“The relationship between approaches to learning and assessment outcomes in undergraduate optometry students”

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“The relationship between approaches to learning and assessment outcomes in undergraduate optometry students”

Linda A. Moore

M.A. (Higher Education)  June 2015
Declaration

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Abstract

A cross-sectional quantitative study was implemented to identify and analyse student approaches to learning (SALs) in the four stages of an undergraduate optometry honours degree programme. Study results will be used to inform optometric educators of the SAL trends of this student cohort. Seventy-three undergraduate optometry students participated in the study. Individual participant SAL scores were calculated using the shortened Study Process Questionnaire (R-SPQ-2F) for a semester-long academic module identified for each programme stage. Only R-SPQ-2F main scale SAL scores measuring the deep approach (DA) and surface approach (SA) were included in the final analyses, due to poor internal consistency and reliability of subscale measures, as confirmed using Cronbach’s alpha coefficient. Assessment scores across a range of assessment types represented measures of participant academic performance. No statistically significant differences were found in intra-or-inter-stage DA and SA scores as analysed using the paired t-test. Pearson correlational analysis elicited a negative correlation between the DA and SA scores for stage 4 data and for combined participant data. One-way ANOVA analysis showed no inter-stage or inter-gender SAL differences. Pearson correlation coefficient analyses showed no relationship between SAL and age. Overall, Pearson correlational analyses of SAL and assessment scores showed variable results, with no significant correlations found for most of these analyses. For stage 1 participants, the DA score and multiple choice questions, MCQ, (Online) scores were positively correlated. Stage 3 participant DA scores were positively correlated with Written Theory Question and Literature Review Assignment scores respectively. Stage 4 participants SA scores were negatively correlated with MCQ (Written) and Case Study Question scores respectively. It is envisaged that this study will form the foundation for ongoing investigation into SALs in undergraduate optometry students to further elicit the relationship between SAL and assessment methods across a wider range of academic modules. This information will be used in routine reviews of teaching and assessment materials for the DT224 optometry programme as well in the planning of continuing professional development (CPD) activities for graduates of the programme.
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Chapter 1: Introduction

The study presented here is unique both within the Republic of Ireland (ROI) and the health science discipline of optometry. This chapter describes the context and rationale of the research undertaken. It also presents the aims and objective associated with the measurement and assessment of student approaches to learning (SALs) in undergraduate optometry students.

1.1 Context and rationale

The Dublin Institute of Technology (DIT)’s BSc (Hons) Optometry (DT224) programme is a 4-year undergraduate qualification. Successful completion of this programme is a compulsory eligibility requirement for graduates undertaking the Association of Optometrists, Ireland’s (AOI) professional qualifying examinations. Success in these examinations permits a DT224 graduate to register with the Bord Na Radharcmhastóirí (Irish Optician’s Board), thereby obtaining legal authorisation to practice as an optometrist in the Republic of Ireland (ROI). Optometrists work as autonomous healthcare professionals, delivering comprehensive eye and vision care. This includes measurement of spectacle and contact lens prescriptions, dispensing of spectacles, contact lenses and other visual aids, the detection and diagnosis of ocular pathologies and the rehabilitation of individuals with visual system abnormalities (Millodot, 2009).

During my 16 years as an optometry lecturer on the DT224 programme (and its predecessor), I had noticed that optometry undergraduate students seemed to adopt a variety of learning approaches in their efforts to master the theoretical, practical and clinical aspects of the programme, while conforming to module presentation and assessments. This study is unique in its investigation of SALs in an undergraduate optometry programme. This uniqueness is further enhanced in that the DIT’s DT224 programme at DIT is the only optometry programme within the ROI. To date, other SAL studies in the discipline of optometry could not be sourced in the literature (electronic searches of Google Scholar, ERIC Database, International Education Research Database, Science Direct, PubMed, DIT library database were made using
the following English-language search terms: optometry, approaches to learning, assessment, teaching methods, learning environments), while the number of studies into learning styles of optometry students is limited (Eubank & Pitts, 2011; Mohammed, Narayanasamya, Mutaliba, Kaura & Ariffin, 2011; Prajapati, Dunne, Bartlett & Cubbidge, 2011). This study aimed to address the apparent dearth of information relating to SALs in undergraduate optometry programmes, thereby facilitating increased understanding of the student approaches to learning tasks and the relationship between these and assessment outcomes. This study was therefore undertaken in order to identify the SALs adopted by DT224 students, with a view to informing teaching and assessment methods in current and future module presentations and programme formulations.

1.2 Aims and objectives

The main aims and related objectives of this study were:

**Aims:**
- To identify the SALs adopted by undergraduate optometry students in the four stages of an undergraduate optometry programme in an Irish higher education institution (HEI).
- To identify and quantify associations between SAL scores.
- To identify and quantify intra-stage differences in the SALs.
- To identify and quantify inter-stage differences in the SALs.
- To identify and quantify inter-gender differences in SALs.
- To identify and quantify associations between SAL and age.
- To identify and quantify associations between SAL scores and assessment scores related to a range of different assessment types.
Objectives:

- To use the shortened version of the Study Process Questionnaire (SPQ) (R-SPQ-2F) and accompanying scoring system (Biggs, Kember & Leung, 2001) to quantify the SALs in an undergraduate optometry programme.
- To statistically analyse intra-and-inter-stage differences in SAL scores.
- To statistically analyse the association between types of SALs in each stage.
- To statistically analyse inter-gender differences in SAL scores.
- To statistically analyse the association between the SAL scores and student age.
- To statistically analyse the association between the SAL scores and assessment scores.

The R-SPQ-2F questionnaire has been applied in the measurement of SALs in medical and health science education settings (Fox, McManus & Winder, 2001; Balasooriya, Toohey & Hughes, 2009; Ali & El Sebai, 2010; Munshi, Al-Rukban & Al-Hoqail, 2012; Jayawardena, Hewapathirana, Bannehaka, Ariyasinghe & Ihalagedara, 2013; Weller, Henning, Civil, Lavery, Boyd & Jolly, 2013; Henoch, Ung, Ozane, Falk, Falk, Sarenmalm, Öhlen & Fridh, 2014; Mogre & Amalba, 2014), and is therefore deemed to be appropriate for the measurement of optometry student SALs, as the discipline of optometry is widely regarded as a health science discipline. Academic scores for each student were accessed retrospectively for each of the modules identified for this study. One module was identified for each of four stages of the programme. Access to student marks was approved by the module leaders and the DT224 programme committee.
1.3 Hypotheses

A number of hypotheses applied to this study. The order of presentation of these hypotheses in this section reflects the order in which the analyses were conducted.

_Hypothesis H1_
The first hypothesis (H1) was that a statistically significant correlation exists between SAL scores for each stage separately and for all stages combined. The associated null hypothesis (H1\(_0\)) was that no statistically significant correlation exists between SAL scores for each stage separately and for all stages combined.

