CHAPTER SIX

METHOD OF INVESTIGATION

6.1 PROBLEM FORMULATION AND MOTIVATION FOR THE INVESTIGATION

The first year at university marks an important transitional phase for students in their career development. Research shows that the first year is crucial to success in higher education and graduating (Banning, 1989; Jewler, 1989; Levitz & Noel, 1989). Information on students' personality styles and learning ability and styles can assist in the placement of students through career counselling and in planning and implementing optimum learning opportunities for them.

In Chapter 5 a theoretical integration of Holland's vocational personality types and Kolb's learning abilities and styles was proposed. Only a few studies, reported in Chapter 5, investigating the interaction between Holland's and Kolb's models have been done. The interaction between these two models will be further investigated in this empirical study.

6.2 AIM OF THE STUDY

The primary aim of the empirical study is to investigate the interaction of vocational personality type, and the learning ability and learning style of first-year students registered for courses presented in English and studying for either a science degree or a human sciences degree.

A secondary aim is to investigate the psychometric properties of the two measures of learning style used in the empirical study. Although this is a secondary aim, information relating to the psychometric properties of the two measures of learning style will be given first, followed by information on the interaction of vocational personality type, and learning ability and style. This method will be followed in this chapter as well as in the following chapter where the research results will be reported and discussed. The research results can then be interpreted in the light of the findings pertaining to the psychometric properties of the instruments.

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6.3   RESEARCH DESIGN

6.3.1   Description of the total sample and subsamples used for analysis

All subjects were full-time, first-year students at the University of Pretoria. The official medium of instruction at the university is Afrikaans, but many courses are offered in both Afrikaans and English. As the two learning style inventories used in this study were only available in English it was decided to use only students registered for English courses at the university.

A testing programme to standardize new instruments developed for admission purposes at the university was run during the orientation week at the end of January in 1995 and 1996. The researcher was granted permission to test students registered for courses presented in English in the faculty of Biological and Agricultural Sciences during the 1995 programme. A group of 304 students participated in the university's standardization testing programme and the remaining 99 students completed the instruments for this study. During the second phase of the university's testing programme in 1996 there were no "excess" students from the faculty of Biological and Agricultural Sciences so the 1995 sample could not be increased as planned. A small group of 38 students, registered for Engineering degree courses presented in English, participated in the researcher's study, these being the "excess" students of the university's 1996 test programme for the Engineering faculty.

In 1996 the Department of Psychology at the University of Pretoria granted the researcher permission to test students registered for the two English classes for the first-year Psychology course. Out of a possible total of 441 students, 327 participated in the study, these being the students who attended the class periods during which testing took place. The majority of these students were registered for a BA degree, however some were registered for science degrees such as MBChB, BChD, Nursing, Occupational Therapy and Dietetics. There were also a few students registered for commerce or law degrees. These students were excluded from the sample as only the sciences and human sciences fields of study were of interest in this study. (See Table 6.1 on the following page.).

TABLE 6.1   DISTRIBUTION OF THE TOTAL SAMPLE AND SUBSAMPLES USED FOR ANALYSIS

	TOTAL SAMPLE N = 464	SDS N = 236	LSI N = 419	LSQ N = 415	SDS + LSI N = 230	SDS + LSQ N = 231	SDS + LSI + LSQ N = 226
Gender	(14)*	(2)*	(2)*	(2)*	(2)*	(2)*	(2)*
Male	150	83	135	135	82	81	81
Female	300	151	282	278	146	148	143
Home language	(10)*						
English	170	87	145	145	85	87	85
Afrikaans	8	1	3	3	1	1	1
English + Afrikaans	21	10	20	20	10	10	10
African language(s)	152	73	150	147	71	68	67
English + African language(s)	57	35	57	56	34	35	34
English + other	27	17	27	27	17	17	17
Other	19	13	17	17	12	13	12
Cultural group	(23)*		(1)*	(1)*			
White	177	98	159	159	97	98	97
African	217	112	212	208	107	107	103
Coloured	3	1	3	3	1	1	1
Indian	43	24	43	43	24	24	24
Asian	1	1	1	1	1	1	1
Degree	(4)*						
BSc (Biological & Agricultural Sciences)	99	82	95	93	79	81	79
BA (Psychology class)	253	97	226	225	95	94	92
BEngineering	38	34	38	38	34	34	34
BSc (Psychology class)	63	23	60	59	22	22	21
Law (Psychology class)	5	-	-	-	-	-	-
BCom (Psychology class)	2	-	-	-	-	-	-

* Numbers in brackets indicate the number of missing records.

