics Department at a major south-western research university in the USA, as well as by Mills (2004). In accordance with the students assessed by Tempelaar *et al*. (2006) students in this study were also prepared to put in a high level of effort in order to learn statistics. Most students agreed that they planned to work hard, study hard and complete all of their assignments for statistics.

Although students agreed that they liked and enjoyed statistics, they were somewhat more neutral in rating their feelings of insecurity, frustration and stress when it came to statistics. As a result students were somewhat more neutral in their response to affect. Schau (2003) indicated that statistical anxiety can be understood as a part of the affect measurement. These results suggest that even though students are interested in statistics and value the worth of statistics, they might still feel somewhat anxious regarding the subject matter. This may also relate to the fact that most students were in agreement that statistics as a subject is complicated, highly technical and difficult to master. Nevertheless, students were slightly more positive in rating their own levels of confidence to master statistics. It is noted that students in this study and that of Tempelaar *et al*. (2006) displayed somewhat lower levels of confidence in their own ability to master statistics than students in the studies of Schau (2003) and Mills (2004). Students' rating of their confidence to master statistics (cognitive competence) was not related to how many prior mathematics courses or statistics courses they had completed, but rather to how well they performed at mathematics in high school, and even more so to how good they believed they were at mathematics. This is in accordance with results from Latief and Blignaut (2008) who also found that throughput in an undergraduate statistics course at a South African university was related to students' Grade 12 Mathematics results. Schau (2003) noted that many students think that statistics is mathematics, especially at the beginning of an introductory course to statistics. North and Zewotir (2006) also warn that emphasising mathematical skills in a statistics course leads to the failure of emphasising what is important – namely, the role of statistics in students' professional careers. It therefore appears that students' own concept of mathematics influences their attitudes toward statistics, especially regarding their perception of how well they will be able to succeed in statistics.

Regarding other biographical variables that might influence attitude toward statistics, results in this study is in line with that of Schau (2003), Tempelaar *et al*. (2006), and Waters *et al*. (1989) which showed that males have a somewhat stronger affect (positive feelings) for statistics than females. Older students also revealed a more positive affect and regarded statistics to be less difficult than younger students. This might be somewhat contradictory to the research of Baloglu (2003) which indicated that older students (albeit older than 27 years of age and seen to be seniors) experience more statistics anxiety.

Recommendations

The SATS-36 appears to be valid and reliable for a sample of South African students, but should be validated with other South African samples also. Despite the fact that students believe that statistics is a difficult subject, they are interested to learn more, tend to feel rather positive about the value of the subject for their personal and professional lives, and are willing

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TABLE 8
Gender and age differences regarding students' attitudes towards statistics

Factor		*N*	Mean Rank	Sum of Ranks	Mann-Whitney– *U*	*p* (2-tailed)
Gender						
Affect	Male	63	135.98	8567	4159	0.00**
	Female	170	109.96	18694		
	Total	**233**				
Cognitive Competence	Male	62	127.12	7881.5	4549.5	0.12
	Female	169	111.92	18914.5		
	Total	**231**				
Value	Male	63	124.75	7859.5	4866.5	0.28
	Female	170	114.13	19401.5		
	Total	**233**				
Difficulty	Male	62	125.85	7803	4690	0.19
	Female	170	113.09	19225		
	Total	**232**				
Interest	Male	62	129.01	7998.5	4370.5	0.06
	Female	168	110.51	18566.5		
	Total	**230**				
Effort	Male	63	117	7371	5355	0.94
	Female	171	117.68	20124		
	Total	**234**				
Age						
Affect	Youngest	36	30.57	1100.5	434.5	0.02*
	Oldest	35	41.59	1455.5		
	Total	**71**				
Cognitive Competence	Youngest	36	34.25	1233	567	0.59
	Oldest	34	36.82	1252		
	Total	**70**				
Value	Youngest	36	36.36	1309	643	0.95
	Oldest	36	36.64	1319		
	Total	**72**				
Difficulty	Youngest	34	28.28	961.5	366.5	0.00**
	Oldest	36	42.32	1523.5		
	Total	**70**				
Interest	Youngest	35	33.09	1158	528	0.31
	Oldest	35	37.91	1327		
	Total	**70**				
Effort	Youngest	36	36.21	1303.5	637.5	0.89
	Oldest	36	36.79	1324.5		
	Total	**72**				

*Difference is significant at the 0.05 level; **Difference is significant at the 0.01 level

to spend some effort in order to succeed in their statistics courses. Information provided in the present study could be of great value for statistics instructors. Presenters of statistics courses might capitalise on these positive attitudes in order to further engage their students in the subject. Schau (2003) believed that a body of evidence is growing to show the link between students' attitudes and their achievement in statistics. However, Garfield and Ben-Zvi (2007), in a review of related research, concluded that good attitudes do not necessarily lead to success in statistics and that variables such as motivation, conscientiousness and the desire to learn may be better predictors. Future studies could investigate how and to what extent students' attitudes contribute toward their performance in statistics. In presenting statistics courses, it might be important to stress that statistics is not mathematics and clearly indicate to them which basic algebra skills are needed.

In conclusion, the objectives of this study were achieved in that the results provide preliminary evidence for the validity and reliability of the SATS-36 item version as an instrument to measure attitude toward statistics in a South African sample of students; the general attitude of students towards statistics were explored and the influence of some biographical variables like prior mathematics experience, gender and age on students' attitudes towards statistics were confirmed to some extent.

Possible limitations

Since a sample of convenience was used, results from this study cannot be generalised to other samples of students in South Africa. The sample also did not include an equal representation of different racial groups in South Africa and therefore subsequent analysis with race as a variable was excluded

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from this study. Furthermore, the research design was cross-sectional, which implies that causal inferences cannot be made. The survey was administered to students at the onset of their statistics course or year of study. A limitation of the study is that another measurement was not taken at the end of their course or year of study to determine if their attitudes changed significantly throughout the year.

Suggestions for future research

The SATS-36 should be validated for wider and more representative samples of students in South Africa as well. It could also be investigated whether students in other fields of study held different attitudes towards statistics as compared to students in Industrial Psychology. Future research is needed to further clarify the relationship between gender and age on the one hand and attitudes towards statistics on the other hand. The influence of students' attitudes on their enrolment decisions could also be investigated. Future research could further investigate how student's attitudes towards statistics develop or change over time (using the pre- and post-measurement versions of the SATS-36). Further research could also attempt to confirm or identify other factors that influence or affects student's attitudes toward statistics, such as their overall GPA scores.

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