_Hypothesis H2_
The second hypothesis (H2) was that a statistically significant difference exists between SAL scores within each stage. The associated null hypothesis (H2\(_0\)) was that no statistically significant difference exists between SAL scores within each stage.

_Hypothesis H3_
(Supporting reference: Fox et al., 2001)
The third hypothesis (H3) was that a statistically significant inter-stage difference exists between SAL scores. The associated null hypothesis (H3\(_0\)) was that no statistically significant inter-stage difference exists between SAL scores.

_Hypothesis H4_
(Supporting reference: Zeegers, 2001)
The fourth hypothesis (H4) was that a statistically significant difference exists between SAL scores of male and female participants for all stages combined. The associated null hypothesis (H4\(_0\)) was that no statistically significant difference exists between SAL scores of male and female participants for all stages combined.

_Hypothesis H5_
(Supporting references: Zeegers, 2001; Gijbels, Van de Watering, Dochy & Van den Bossche, 2005; Yonker, 2011)
The fifth hypothesis (H5) was that a statistically significant correlation exists between SAL scores and participant age for all stages combined. The associated null hypothesis \((H_{50})\) was that no statistically significant correlation exists between SAL scores and participant age for all stages combined.

**Hypothesis H6**

(Supporting references: Trig well & Prosser, 1991a; Tian, 2007; Almeida, Teixeira-Dias, Martinho & Balasooriya, 2012; Jayawardena et al., 2013; Weller et al., 2013)

The sixth hypothesis (H6) was that a statistically significant correlation exists between SAL scores and assessment scores for each stage. The associated null hypothesis \((H_{60})\) was that no statistically significant correlation exists between SAL scores and assessment scores for each stage.

The findings of previous studies into the SALs of students attending an HEI are summarised in Chapter 2: Literature Review.
Chapter 2: Literature Review

This chapter commences with a broad definition of student approaches to learning (SAL), including a description of the subcategories of SALs that apply. Factors influencing the SAL of an individual are then discussed, followed by a summary of research findings on relationships between SAL and assessment scores as a measure of assessment outcome. This chapter concludes with an overview of the R-SPQ-2F questionnaire and its applications in the measurement of SALs in medical and health science student educational settings.

2.1 Student Approaches to Learning (SAL) defined

Learning takes place when new knowledge and skills are acquired through sensory data perception and assimilation (Cegielski, Hazen & Rainder, 2011) and is a lifelong process of cognitive change (Almeida et al., 2011). This ‘process’ of learning underpins the student approach to learning (SAL) (Zhang, 2000) adopted by individuals both in formal and informal learning contexts, although only SALs in the formal learning context are explored in this study.

The SAL describes the student’s intention upon task commencement and task completion strategies adopted (May, Chung, Elliott & Fisher, 2012). It represents the nature of the relationship between a student’s individual internal characteristics and external learning context, including the learning environment, task and assessment demands. It therefore gives a measure of the interaction between the student and the learning environment (Biggs et al., 2001; Byrne, Flood & Willis, 2002) and how this relates to study activity. Instruments for measuring the SAL quantify students’ perceptions of their learning environments and learning-related activities as these relate to teaching, learning (Biggs et al., 2001) and assessment (Gijbels et al., 2005). Results of SAL questionnaires can be used to gauge a student’s understanding of the way in which learning should be approached in an educational environment (Greasley & Ashworth, 2007). It is therefore regarded as a major contributing factor to academic performance (Chiou, Lian & Tsai, 2012). It is for this reason that the SAL can be used to explain why students achieve different levels of success in meeting the learning
outcomes after studying the same assessment materials (Marton & Säljö, 1976). As the SAL is learning context-dependent, it is assumed to be dynamic, changing as learning environments change. The SAL is therefore assumed to be temporally variable (Vermetten, Vermunt & Lodewijks, 1999; Zeegers, 2001).

The concept of a SAL was pioneered by Marton and Säljö (1976), who applied Craik and Lockhart’s (1972) ‘levels of processing’ theory to a learning environment. According to this theory, new information is cognitively processed in a hierarchy according to the ‘depth’ of information processing, from ‘surface’ to ‘deep’. A greater degree of semantic or cognitive analysis is assumed to be associated with ‘deep’ processing. Marton and Säljö (1976) identified two associated processes adopted by students learning new materials: ‘surface-level’ processes and ‘deep-level’ processes. These are regarded as being central to the learning and retention of new information in a learning environment and are explored in greater detail in the next section.

2.1.1 ‘Surface’ approach to learning (SA)

Students who associate learning with memorising tend to adopt a ‘surface’ approach (SA) to learning (Yonker, 2011). This SA is typified by the emphasising of rote-learning and memorisation of information, with the aim of its subsequent reproduction (Marton & Säljö, 1976; Trigwell & Prosser, 1991a; Weller et al., 2013). Facts and disconnected items of information are memorised in an unrelated manner (Byrne et al., 2002; Emilia, Bloomfield & Rotem, 2012) as students fail to actively engage with the learning task (Chiou et al., 2012).

Students favouring a SA seem to be primarily motivated by extrinsic factors, such as fear of failure associated with the need to pass an examination (Felder & Brent, 2005; Chiou et al., 2012). Assessment methods rewarding information reproduction, associated levels of anxiety and heavy workloads (Abraham, Kamath, Upadhya & Ramnarayan, 2006) further encourage the adoption of a SA. In such instances, reasons for learning are unrelated to material content (Fransson, 1977), while successful completion of learning task requirements are prioritised (Zeegers, 2001). Students therefore limit their study activity to a defined syllabus and specified tasks (Emilia et al., 2012). They tend to study only what is discussed in the classroom, avoiding
subsequent exploration and reflection related to lecture-based materials (Yonker, 2011).

Overall, students adopting a SA demonstrate lower-level cognitive processing of learning materials (Chiou et al., 2012) and an associated desire to avoid mental effort and elaborative cognitive processing (Yonker, 2011). This leads to poor understanding of learning material (Byrne et al., 2002). Weller et al. (2013) suggests that adoption of a SA by medical students is likely to lead to rapidly forgetting information learned, negatively impacting on subsequent medical competence.

2.1.2 ‘Deep’ approach to learning (DA)
In contrast to students adopting a SA, students who engage in a ‘deep’ approach (DA) to learning are predominantly motivated by intrinsic factors, such as a general interest in learning, the content of the material and learning to promote a sense of satisfaction (Fransson, 1977; Felder & Brent, 2005; Chiou et al., 2012; Emilia et al., 2012). Students predisposed to the adoption of a DA seek meaning in educational material, emphasising the understanding of this material (Trigwell & Prosser, 1991a; Byrne et al., 2002; Weller et al., 2013). They engage in effortful cognitive activity (Yonker, 2011), while critically examining learning materials, seeking ways to associate new information with previously-acquired knowledge and pre-existing cognitive frameworks, thereby relating the information to its wider context (Zeegers, 2001; Felder & Brent, 2005). Adoption of a DA therefore facilitates students in expanding their body of knowledge. This active engagement is central to the distinction between the DA and SA (Chiou et al., 2012; Emilia et al., 2012). Students predisposed to adoption of a DA are therefore motivated by intellectual curiosity, rather than by external rewards or acknowledgement of their efforts (Felder & Brent, 2005).