Evaluation of the psychometric properties of the two measures of learning style, the Learning Style Inventory (LSI) and the Learning Style Questionnaire (LSQ)

As the Self-Directed Search (SDS), used as a measure of vocational personality, is not relevant to this part of the study the subsample sizes for this analysis are larger than the subsample used for the investigation of the interaction of the three instruments in the following section. All completed answer sheets for the LSI and LSQ were used for the evaluation of the psychometric properties of these two instruments. The sample sizes for the LSI and LSQ, as well as the distribution for gender, home language, cultural group and field of study for these two instruments are given in Table 6.1. The mean age for both the LSI and LSQ subsamples is 19.2 years, ranging from 16.2 to 36.8 years.

The sample sizes for the LSI (N = 419) and for the LSQ (N = 415) are very similar (see Table 6.1). There is a higher proportion of females than males in these samples (approximately two-thirds females to one-third males). Regarding home language, 145 (35%) students are English first language speakers and for the rest English is probably a second language. The african cultural group comprises 50% of the LSI and LSQ samples and the white group 38% of these samples. The other cultural groups are under-represented. The two fields of study (BSc and BA) are fairly evenly represented in the samples for both the LSI and the LSQ. The BSc field of study comprises the BSc (Biological & Agricultural Sciences), BEngineering and BSc (Psychology class) students and in total represents 46% of the sample, whereas the BA field of study represents 54% of the sample.

Investigation of the interaction of the Self-Directed Search (SDS), the Learning Style Inventory (LSI) and the Learning Style Questionnaire (LSQ) for the BSc and BA groups

The subsample used for this analysis (N = 226) comprises subjects who completed all three the instruments (SDS, LSI, LSQ) (See Table 6.1). Two subgroups were formed. One subgroup consists of the BSc (Biological and Agricultural Sciences) students, BSc students tested in the Psychology class, as well as the BEngineering students. This subgroup (N = 134) is referred to as the BSc group. The other subgroup consists of the BA students tested in the Psychology class. This subgroup (N = 92) is referred to as the BA group. The gender, cultural and language

composition of this sample can be seen in Tables 6.2 to 6.4 on the following pages. There is a higher proportion of females than males in the sample and males are under-represented in the BA group (see Table 6.2). Whereas the white and african cultural groups are fairly equally represented in the sample, the coloured, Indian and Asian cultural groups are under-represented (see Table 6.3). In the BA group 52 students (56.5%) are from the african cultural group. In the sample only 85 students (37.6%) are primarily English mother tongue speakers (see Table 6.4). For the rest of the students English is probably a second language. The BA group consists of predominantly English second language speakers. The mean age for the BSc group is 18.6 years, ranging from 16.2 to 24 years, and the mean age for the BA group is 19 years, ranging from 16.2 to 27 years.

TABLE 6.2   COMPOSITION OF THE ANALYSIS SAMPLE ACCORDING TO FIELD OF STUDY AND GENDER

| GENDER | FIELD OF STUDY | | N |
	BSc	BA	
Males	66	15	81
Females	66	77	143
TOTAL	132	92	224

Two students in the BSc group did not indicate their gender.

TABLE 6.3   COMPOSITION OF THE ANALYSIS SAMPLE ACCORDING TO FIELD OF

STUDY AND CULTURAL GROUP

CULTURAL GROUP	FIELD OF STUDY		
	BSc	BA	N
White	60	37	97
African	51	52	103
Coloured	0	1	1
Indian	23	1	24
Asian	0	1	1
TOTAL	134	92	226

TABLE 6.4   COMPOSITION OF THE ANALYSIS SAMPLE ACCORDING TO FIELD OF

STUDY AND HOME LANGUAGE

LANGUAGE GROUP	FIELD OF STUDY		
	BSc	BA	N
English	65	20	85
Afrikaans	1	0	1
English + Afrikaans	4	6	10
African language(s)	28	39	67
English + African languages	22	12	34
English + other	9	8	17
Other	5	7	12
TOTAL	134	92	226

6.3.2   Data collection

A total of 464 students were tested. The 99 BSc students in the faculty of Biological and Agricultural Sciences, and the 38 BSc Engineering students were tested during one session.   The two Psychology classes were only available for single lecture periods at a time and test administration required two lecture periods. The students therefore completed the Biographical Information questionnaire and the two learning style instruments during one lecture period and the SDS during another lecture period. The four test sessions for these two groups took place during a one week period at the end of March 1996. Not all the students tested attended both sessions resulting in incomplete datasets. The researcher conducted all the test sessions.