Factors that have been proposed as promoting the adoption of a DA include: relevance of material to students’ interests (Fransson, 1977); interest, support and enthusiasm of academic teaching staff (Ramsden, 1979); learning environments that facilitate students in managing their own independent learning (Ramsden & Entwistle, 1981).

The DA is based on interpretation and cognitive integration of learning material content, and is therefore likely to facilitate longer retention of information
learned (Felder & Brent, 2005). This is consistent with Marton and Säljö (1976)’s assertion that a DA results in an increased ability to remember factual details. The DA is therefore seen as the most desirable and successful SAL in medical education settings, as medical students engaged in clinical work favour deep LAs (Emilia et al., 2012), thereby forming a good foundation for lifelong learning (Abraham et al., 2006).

2.1.3 ‘Strategic’ and ‘motivation’ approaches to learning
The flexibility and interchangeability of SALs may be further explained by assuming that SALs encompass two additional components. The ‘strategy’ component represents the task engagement process. The ‘motive’ component refers to the orientation or motivation to engage in a learning task. The adoption of multiple motive-strategy SAL combinations is therefore possible (Chiou et al., 2012). The ‘strategic’ SAL may combine SA and DA (Biggs et al., 2001; Weller et al., 2013). While the SA and DA components of SAL describe the way in which students engage in task content, ‘strategic’ SAL reflects the student’s organisation of location, timing and duration of the task (Emilia et al., 2012), reflecting the student’s space and time management (Biggs et al., 2001) as they arrange the learning context (Yonker, 2011). Biggs et al. (2001) and Almeida et al. (2011) agree that students adopting a ‘strategic’ SAL are capable of efficient organisation of their learning, thereby maximising their chances of successful assessment outcomes. This is because assessment outcome is accepted as the primary influence on students adopting a ‘strategic’ SAL (Biggs et al., 2001; Weller et al., 2013). It is therefore the SAL most often adopted when students are motivated by a sense of competition and vocational relevance, where success is intended to be achieved by any means necessary (Byrne et al., 2002; Emilia et al., 2012). As this is the SAL favoured by students with an achieving orientation, it is also known as the ‘achieving’ SAL (Felder & Brent, 2005).

The strategic SAL is included in the R-SPQ-2F only insofar as it is considered as a subdivision of the SA and DA main scale measures (Biggs et al., 2001). This strategic SAL will therefore not be considered further as a separate SAL within the context of this study.

The prioritisation of SALs may change as a student works. The choice of SAL depends on the demands of the materials and learning environment, including
assessment deadlines and time demands associated with meeting these deadlines. Students might change from a DA to a SA, or a predominantly SA to a DA if they feel that this will benefit the assessment outcome (Felder & Brent, 2005; Almeida et al., 2011; Emilia et al., 2012). A perception of insufficient time for assessment preparation could predispose a student to the adoption of a SA to learning (Yonker, 2011). This demonstrates that students may be flexible in their SAL adoption (Abrahams et al., 2006). Flexibility is an important characteristic, particularly of the student who has a tendency towards adopting a DA, as it has been suggested that students adopting this SAL exhibit versatility in their learning (Entwistle & McCune, 2013). Consecutive, but not simultaneous, adoption of SALs is therefore possible (University of Oxford, 2014).

The SALs described here are associated with the SAL classifications adopted by Biggs et al. (2001) in the R-SPQ-2F instrument for measuring SAL. The R-SPQ-2F will be described in greater detail in Section 2.4.2.

While the afore-mentioned classification assumes some level of student engagement with study material, this is not always the case. Entwistle (1991) identified another less consistently defined SAL, called the ‘non-academic orientation’ or ‘study pathologies’. This represents a complete absence of engagement between the student and the academic learning task and will not be described further here. The lack of further inclusion in this study is because some level of student engagement with learning materials is assumed on the basis of existence of assessment scores representing a measurement of knowledge of learning materials.

Factors influencing the SALs adopted are now explored further.

### 2.2 Factors influencing the approaches to learning

Factors influencing the SAL adopted by an individual student are broadly classified into two categories: personological factors and contextual factors (Zeegers, 2001). These factors influence each other during the interaction between a student and the learning environment and therefore potentially influence the SAL adopted by students.
2.2.1 Personological factors

These are factors internal (intrinsic) to the student and include gender, age, prior experience (Zeegers, 2001) and attention (Fransson, 1977). The first two of these will be investigated in this study, while the remaining two factors were not examined.

Zeegers (2001) reported no gender differences in SAL scores for science students. Byrne et al. (2002) similarly reported no gender differences in SAL scores for accounting students. No gender differences in SAL were reported by Miller, Finley and McKinley (1990, as cited in Chiou et al., 2012); Richardson (1993) and Wilson, Smart and Watson (1996). May et al. (2012) reported no gender differences in DA and SA measures of SAL, while Sadler-Smith (1996, as cited in Chiou et al., 2012) and Severiens and ten Dam (1996) have shown that female students have higher SA scores. Gledhill and Van der Merwe (1989, as cited in Chiou et al., 2012) claim that female students have higher DA scores. Hayes and Richardson (1995) suggested that gender differences in SALs are likely to be dependent on the learning discipline and context. Chiou et al.’s (2012) investigation into SALs in Biology students further supported this, proposing the existence of complex relationships between the students’ preferred SAL and demands of the learning environment. Chiou et al. (2012) recommended further investigation of the relationship between SAL and gender, and the associated influence of the learning environment. This requires further investigation to identify whether gender differences in SALs exist, and to clarify the nature of these differences.

The findings of Zeegers’ (2001) study into SALs adopted by science students suggest that age influences both the SAL score and the assessment score. Richardson’s (1995) investigation of SALs in students of the social sciences delivered similar conclusions. Biggs et al. (2001) explains that increased age is likely to be associated with a greater amount of prior learning experience, which could influence the SAL selected. Yonker (2011) studied the SALs of psychology students and proposed that, while older students were more likely to adopt a SA, no age-based differences in the adoption of a DA were identified. Gijbels et al.’s (2005) findings differed in that they found that older law students had higher mean DA scores.