The assessment instruments were coded and the data computerized. Only complete SDS questionnaires were scored. In the case of scoring the LSI and LSQ, missing or ambiguous responses were substituted with the group average score for the relevant item, for a maximum of two items on a questionnaire. For the LSI the group average score was substituted for one item in 43 cases and for two items in 9 cases. For the LSQ the group average score was substituted for one item in 39 cases and for two items in 4 cases. Due to incomplete questionnaires that could not be scored the numbers of usable questionnaires thus differs from instrument to instrument. The total number of students tested and the final numbers of scored questionnaires are given in Table 6.1.

The order in which the instruments were completed was as follows: first the Biographical Information questionnaire, followed by the two learning style instruments, and finally the SDS. The order in which the LSI and LSQ were completed was varied to control for a possible effect due to answering two measures of learning abilities and styles at the same test session. Two groups were formed. Group 1 first answered the LSI followed by the LSQ, and Group 2 first answered the LSQ followed by the LSI. The method used to investigate a possible effect due to the order in which the LSI and LSQ were answered is described in section 6.4.3.1.

Subjects were assigned learning styles based on the two composite scores AC-CE and AE-RO of the LSI and LSQ. If a zero score was obtained for one of the composite scores (i.e. a zero score on one bipolar axis), then the subject was allocated two

learning styles. If zero scores were obtained for both composite scores (i.e. zero scores on both axes), then the subject was not allocated a learning style. The distributions of learning styles for the BSc and BA groups for the LSI and LSQ are reported in sections 7.3.7 and 7.4.

6.3.3   Measurement instruments

The test battery consisted of a Biographical Information questionnaire, the Self-Directed Search (SDS), the Learning Style Inventory (LSI) (a normative, Likert scale version of Kolb's LSI-1985) developed by Geiger *et al.* (1993)) and the Learning Style Questionnaire (LSQ) developed by Marshall and Merritt (Marshall & Merritt 1985, 1986; Merritt & Marshall, 1984).

6.3.3.1   The biographical information questionnaire

A short biographical questionnaire was compiled for the purposes of this study to obtain background information on the students (see Appendix A). Information on gender, age, home language, cultural group and degree for which the student was registered was requested.

6.3.3.2   The Self-Directed Search (SDS)

The SDS was developed as a *"self-administered, self-scored and self-interpreted vocational counseling tool"* (Holland & Rayman, 1986, p. 55) for adolescents and adults. The American version consists of two booklets: an assessment booklet and an occupational classification booklet. The SDS developed over a long period of time from Holland's theory, his experience as a vocational counsellor and his ongoing research. It was first published in 1971 and was revised several times, the latest version being that of 1985. Holland stated that the SDS is an interest inventory as well as a personality inventory, a values inventory and a competency inventory.

The SDS used in this study was published by the Human Sciences Research Council in 1987 and is an adaptation of Holland's 1977 and 1985 versions. The South African version is available in an English and an Afrikaans form and was standardized using Standard 7, 8, 9 and 10 pupils representative of all the cultural groups in South

Africa during the period 1985 to 1987. The original American structure was retained and the items were predominantly from the 1985 revised American edition. Only nine items were amended or replaced (Gevers *et al.*, 1992) and the South African version is thus very similar to the American SDS. The instrument yields six scores (Realistic, Investigative, Artistic, Social, Enterprising and Conventional) from the following four scales: Activities (11 items for each of the six personality types), Competencies (11 items for each of the six personality types), Occupations (14 items for each of the six personality types) and two Self-Ratings of abilities or skills (two 6-point scales for each of the six personality types). Each of the six scores is the sum of the four scale scores for a specific personality type. A three-letter Holland code is then assigned from the ordinal relationship of the three highest total scores. Test-retest reliability coefficients (8-week interval) of between 0,57 and 0.85 and reliability coefficients of between 0,77 and 0,88 for the six personality scores are reported in the SDS manual (Gevers *et al.*, 1992). Intercorrelations of the six fields provided evidence that supported Holland's theoretical hexagonal model. These results are similar to those for the American 1985 revised version of the SDS reported by Krieshok (1987). Alpha coefficient values for the six summary scales range from .59 to .92 with most falling in the .70 and .80 range. Test-retest reliabilities are reported as correlations between the 1977 and 1985 editions, administered from 1 to 14 days apart. Scale-to-scale correlations range from .81 to .93 which indicates good reliability for a measure of interests.

In a study by du Toit (1988) on a large sample of black standard 10 pupils (N = 5994) intercorrelations and factor analysis confirmed relationships between the six personality types and the hexagonal/circular structure as proposed by Holland. Reliability coefficients were satisfactory and compared favourably with those obtained by Holland and others. Most of the pupils resembled the Social personality type. The Realistic, Enterprising and Investigative fields were identified as making a small contribution to the prediction of academic achievement. Du Toit concluded that the SDS has utility for use with black pupils.

A study conducted on a group of black adolescents by Brand *et al.* (1994) found the SDS to be an effective assessment technique in a non-western cultural environment lending support to the view that Holland's theory and the SDS is applicable to most cultures.

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As the American and South African versions of the SDS are very similar comment on the American version pertains to the South African one.

The SDS has been translated or adapted for use in many countries such as Australia, New Zealand, Canada, Japan, the Netherlands, Switzerland, Italy, Nigeria and Guyana. Research has shown construct validity and reliability results similar to those obtained in the United States providing evidence of the instrument's transportability across cultures (Holland & Rayman, 1986). The SDS has proved itself as a useful instrument applicable to many cultures and client populations, including the mentally ill (Loughead & Black, 1990) and the learning disabled (Cummings & Maddux, 1987), in paper and pencil as well as computer form (McKee & Levinson, 1990).

Kimball, Sedlacek and Brooks (1973) compared black and white vocational interests using the SDS and found that blacks and whites were equally satisfied with their codes. They reported a greater number of Social codes for blacks compared to more Realistic and Investigative first choices by whites. Similar results in the South African context were reported by du Toit (1988). In a summary of the literature on African American and Anglo differences in patterns of interests, Carter and Swanson (1990) found that African Americans tended to have more Social-Enterprising-Conventional interests, whereas Anglos tended to have more Realistic-Investigative-Artistic interests.

Gottfredson and Holland (1975) reported on a study using large samples of college students (894 men and 989 women) in which it was demonstrated that each section of the SDS (activities, competencies, occupations, self-ratings and vocational aspirations) had predictive validity with respect to occupational choices one or three years after completing the SDS. The results indicated that divergent content could be used to assess the types. Current vocational choice was the best predictor of later choice and scores based on sex-specific norms were less efficient predictors than raw scores. Holland (Holland & Rayman, 1986, p. 71) reported that construct, predictive, content and concurrent validity research results for the SDS *"appear to be as positive and clear as that for similar inventories."* A study by Dumenci (1995) supported the convergent and discriminant validity of the SDS. Research on the effects of the SDS commonly find that the SDS increases self-understanding and satisfaction with a vocational aspiration, and increases the number of vocational options a person is

considering.

Daniels (1989) stated that the SDS is widely used as the vocational instrument of choice with adolescent, young adult and adult populations in the United States as well as in several other countries. It is his opinion that Holland successfully addressed most of the criticisms levelled at the SDS in the 1985 revision. Daniels indicated a remaining problem in that the scales do not have the same number of items and thus contribute unequally to the total scores. The Occupations scale contributes more to the total than the other scales, and the Self-Ratings of abilities or skills contributes more than either Activities or Competencies. According to Daniels this places undue emphasis on fantasy as opposed to experience. However Daniels (1989) concluded *"the SDS remains an excellent vocational counseling tool that can be used with most adolescents and adults"* (p. 330).

6.3.3.3   Two measures of learning style

As pointed out in Chapter 4 the psychometric properties of Kolb's LSI have been investigated in several studies and have been criticized by several authors. The ipsative scoring format of the LSI presents statistical problems which make the unequivocal interpretation of procedures such as factor analysis of the results problematic. The researcher therefore decided to use normative rather than ipsative measures of learning style to avoid the limitations an ipsative instrument places on statistical analysis of data.

6.3.3.3.1   Learning Style Inventory (LSI)

The development of the Learning Style Inventory (LSI) by Geiger *et al.* (1993) is described in Chapter 4. It contains the same stimulus material as Kolb's LSI-1985, but the twelve sentence items with four word endings are randomly presented as complete sentences. The instrument thus has 48 items, 12 items for each of the four scales. The four scales consist of the same items as for the LSI-1985, the LSI being a normative version of the LSI-1985. Whereas Geiger *et al.* used a seven-point Likert scale, the researcher has used a five-point scale. A copy of the LSI can be found in Appendix B. The researcher wrote to the main author and obtained from him the instrument and permission to use it for research purposes. Scores are obtained for

the four scales (CE, RO, AC, AE), as well as for the two composite scores AC-CE and AE-RO. Based on the two composite scores subjects were assigned to one of four learning styles (Diverger, Assimilator, Converger, Accommodator). Geiger *et al.* (1993) reported internal consistency reliabilities based on alpha coefficient as follows: CE = .83, RO = .77, AC = .86, AE = .84. Adjusted scale correlations for the four scales ranged from .466 to .615. Factor analysis of the LSI did not produce bipolar dimensions, but strong support for the four separate learning abilities was obtained.