Fransson’s (1977) examination of SALs in education students showed that the two main levels of information processing, the ‘deep’ level (associated with the DA to learning) and the ‘surface’ level (associated with the SA to learning) were related
to two different levels of attention during a learning task. Students adopting a DA demonstrated a high level of attention to the subject matter in an attempt to gain a more detailed understanding of the information presented. Students adopting a DA, while only applying a low attentional level, were more likely to form a general impression of the material. This would facilitate a return to it when a greater level of attention to this information is required at a later stage. Students with a SA associated with a high level of attention undertake mental imprinting of learning material. Students favouring a SA, while demonstrating a low level of attention to a learning task, limited themselves to only reading the material in the hope that some of the information would be retained in memory (Fransson, 1977). Other more general factors that need to be considered as potential moderators in the relationship between SALs and assessment scores are: prior academic achievement (Snelgrove & Slater, 2003; Zeegers, 2001); self-confidence (Watkins & Biggs, 1996, as cited in Gijbels et al., 2005); academic self-efficacy (Pintrich & de Groot, 1990). Gijbels et al. (2005) recommends that these should be considered in future studies of SALs in higher educational environments.

While the afore-mentioned factors represent concrete influences on the SAL selected, the contribution of student perception of the learning environment should also be acknowledged. This could be classified as a personological or a contextual factor, but is treated as person-based for the purposes of this discussion, as perception is assumed to fundamentally arise from within a person. Entwistle (1991) maintains that the perception of the learning environment has a greater influence on learning than the actual context of learning does. Gow and Kember (1990) suggest that student perception of the learning environment potentially influences both intrinsic and extrinsic study motivation. Trigwell and Prosser (1991a) quantitatively studied the relationship between student perceptions of their environment, SAL and learning outcomes. They found that learning environments that are perceived to encourage a DA are more likely to facilitate a higher quality of learning than environments designed to discourage a SA. Student perception of academic workload within the learning environment has also been studied. Entwistle and Ramsden (1983, as cited in Trigwell & Prosser, 1991a) found that a perceived heavy workload at an individual level fostered the adoption of a SA. Leung, Mok and Wong (2008) further supported
this finding by showing that nursing students moved towards a SA as the perceived workload increased. Gow and Kember’s (1990) findings concur with this in that they found that when a student perceives the educational environment as stressful, they will tend more towards a SA. The perceived relevance of the assessment to training goals can also influence the SAL adopted by students. An assessment perceived as irrelevant will encourage adoption of a SA associated with the purpose of passing an exam (Weller et al., 2013).

2.2.2 Contextual factors
Although the learning context was not directly measured in this study, Marton and Säljö (1976) first recognised that this context influences the selection of the SAL. A discussion of these factors therefore contributes towards the understanding of the results. Entwistle (1991) proposed that the interaction between student and learning environment is central to the learning outcome that can be achieved and that environmental influences are mediated by individual student characteristics. Contextual factors extrinsic to the student include teaching and learning activities, assessment procedures and institutional values. These factors may be more predictive of academic success than the instruments used to measure SAL (Zeegers, 2001). Almeida et al. (2011) suggested that the identification of SAL facilitates educator conceptualisation of student experience of learning contexts. Both the real and perceived environmental factors must be considered when reviewing the SALs adopted by a cohort of students (Zeegers, 2001).

The majority of contextual learning factors are educator-controlled. These include the curriculum (Byrne et al., 2002; Almeida et al., 2011), associated learning outcomes (Emilia et al., 2012) and the teaching and assessment strategies adopted to meet these outcomes (Byrne et al., 2002; Abraham et al., 2006; Almeida et al., 2011). A didactic teaching environment or a more interactive environment influences the SAL adopted, as different learning environments, instructional methods and assessment types require different SALs for success (Abraham et al., 2006, Almeida et al., 2011; Chiou et al., 2012; May et al., 2012). Entwistle (1991) proposed that lecturers’ theories of teaching and associated manner of structuring and presentation of knowledge influences the SAL. This contextual aspect of SAL is the reason that
SAL is likely to vary across different disciplines (Abraham et al., 2006, Almeida et al., 2011; Chiou et al., 2012; May et al., 2012). This variation in approaches may also apply to the SALs emphasised by lecturers, although this has not received much attention in the literature. Mattick, Dennis & Bligh (2012) illustrated this difference by reporting that medical students scored higher on the DA when compared to students in other higher education disciplines.

Abraham et al. (2006) and Almeida et al. (2011) suggested that the measurement of SALs could be used as a tool to evaluate the effectiveness of teaching strategies, while assisting in the identification of students who are having difficulty learning material due to ineffective learning strategies. Zhang (2000) maintains that lecturers should recognise individual SAL differences, in order to make an effort to motivate students to learn in a more effective way. Biggs et al. (2001) suggests that teaching and assessment methods often encourage a SA when they are misaligned with the subject’s teaching aims. It is interesting to note that students adopting a DA tend to express a greater level of satisfaction with the way in which the subject has been taught (Felder & Brent, 2005).

Another contextual factor is the time available for processing and learning of material, as Craik and Lockhart (1972) suggest that this influences the SAL selected. A learning environment where there is either a real or perceived shortage of time relative to what is required for successful task completion tends to favour a SA (Gow & Kember, 1990). A switch from deep to surface processing may also occur mid-task in instances where a student fails to adhere to their learning schedule (Clarke, 1986).

An additional contextual consideration is that SAL adoption may be culturally-specific (Zeegers, 2001). Cohen, Manion and Morrison (2011, p. 479) caution that it is often “dangerous to import tests developed in one language and one culture into another language and another culture, as there are problems with validity, bias and reliability”. The validity of the questions and scoring methods for the R-SPQ-2F instrument may therefore be different to that proposed by Biggs et al. (2001), as a result of the cultural sensitivity of the instrument (Socha & Sigler, 2014). The cultural sensitivity of this instrument has formed the basis of a number of publications (Sadler-Smith & Tsang, 1998; Leung, Ginns & Kember, 2008; Immekus & Imbrie, 2010; Fryer, Ginns, Walker & Nakao, 2011; Malie & Akir, 2012; Munshi et al., 2012; Stes,
Maeyer & Van Petegem, 2013). This will not be explored further here, as this study involves application of the R-SPQ-2F to a largely monocultural group of student participants who have English as their first language and are studying in a Western culture. Therefore, any further discussion on the cultural sensitivity of this instrument is beyond the scope of this study.

2.3 The relationship between SAL and assessment outcome

The assessment outcome is regarded as the ‘product’ of learning (Zhang, 2000). Assessment grades (scores) are a quantitative measure of student achievement (Trigwell & Prosser, 1991a). Assessment format and requirements have been identified as main drivers of student learning, thereby influencing the SAL adopted (Byrne et al., 2002; Weller et al., 2013). Zeegers argued that the relationship between SAL and assessment grades is inconsistent, but believes that a DA contributes positively towards achieving learning outcomes. Entwistle (1991) suggested that the balance between the adoption of a DA and SA is influenced – within the same student – by assessment demands. Alignment of assessment style with the learning outcomes of an academic programme could encourage deep learning (Weller et al., 2013).