6.3.3.3.2   Learning Style Questionnaire (LSQ)

The development of the normative Learning Style Questionnaire (LSQ) (Merritt & Marshall, 1984; Marshall & Merritt, 1985, 1986) is described in Chapter 4. The instrument consists of 40 items, 10 items for each of the four scales (CE, RO, AC, AE). Each item consists of a word pair on a five-point semantic differential scale. Each of the two words in an item represent opposing learning abilities. A copy of the LSQ can be found in Appendix C. The researcher wrote to the authors and obtained from them the instrument and permission to use it for research purposes. Scores are obtained for the four scales, as well as for the two composite scores AC-CE and AE-RO. Based on the two composite scores subjects were assigned to one of four learning styles (Diverger, Assimilator, Converger, Accommodator). Marshall and Merritt (1986) reported internal consistency reliabilities based on alpha coefficient as follows: CE = .78, RO = .86, AC = .85, AE = .88, CE-AC = .90 and RO-AC = .93. Factor analysis showed that items loaded on bipolar factors in accordance with Kolb's proposed learning abilities and styles, thus providing construct validity for these dimensions.

6.4   DATA PROCEDURE

6.4.1 Introduction

The hypotheses investigated in this study focus on determining the relationships between two fields of study, vocational personality and learning abilities with a view to investigating possible relationships between vocational personality type and learning ability. Psychometric properties of the LSI and LSQ are also investigated. Specific hypotheses are formulated in further sections of this chapter.

6.4.2   Variables

The variables used in this study are as follows:

(i)   Dependent variables

The dependent variables used in this study are as follows:

- six vocational personality types (Realistic, Investigative, Artistic, Social, Enterprising, Conventional) as measured by the SDS;
- four learning abilities (Concrete Experience, Reflective Observation, Abstract Conceptualization, Active Experimentation) as measured by the LSI and the LSQ;
- four learning styles (Diverger, Assimilator, Converger, Accommodator) as measured by the LSI and LSQ.

(ii)   Independent variables

The independent variables used in this study are as follows:

- two fields of study: science (BSc) and human sciences (BA)

It was not possible to include gender as a variable in this study as there are only 15 males in the BA group (see Table 6.2). It is generally recommended that there be at least twice, but preferably three times, the number of subjects than variables for analysis (Edens, 1987). As 14 variables were used it was not possible to differentiate between gender in the analysis sample. Culture could also not be used as a variable for the same reason.

Differences in Holland personality type scores according to gender have been reported (Tokar & Swanson, 1995). Dumenci (1995) found I types and S types over-represented in males and females, respectively. The SDS manual (Gevers *et al.*, 1992) reported that gender differences occur on the R, A and S fields with girls obtaining lower mean scores than boys on the R field and higher mean scores on the A and S fields. While some research (Hickcox, 1990) reported no gender differences with respect to learning styles, other studies reported women tended to get higher

scores on CE and men tended to score higher on AC (Garvey *et al.*, 1984; Hickcox, 1990).

With respect to culture, research on the personality types has shown africans and african Americans tended to have more Social-Enterprising-Conventional interests, whereas whites and anglos tended to have more Realistic-Investigative-Artistic interests (Carter & Swanson, 1990; Du Toit, 1988; Kimball *et al.*, 1973). Yuen and Lee (1994) investigated the applicability of Kolb's learning styles to non-Western final-year Singaporean university students. It was hypothesized that the Singaporean students representing the Arts, Science, Law, Computer Science, Medicine and Business Administration faculties would score high on Abstract Conceptualization due to the influence of the local educational system and the traditional Chinese culture influenced by Confucian ethics which place a high value on intellectual development. The Singaporean students obtained much higher mean scores on AC and lower mean scores on AE on the LSI-1985 when compared with data reported in the literature for American students.

6.4.3   Data processing procedure

The data was analyzed using the SAS (SAS Institute Inc., 1990) and BMDP (BMDP Statistical Software Inc., 1993) statistical packages. The computer program and procedures used will be named where appropriate.

6.4.3.1   SECTION 1: Evaluation of the psychometric properties of the two measures of learning style, the Learning Style Inventory (LSI) and the Learning Style Questionnaire (LSQ)

As the reliability and validity of the LSI and LSQ are unknown for South African use it was decided to investigate the psychometric properties of these two measurements for first-year South African students who are English mother tongue or second language speakers.

(i)   Description of the sample

The sample size for the LSI and LSQ, as well as the distribution for gender, home

language, cultural group and field of study for these two instruments are given in Table 6.1. The subsamples are described in section 6.3.1.

The order in which the LSI and LSQ were completed was varied to control for a possible effect due to answering two measures of learning abilities and styles at the same test session. Two groups were formed. Group 1 first answered the LSI followed by the LSQ, and Group 2 first answered the LSQ followed by the LSI. The distribution of gender, language, cultural group and field of study for the LSI and LSQ subsamples according to the order in which the two instruments were completed (Group 1 and Group 2) is given in Table 6.5 on the following page.

There is a higher proportion of females than males in the total sample (approximately two-thirds females to one-third males), but the distribution of females and males for Group 1 and Group 2, for both the LSI and the LSQ, is fairly evenly balanced (see Table 6.5). Regarding home language, 145 (35%) students are English first language speakers and for the rest English is probably a second language (see Table 6.5). The different categories of home language are fairly evenly represented in Group 1 and Group 2, for both the LSI and the LSQ (see Table 6.5). The african cultural group represents 50% of the total sample and the white group 38% of the total sample for both the LSI and the LSQ (see Table 6.5). The other cultural groups are under-represented. The different cultural groups are fairly evenly represented in Group 1 and Group 2. The two fields of study (BSc and BA) are fairly evenly represented in the total sample as well as within Group 1 and Group 2, for both the LSI and the LSQ. The BSc field of study comprises the BSc (Biological & Agricultural Sciences), BEngineering and BSc (Psychology class) and in total represents 46% of the sample, whereas the BA field of study represents 54% of the sample (see Table 6.5).

The existence of a possible effect due to the order in which the LSI and LSQ were completed was investigated. Hotelling's T test was used to test the statistical significance of the differences between the means of the four scales of the LSI and LSQ for Group 1 and Group 2 using the BMDP3D t-test statistical package (BMDP Statistical Software Inc., 1993). The following hypothesis was tested:

Ho1:   *Group 1 and Group 2 have equal vector of means for the four scales of the LSI and LSQ.*

TABLE 6.5   DISTRIBUTION OF THE LSI AND LSQ SUBSAMPLES ACCORDING TO THE ORDER IN WHICH THE TWO LEARNING STYLE INSTRUMENTS WERE COMPLETED (GROUP 1 AND GROUP 2)

	Learning Style Inventory (LSI) N = 419			Learning Style Questionnaire (LSQ) N = 415		
	Group 1	Group 2	Total	Group 1	Group 2	Total
Gender (2)*						
Male	77	58	135	77	58	135
Female	137	145	282	133	145	278
			417			413
Home language						
English	75	70	145	74	71	145
Afrikaans	2	1	3	2	1	3
English + Afrikaans	7	13	20	7	13	20
African language(s)	86	64	150	84	63	147
English + African language(s)	30	27	57	29	27	56
English + other	8	19	27	8	19	27
Other	7	10	17	7	10	17
			419			415
Cultural group (1)*						
White	66	93	159	65	94	159
African	119	93	212	116	92	208
Coloured	2	1	3	2	1	3
Indian	26	17	43	26	17	43
Asian	1	0	1	1	0	1
			418			414
Degree						
BSc (Biological & Agricultural Sciences)	48	47	95	47	46	93
BA (Psychology class)	123	103	226	121	104	225
BEngineering	22	16	38	22	16	38
BSc (Psychology class)	22	38	60	21	38	59
			419			415

*   Numbers indicated in brackets indicate the number of missing records.

Hi1:   *Group 1 and Group 2 do not have equal vector of means for the four scales of the LSI and LSQ.*

The results are reported in the following chapter.

(ii)   Item analysis of the LSI and the LSQ

Item analysis for the LSI and LSQ was done using the ITEMAN Conventional Item Analysis Program (Assessment Systems Corporation, 1993). The mean and standard deviation as well as the item-scale correlation for each item are reported in the following chapter.

(iii)   Reliability of the LSI and the LSQ

For a measure to be **reliable** it must be free of measurement errors (Sirkin, 1995). A reliability coefficient varies from zero to one where zero indicates no reliability and one indicates complete reliability. If important decisions are to be made concerning peoples' lives and futures, then reliability is important so that consistent diagnoses or predictions can be made. (It must be remembered reliability only indicates the accuracy of a measure, not its validity.) In such circumstances Owen and Taljaard (1995) stated that the reliability of a measure should be of the order of 0.90 or higher, especially if only one measure is available. However in general a measure with a reliability coefficient of the order of 0.60 can provide useful information provided the results are interpreted with caution and the required expertise. Different techniques are used to determine the reliability of a measure such as test-retest reliability, using parallel forms of the measurement instrument, and measures of internal consistency such as split-half reliability (Spearman-Brown formula), the Kuder-Richardson formulae and Cronbach's alpha coefficient. The alpha coefficient is used to estimate the reliability of a measure when a testee's score can vary from item to item (and is not 0 or 1) such as is the case with a Likert or semantic differential scale (Owen & Taljaard, 1995).