The overarching aim of higher education institutions (HEIs) is to produce high quality learning outcomes in its graduates (Trigwell & Prosser, 1991a). Assessments and other contextual elements in the learning and teaching environments should be constructively aligned to promote a DA (Biggs et al., 2001). This implies that factors under the control of the lecturer should be consistent with the learning outcomes that are being pursued during the course of instruction. To facilitate this, desired learning outcomes should be clearly communicated to students as expectations, instruction methods favouring aspirational learning outcomes are employed and assessments should be explicitly directed towards the learning outcomes (Felder & Brent, 2005).

Assessment results have been used as a measure of learning outcome in previous studies exploring the relationship between SAL and assessment scores (Trigwell & Prosser, 1991a, 1991b; Byrne et al., 2001; Gijbels et al., 2005). Weller et al. (2013) proposed that alignment of assessment style with the learning outcomes of an academic programme could encourage deep learning. This is supported by Trigwell
and Prosser’s (1991a) suggestion that adoption of a DA is usually related to high quality learning outcomes and that favouring a SA is usually related to lower quality outcomes. Biggs et al. (2001) and Weller et al. (2013) proposed that the quality of examinations could be measured by the SAL adopted by students as they prepared for those examinations. In his study of SAL using the Study Process Questionnaire (SPQ) on science students, Zeegers (2001) showed that a DA was positively correlated with assessment outcome. The type of assessment was not specified in this study, as the assessment score was presented and analysed only as the grade point average (GPA). Zeegers (2001) also found a small negative correlation between assessment marks and SA, and that it is this latter SAL that demonstrates the greatest amount of temporal stability. Almeida et al.’s (2011) findings agreed with those of Zeegers (2001), but differed to the extent that they found a divergence of SALs (as measured using the Approaches and Study Skills Inventory for Students, ASSIST instrument) for chemistry students with high assessment scores. However, they showed a significant relationship between low assessment scores and the adoption of a SA. As in Zeeger’s (2011) study, Almeida et al. (2011) did not break down this analysis of assessment score by component, instead, adopting an overall assessment score in their analyses. Even though these studies did not investigate the specific forms of assessment and their relationship to SALs, other studies did undertake this deeper analysis.

The link between SAL and assessment outcome has been further explored by investigating types of assessment. Entwistle (1991) maintains that the nature of the examination influences the level of understanding of material sought by the students, but did not further define the types of examination this assertion refers to. Gijbels et al. (2005) analysed the relationship between SAL and scores achieved for different types of multiple choice questions (MCQs). This analysis included a breakdown of the types of MCQs into those covering ‘concepts’, ‘principles’ and ‘application’. No correlation was found between SAL and MCQ assessment scores in his study on SAL in law students. Jayawardena et al. (2013) concurred with this result. Yonker (2011) also sub-classified MCQ questions when exploring psychology student SALs in relation to MCQs that were labelled as either ‘factual’ or ‘applied’, with the latter assuming to involve a higher level of cognitive processing. Yonker (2011) found that students adopting a SA achieved worse scores for both of these MCQ categories,
concluding that ‘applied’ MCQs may not be complex enough to elicit a positive relationship between DA and MCQ assessment score. Using the R-SPQ-2F, Weller et al. (2013) demonstrated that trainee anaesthetists adopted a SA when preparing for MCQs, proposing that this may be because students are required only to recognise and identify the correct answer when questions are in this format. It is thought that students tend to adopt rote memorisation of past questions in an attempt to achieve high assessment outcomes in MCQ assessments. Weller et al. (2013) further suggested that the quality of MCQs should be enhanced to encourage higher-order problem-solving and deep thinking. It should be noted, however, that there was no distinction made between types of MCQs in his study. Similarly, Scouller (1998) showed that education students were also more likely to employ a SA when preparing for MCQ examinations, arguing that this was because they perceived MCQs as assessing lower-level, knowledge-based cognitive processing mechanisms. Thus assessment methods perceived by students as assessing knowledge reproduction, encourage SA adoption, while disadvantaging those that employ DA. Poorer performance in MCQ assessments is associated with the employment of a DA. This fails both the educator and the student because the higher education graduate objective of development of analytical and critical thinking may not be achieved. Furthermore, students would be unlikely to learn the skills needed for their own academic and professional development (Scouller, 1998).

Scouller (1998) further suggests that the DA is likely to be employed during essay assignment preparation and completion, perceived by students to assess higher levels of cognitive processing. Students adopting a SA tended to perform more poorly in essay-based assignments. Similarly, Tian (2007) showed that students undertaking Chinese-language studies performed better on essay-based assignments when they adopted a DA. This is consistent with Weller et al.’s (2013) proposal that such assessments where construction of the answer is required promotes the use of a DA in medical students. This contrasts with Tian’s (2007) findings when analysing SAL relative to formal examination scores, showing that neither the SA nor DA were favoured by students when preparing for these examinations. Yonker (2011) also found no significant differences in the SALs adopted by psychology students undertaking a written project assessment. This is similar to Jayawardena et al.’s (2013)
finding of no significant correlation between SALs and academic performance as measured by the scores obtained during short answer questions. Jayawardena et al. (2013) further found a lack of significant correlation between scores on a clinical skills assessment and SAL as measured by the R-SPQ-2F. This is the only study that could be sourced that directly addresses exploration of relationships between clinical skills assessment performance and SAL as measured by the R-SPQ-2F. May et al. (2012) investigated the relationship between SALs, as measured using the ASSIST questionnaire, and the performance of medical students on a clinical skills examination. The result of May et al.’s (2012) study showed that the SA showed no significant correlation between scores on a clinical skills assessment, while the DA was found to have a significant positive correlation with the clinical skills assessment score.