The internal consistency of the LSI and LSQ was investigated using the alpha coefficient which was calculated for the four learning abilities (AC, CE, AE, RO) using the ITEMAN Conventional Item Analysis Program (Assessment Systems Corporation,

1993). The results are reported in the following chapter.

(iv)   **Construct validity of the LSI and the LSQ**

Validity is *"the extent to which the concept one wishes to measure is actually being measured by a particular scale or index"* (Sirkin, 1995, p. 69). **Construct validity** is a form of validity testing used in theory validation and is *"the extent to which a test measures a particular theoretical construct"* (Neale & Liebert, 1980, p. 40). When there is no definite criterion against which the construct can be validated indirect measures are used. Empirical investigation of construct validity makes use of correlation measures of the association between the construct under investigation and variables theoretically related to the construct. In this study the results of the discriminant analysis and factor analysis, as well as the distribution of frequency of learning styles for the BSc and BA groups were used to investigate the construct validity of the LSI and the LSQ. The FREQ procedure of the SAS statistical package (SAS Institute Inc., 1990) was used to calculate the frequency distribution of learning styles for the two fields of study for the LSI and the LSQ. The FREQ procedure was also used to calculate the Chi-square test of significance for the frequencies. The results are reported in the following chapter.

6.4.3.2   **SECTION 2: Investigation of the interaction of the SDS, LSI and LSQ for the BSc and BA groups**

(i)   **Description of the sample**

As described in section 6.3.1, the sample consisted of first-year students registered for English courses in two fields of study, namely BSc and BA. The composition of the sample is given in Tables 6.2 to 6.4. The following were calculated for the dependent variables (see 6.4.2) using the Univariate Procedure statistical package (SAS Institute Inc., 1990):

(1) arithmetic mean;

(2) standard deviation;

(3) skewness;

(4) kurtosis.

These descriptive statistics are given in table form in the next chapter.

(ii)   Hotelling's T test

Hotelling's T test was used to test the statistical significance of the differences between the average profiles of the BSc and BA groups using the BMDP3D t-tests statistical package (BMDP Statistical Software Inc., 1993). The following hypothesis was tested:

Ho2:   *The Bsc and BA groups have equal vector of means for all dependent variables.*

Hi2:   *The Bsc and BA groups do not have equal vector of means for all dependent variables.*

The results are reported in the next chapter.

(iii)   Discriminant analysis

Using discriminant analysis the differences between two or more groups with respect to a number of variables can be studied either to **interpret** group differences or to **classify** cases or subjects into groups (Klecka, 1980). It is a statistical technique that identifies which dependent variables are relevant to and which discriminate between a number of criterion groups (Schoeman, 1978). Dependent variables that have been measured for two or more criterion groups are combined in a discriminant function that aims to maximally discriminate between the criterion groups (Edens, 1987). The discriminant function can then be used to decide to which criterion group a subject belongs.   Discriminant analysis is thus used as a descriptive and a predictive technique.

Discriminant analysis was used as an initial step in the statistical investigation of the general hypothesis stated in 6.4.1.   The aim was to determine which of the dependent variables best discriminated between the groups. The sample was divided in two homogeneous subgroups according to field of study (BSc and BA).   Thereafter a stepwise discriminant analysis was carried out using the BMDP7M statistical

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package (BMDP Statistical Software Inc., 1990) on the two groups.

During the first step discriminant analysis was carried out for the two groups using the following dependent variables:

- six personality types (R I A S E C) measured by the SDS;
- four learning abilities (CE RO AC AE) measured by the LSI;
- four learning abilities (CE RO AC AE) measured by the LSQ.

The hypotheses tested were as follows:

Ho3: *It is not possible to discriminate between fields of study using personality type as measured by the SDS.*

Hi3: *It is possible to discriminate between fields of study using personality type as measured by the SDS.*

Ho4: *It is not possible to discriminate between fields of study using learning abilities as measured by the LSI.*

Hi4: *It is possible to discriminate between fields of study using learning abilities as measured by the LSI.*

Ho5: *It is not possible to discriminate between fields of study using learning abilities as measured by the LSQ.*

Hi5: *It is possible to discriminate between fields of study using learning abilities as measured by the LSQ.*

Lastly, a discriminant analysis was carried out using a combination of the SDS, LSI and LSQ to determine if a combined interaction between all the variables could discriminate between the fields of study.

Ho6: *It is not possible to discriminate between fields of study using personality type as measured by the SDS together with learning ability as measured by the LSI*

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and LSQ.

Hi6:   *It is possible to discriminate between fields of study using personality type as measured by the SDS together with learning ability as measured by the LSI and LSQ.*

The results of these stepwise discriminant analyses are given in the following chapter.

(iv)   Factor analysis

Factor analysis is not one, simple statistical method, but rather a broad category of approaches concerned with grouping variables (Nunnally, 1978). When a group of variables has a great deal in common a factor is said to exist and the related variables are found using the correlational technique (Child, 1990). The main objective of factor analysis is to determine the minimum number of factors that would satisfactorily produce the correlations among the observed variables (Kim & Mueller, 1994). According to Schepers (1990) factor analysis has a twofold aim, namely to describe a large number of intercorrelated variables in terms of a small number of independent constructs or factors, and to describe individuals in the sample using a small number of factors.

According to Child (1990) most kinds of distributions can be used for factor analysis provided they are not excessively skewed, truncated or multimodal. A variable used in factor analysis should not be created from the manipulation (addition, subtraction, etc.) of variables already in the analysis (Child, 1990). For this reason the composite scores for the LSI and LSQ (AC-CE and AE-RO) were not included in the factor analysis. Three types of factors, namely general, bipolar and group factors, are found. Factors with eigenvalues greater than one can be interpreted and factor loadings of .30 or higher are noted (Nunnally, 1978). The pattern of factor loadings leads to the naming and interpreting of factors. Variables with unusually high loadings give clues as to the nature of the factor and loadings are considered in descending order of magnitude as a guide to interpretation (Child, 1990; Lemke & Wiersma, 1976).

In this study the principal factor method was used to extract factors followed by a direct quartimin (oblique) rotation of factors.   This procedure was applied to the

combined BSc and BA group, as well as to the individual BSc and BA groups using the BMDP4M factor analysis statistical package (BMDP Statistical Software Inc., 1993). Rotational procedures are used in research that focuses on the psychological meaning of the grouping of variables embedded in the matrix of intercorrelations of the variables as opposed to non-rotational procedures that focus on the meaning of the first centroid (general) factor such as in research on intelligence tests (Lemke & Wiersma, 1976). Tables of the oblique rotated factor loadings for the BSc, the BA and the combined BSc and BA groups are given in the following chapter.

(v)   Intercorrelations for Holland personality types and Kolb learning abilities

Intercorrelations for Holland personality types as measured by the SDS and Kolb learning abilities as measured by the LSI and the LSQ were calculated for the BSc and the BA groups using the CORR procedure of the SAS statistical package (SAS Institute Inc., 1990). The intercorrelation tables appear in the following chapter.

(vi)   Frequencies of Holland personality types and Kolb learning style types

Frequency distributions for Holland personality types as measured by the SDS and Kolb learning abilities as measured by the LSI and the LSQ were calculated for the BSc and the BA groups using the FREQ procedure of the SAS statistical package (SAS Institute Inc., 1990). The frequency distribution tables appear in the following chapter.

6.5   SUMMARY

In this chapter the sample and subsamples used for analysis, and the measurement instruments used (SDS, LSI and LSQ) are described. The procedure to investigate the aims of the study is described.

Firstly, the psychometric properties of the two measures of learning style (LSI and LSQ) are investigated using subsamples of subjects who completed these instruments. Item analysis of each instrument will be carried out and the internal reliability of the four ability scales will be reported using the alpha coefficient. The distribution of the frequency of the four learning styles for the BSc and BA subgroups will be reported

to investigate the construct validity of these two instruments and the results of the discriminant and factor analysis will also be taken into account.

Secondly, the interaction of the SDS, LSI and LSQ is investigated. The subsample of subjects who completed all three instruments will be divided into BSc and BA subgroups. Hotelling's T test will be used to test for significant differences between the average profiles of these two subgroups. The subgroups will further be investigated with respect to a number of dependent variables (vocational personality type and learning ability) using discriminant and factor analysis. To further facilitate the validation of the integrated model of Holland's vocational personality types and Kolb's learning abilities and styles proposed in Chapter 5, intercorrelations for the vocational personality types and learning abilities for the subgroups will be determined. Likewise, the frequency distribution of learning styles for the subgroups will be determined.

The results of the above investigations are reported in the following chapter.