2.4 The measurement of SAL

2.4.1 General approaches to SAL measurement

Questionnaires are a widely-used method used to elicit insight into individual perceptions and attitudes (Barach & Holtom, 2008). The instruments measuring SALs have been developed to measure the behavioural and conceptual processes in which students engage while learning (Emilia et al., 2012). According to Zeegers (2001), the two most common instruments used to evaluate students’ SALs in higher education are the Study Process Questionnaire (SPQ) (Scouller, 1998; Zhang, 2000; Zeegers, 2001; Evans, Kirby & Fabrigar, 2003; Snelgrove & Slater, 2003, Wilson & Fowler, 2005, Tian, 2007) and the Approaches to Study Inventory (ASI) (Trigwell & Prosser, 1991a) and its revised version, the Revised Approaches to Study Inventory (RASI). Other studies have applied a range of SAL instruments: Approaches to Learning Inventory (ALI) (Clarke, 1986); Short Inventory of Approaches to Learning (SIAL) (Abraham et al., 2006); Lancaster Approaches to Studying Questionnaire (LASQ) (Felder & Brent, 2005); Approaches and Study Skills Inventory for Students (ASSIST) (Byrne et al., 2002; Diseth & Martinsen, 2003, Diseth, 2007; Almeida et al., 2011; Eubank & Pitts, 2011; May et al., 2012; Reid, Evans & Duvall, 2012) and Approaches to Learning Biology (ALB) (Chiou et al., 2012).
2.4.2 The Revised Two-Factor Study Process Questionnaire (R-SPQ-2F)

The original version of this questionnaire, the SPQ, conceptualises student learning as a composite of motives and strategies, amenable to change as students’ perception of assessment requirements change (Zeegers, 2001). Although widely used, the SPQ was lengthy to administer in classroom settings, and not all variables measured by this instrument were relevant to predicting student perceptions in relation to their SA and DA (Yonker, 2011). A shortened version of the SPQ, the Revised Two-Factor Study Process Questionnaire (R-SPQ-2F), was therefore devised, validated and published by Biggs et al. (2001) to streamline the administration and interpretation of student responses in the measurement of SALs. The R-SPQ-2F was developed as a tool to be used by teachers and educators to facilitate evaluation of the classroom learning environment and the impact that this has on individual selection of the SAL. Biggs et al. (2001) showed that the R-SPQ-2F is a reliable measure of SAL in students across a range of academic disciplines. As seen in Table 2.1 below, the R-SPQ-2F has been used widely in measurements of SAL in medical and health sciences (Fox et al., 2001; Balasooriya et al., 2009; Ali & El Sebai, 2010; Munshi et al., 2012; Jayawardena et al., 2013; Weller et al., 2013; Henoch et al., 2014; Mogre & Amalba, 2014).
<table>
<thead>
<tr>
<th>Author</th>
<th>Title</th>
<th>Discipline (and sample size)</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fox et al. (2001)</td>
<td>The shortened Study Process Questionnaire: An investigation of its structure and longitudinal stability using confirmatory factor analysis.</td>
<td>Undergraduate medical students (n=1,349)</td>
<td>To validate the R-SPQ-2F for measuring SAL in medical students, and to assess the temporal stability of this instrument.</td>
</tr>
<tr>
<td>Balasooriya et al. (2009)</td>
<td>The cross-over phenomenon: unexpected patterns of change in students’ approaches to learning.</td>
<td>Undergraduate medical students (n=129)</td>
<td>To explore SALs adopted over a range of learning units.</td>
</tr>
<tr>
<td>Munshi et al., (2012)</td>
<td>Reliability and validity of an Arabic version of the revised two-factor study process questionnaire.</td>
<td>Undergraduate medical students (n=83)</td>
<td>To validate an Arabic version of the R-SPQ-2F.</td>
</tr>
<tr>
<td>Jayawardena et al. (2013)</td>
<td>Association of learning approaches with academic performance of Sri-Lankan first-year dental students.</td>
<td>Undergraduate dental students (n=74)</td>
<td>To explore the SALs of dental students and how these relate to academic performance as quantified by assessment scores for MCQs, short answer questions, clinical examinations, GPA.</td>
</tr>
<tr>
<td>Weller et al. (2013)</td>
<td>Approaches to learning for the ANZCA Final Examination and validation of the revised Study Process Questionnaire in specialist medical training.</td>
<td>Medical (advanced specialist) anaesthetics training students (n=236)</td>
<td>To explore how the SALs of anaesthetics trainees relate to learning outcomes as measured by performance in MCQ and oral viva assessments. Including assessment of student perceptions related to study time and perceived value of assessment.</td>
</tr>
<tr>
<td>Henoch et al. (2014)</td>
<td>Nursing students’ experiences of involvement in clinical research.</td>
<td>Undergraduate nursing students (n=126)</td>
<td>To explore the SALs of nursing students and how these relate to their interest in undertaking research data collection.</td>
</tr>
<tr>
<td>Mogre &amp; Amalba (2014)</td>
<td>Assessing the reliability and validity of the Revised Two Factor Study Process Questionnaire (R-SPQ-2F) in Ghanaian medical students.</td>
<td>Undergraduate medical students (n=189)</td>
<td>To validate a Ghanian version of the R-SPQ-2F.</td>
</tr>
</tbody>
</table>

**Table 2.1.** Summary of studies using the R-SPQ-2F in medical and health sciences
This past use of the R-SPQ-2F in medical and health science SAL measurement makes it an appropriate tool to measure the SALs of optometry students, as optometry is considered to be a health science discipline. The R-SPQ-2F has also been used to measure the SALs or students in a range of other disciplines (Gijbels et al., 2005; Immekus & Imbrie, 2010; Fryer et al., 2011; Yonker, 2011; Kyndt, Cascallar & Dochy, 2012; Malie & Akir, 2012; Ngidi, 2013; Stes et al., 2013).

The research design used to investigate the SALs of undergraduate optometry students using the R-SPQ-2F instrument in this study is described next.
Chapter 3: Research Design

The theoretical perspective, methodology, method and ethics considerations associated with this study are described in this chapter.

3.1 Theoretical perspective

The epistemology for this study is objectivism, associated with the positivist paradigm (positivism) theoretical perspective. Central to this paradigm is that the world is external and objective. This assumes that data options are pre-defined, and that data quantification methods are pre-determined through defined measurements and statistical analyses of data. Identified measurable variables are used to formulate and test hypotheses, using the deductive approach to establish whether relationships and associations exist between data sets, as well as to measure the nature and extent of these relationships and associations (Gray, 2013).

3.2 Methodology

A cross-sectional between-subjects quantitative design was used in this study. A cross-sectional design was appropriate, as data collection took place over a short period of time (Cohen et al., 2011; Gray, 2013). Undergraduate optometry students were asked to complete the R-SPQ-2F questionnaire to elicit their student approaches to learning (SALs) in relation to a specified module in the 2014-2015 academic year. One such module was identified for each of the four consecutive stages of the programme. These modules were identified on the basis that they were core to the optometry programme and delivered only to optometry students, unlike some other modules where student from multiple programmes are co-taught. A further rationale for selection was that the selection of modules was limited to those delivered only in the first semester of the academic year, as the time constraints associated with this study meant that inclusion of year-long modules would not fit in with the time available for this study. Individual student assessment scores across a range of assessment types for each of these modules were retrieved from academic assessment
records. The R-SPQ-2F score quantified the SAL for each student. These were analysed to identify SAL trends within each stage and between programme stages. Further analyses were carried out to identify correlations between SAL scores and assessment scores for a range of assessment types for each identified module.

The ethical considerations applying to this study are summarised first, followed by a description of the methods used.

### 3.3 Ethical considerations

This study was undertaken in accordance with Dublin Institute of Technology (DIT) Research Ethics Committee guidelines (DIT, 2009) and approval (Ref 14-37, Appendix A). The experimental design also conforms to the British Psychological Society’s *Code of Human Research Ethics* (2010).

The following specific ethical considerations were included in the methods description below: participant age; informed consent; right to withdraw; participant anonymity; participant debriefing; secure data storage and anonymous presentation of data (BPS, 2010). A further consideration was the balance of power, as two (stage 1 and stage 4) modules were delivered by the primary researcher in this study. The way in which this was addressed during the data collection and analysis processes is described later in this chapter.

### 3.4 Methods

#### 3.4.1 Participants

Convenience (opportunity) sampling was used to identify potential participants, who were invited to participate in this study. According to this sampling method, participant questionnaire respondents were selected on the basis of their accessibility and availability at the time of the study (Cohen et al., 2011). Seventy-three students enrolled on all four stages of an undergraduate optometry programme volunteered to participate in the study. Participant gender and age profiles for each stage are summarised in Tables 3.1 and 3.2.
Table 3.1. Participant gender profile

<table>
<thead>
<tr>
<th>Stage (and sample size)</th>
<th>No. female participants</th>
<th>No. male participants</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 (n=19)</td>
<td>15</td>
<td>4</td>
</tr>
<tr>
<td>2 (n=13)</td>
<td>10</td>
<td>3</td>
</tr>
<tr>
<td>3 (n=18)</td>
<td>14</td>
<td>4</td>
</tr>
<tr>
<td>4 (n=23)</td>
<td>17</td>
<td>6</td>
</tr>
<tr>
<td>All Stages (n=73)</td>
<td>56</td>
<td>17</td>
</tr>
</tbody>
</table>

Table 3.2. Participant age profile

<table>
<thead>
<tr>
<th>Stage (and sample size)</th>
<th>Mean Age± Standard Deviation (years)</th>
<th>Age Range (years)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 (n=19)</td>
<td>18.3 ± 0.58</td>
<td>18-20</td>
</tr>
<tr>
<td>2 (n=13)</td>
<td>20.5 ± 2.26</td>
<td>19-26</td>
</tr>
<tr>
<td>3 (n=19)</td>
<td>21.9 ± 3.83</td>
<td>20-35</td>
</tr>
<tr>
<td>4 (n=23)</td>
<td>22.3 ± 1.99</td>
<td>21-28</td>
</tr>
<tr>
<td>All Stages (n=73)</td>
<td>20.9 ± 2.88</td>
<td>18-35</td>
</tr>
</tbody>
</table>

The data in these tables is only for participants meeting the inclusion criteria for the student. Data from students younger than 18 years of age at the time of data collection were excluded from this study. These students are considered as minors and would have required parental consent for use of their data (DIT, 2009), which would not have been practical to obtain when administering questionnaires in a classroom setting.

Participants were informed both verbally and in writing of the intent and confidentiality of the study (see the ‘Participant Information Sheet’ in Appendix A). They were advised that their responses would be analysed and presented in such a way as to protect their anonymity. Each participant signed a participant ‘Consent Form’ (Appendix A) prior to completing the R-SPQ-2F questionnaire. Students were also informed of their right to withdraw from the study at any time. Participants received no financial compensation or other reward for participation.

3.4.2 Data storage

Each participant was allocated a unique study participant identifier (Crawford, Alhreish & Popvish, 2012). No personal identifiers were used, thereby protecting the anonymity of participant responses (BPS, 2010). The participant identifier was based on the stage of study, with ‘11’ indicating participant number one in stage one of the
programme, ‘12’ indicating the second participant in stage one, and so on. Participants were randomly allocated these numbers within each stage. The DIT undergraduate optometry programme is a small programme and unique in the ROI. Participant anonymity was therefore enhanced by the allocation of numbers ‘1’, ‘2’, ‘3’ and ‘4’ to each of the modules to correspond with the stage of delivery of the module, rather than using the name of the module. Original questionnaires, hard copy versions of module mark sheets, participant names, student numbers and module identifiers were stored securely in a locked filing cabinet in a secure DIT staff office. It is intended to shred these at the end of 2015, upon the completion of this study.

3.4.3 Participant debriefing

Participating students will be given the opportunity to access to their individual SAL results after completion of the quality assurance and examination board procedures for the 2014-2015 academic year. Debriefing of participants is in keeping with best practice as promoted by the BPS’s (2010) *Code of Human Research Ethics*. Felder and Spurlin (2005) and Mohammed et al. (2011) recommended sharing of individual student participant’s individual learning style results with them, as it could provide valuable clues about a student’s possible learning style strengths and weaknesses. As learning style is related to SAL, this approach to participant debriefing is assumed to be relevant to SAL studies. Students making use of this debriefing opportunity will be informed that no SAL instrument can be regarded as an entirely reliable assessment of SAL, but rather, the SAL scores generated should be treated only as a general guideline. Furthermore, students will also be assured that their own SALs as measured by the R-SPQ-2F are not indicators as to what they are capable of achieving academically (Felder & Spurlin, 2005).

3.5 The R-SPQ-2F learning approach questionnaire

The SALs were measured using the shortened version of the Study Process Questionnaire (R-SPQ-2F) and associated scoring system (Biggs et al., 2001) (Appendix B). Biggs et al. (2001, p. 145) granted permission for the use of this tool for research purposes:
Readers are invited to use it for evaluating their teaching and for genuine research purposes. The conditions are that they acknowledge the source as the present paper and accept that the copyright on the questionnaire is owned by John Biggs and David Kember.

The R-SPQ-2F was developed as a 20-item instrument for self-report of attitudes towards aspects of learning. Ten of the R-SPQ-2F items load onto a factor capturing deep SAL (identified as the ‘deep approach’, DA, in this study), with the remaining ten items loaded onto a factor capturing the surface SAL (identified as the ‘surface approach’, SA, in this study) (Weller et al., 2013).

The R-SPQ-2F is unidimensional, as only a single attitude is measured per statement or question presented to the participant (Cohen et al., 2011). The 5-point Likert scale in the R-SPQ-2F is based on the frequency with which each statement describes participant attitude and way of studying (Yonker, 2011; Socha & Sigler, 2014). A Likert-type questionnaire is a fixed-choice format, designed to measure attitudes and opinions, with no ‘correct’ answers. When completing the R-SPQ-2F, the participant respondent was asked to select ‘A’, ‘B’, ‘C’, ‘D’ or ‘E’ to indicate their level of agreement with a statement, where ‘A’ is ‘never or only rarely true of me’ and ‘E’ is ‘always or almost always true of me’. The degree, intensity and relative ordering of participant responses were therefore measured (Gliem & Gliem, 2003; Rattray & Jones, 2007). The scoring system was used to generate scores for each of the following R-SPQ-2F main scales: deep SAL (DA); surface SAL (SA). The four subscales associated with these are: deep motive (DM); deep strategy (DS); surface motive (SM) and surface strategy (SS) (Biggs et al., 2001).

The advantage of using such multi-item scales, in preference to single-item scales, is to avoid bias and misinterpretation, while reducing the measurement error (Rattray & Jones, 2007). The response differentiation is thus maintained, while generating numbers for further analyses (Cohen et al., 2011). Questionnaires such as this with forced-choice responses are widely used in educational research (Norman, 2010).
3.6 Data collection

3.6.1 R-SPQ-2F questionnaire

The R-SPQ-2F was administered to the student participants in a lecture-based setting during semester 1 of the 2014-2015 academic cycle. The lecture room represents a naturalistic setting and is therefore appropriate to SAL studies, as the learning environment is regarded as having an important influence on the SAL (Almeida et al., 2011). Collecting student questionnaire data in this way while a module is running, but before the end-of-module examination, is consistent with methodology of Zeegers (2001), Diseth and Martinsen (2003) and Diseth, Pallesan, Brunborg and Larson (2010).

The questionnaires were administered in a paper-based format, as this format is recognised as being associated with a higher participant response rate when compared to online questionnaire completion (Nulty, 2008). The questionnaires were self-administered in the presence of the researcher. Advantages of this include facilitation of immediate responses to participant queries, a good response rate, reduced timeframe for data collection and increased likelihood of questionnaire completion (Cohen et al., 2011). The main disadvantage associated with this method is that the presence of the researcher may cause participants to feel compelled to complete the questionnaire (Baruch & Holtom, 2008; Cohen et al., 2011).

Learning is content-driven, varying according to the requirements of different disciplines (Zeegers, 2001). This may result in the adoption of different SALs for different modules (Felder & Brent, 2005). Participants were therefore asked to complete the R-SPQ-2F considering their SAL adopted for the named module for their stage of the programme (Biggs et al., 2001; Yonker, 2011). Note, however, that they were not asked to link their R-SPQ-2F responses to particular assessments or assessment types only, but rather, to respond considering their general approach to learning for a named module (Scouluer, 1998). The wording of the R-SPQ-2F was not changed for this study, as this would have required a re-validation of the questionnaire in order to enhance the statistical reliability of the participant responses. The timescale for this study did not facilitate such a revalidation process, as the number of participants is too small for such a revalidation to be valid. However, such rewording
and revalidation may be carried out as part of a longitudinal study in future. Participants were permitted a maximum of twenty minutes for completion of the R-SPQ-2F questionnaire. A time limit was imposed as this increased the likelihood of participants being more instinctive in answering of the questions (Crawford et al., 2012). However, most of the students managed to complete the questionnaire well in advance of this time limit. Students were not emailed information prior to the survey, as this could have meant that the results on the day of answering the questionnaire may have been less instinctual.

Student participants were asked to record their student numbers instead of their names at the start of the questionnaire. This further anonymised their responses both in the answering of the questions, but also in facilitating access to and analysis of their data, as student assessment records are stored using their student numbers. Participants were also asked to record their gender as ‘male’ or ‘female’ and their age or date of birth.

Completed questionnaires were only reviewed and analysed once the assessment marks for semester 1 modules been finalised through the routine DIT quality assurance procedures pertaining to confirmation of student assessment results. This time delay between questionnaire completion and analysis was to avoid a potential power imbalance where some modules and assessments were delivered and administered by the primary researcher (Cohen et al., 2011).

### 3.6.2 Assessment scores

Module assessment scores were used in this study as a measure of learning outcome, as per the methodology of Trigwell and Prosser (1991a, 1991b). Assessment data for each of the modules identified for this study were accessed through student assessment records (Trigwell & Prosser, 1991a) held by module leaders for each of the identified modules. Access to this data was approved by the DT224 Programme Committee, as well as by individual module leaders, which was part of the ethical approval process for this study. Modules are referred to as ‘stage 1’ module, ‘stage 2’ module, ‘stage 3’ module and ‘stage 4’ module. This module naming system was adopted to facilitate the anonymous presentation of data so as to further protect the identity of the student participants. For each module, a percentage score for each type of assessment within
the module was calculated, using both continuing assessment and end-of-module assessment data. These percentage scores were used for further analysis.

The results of these investigations and analyses as described here are presented next in Chapter 4.
Chapter 4: Data Analysis and Results

Data analysis and graphical representation in this study was carried out using the IBM® SPSS® (Statistical Package for the Social Sciences) Version 20.0 and MS Excel 2013 software.

The data analysis methods and results are presented separately for the R-SPQ-2F scores and assessment scores. This is followed by an exploration of the relationship between the SAL and assessment scores.

4.1 Participant response rate (RR)

4.1.1 Data analysis methods
The participant questionnaire response rate (RR) was calculated as the number of completed surveys, divided by the number of eligible invited participants, multiplied by 100 (Shaw, Bednall & Hall, 2002). This is an indicator used to determine the potential consistency of the study and its contribution to the body of knowledge of SALs in higher education (Baruch & Holtom, 2008).

4.1.2 Results
Seventy-three undergraduate optometry students volunteered to participate in this study, representing an overall participant response rate (RR) of 88% (73 out of 83 students). The RRs were 79% (19 out of 24 students), 87% (13 out of 15 students), 86% (18 out of 21 students) and 100% (23 out of 23 students) for stages 1, 2, 3 and 4 of the programme respectively. Students not participating in the study did so for reasons of being younger than 18 years of age or due to absence from class on the day of data collection. One student’s data was withdrawn from the study as absence from the end-of-module examination rendered that participant’s data set incomplete.
4.2 Cronbach’s alpha ($\alpha$) analysis for questionnaire scale reliability

4.2.1 Data analysis methods

Biggs et al. (2001) carried out confirmatory factor analysis (CFA) of items in the R-SPQ-2F to validate the measurement of test dimensions, thereby confirming the reliability and consistency of using the R-SPQ-2F as an SAL measurement tool. Application of CFA was not appropriate to the study reported here, as the sample size for each individual stage and all stages combined is less than the minimum recommended number of 300 participants needed to make CFA viable (Cohen et al., 2011).

Questionnaire reliability refers to the “repeatability, stability or internal consistency of a questionnaire” (Rattray & Jones, 2007, p. 237). Internal consistency reflects the inter-relatedness of questionnaire items (Tavakol & Dennick, 2011). Gliem & Gliem (2003) maintain that when using Likert-type questionnaires, it is imperative to report the Cronbach alpha ($\alpha$) statistic for internal consistency reliability for all questionnaire scales and subscales. This is the most widely used measure of internal consistency for composite scores in educational studies and is used for demonstrating questionnaire reliability (Rattray & Jones, 2007; Cohen et al., 2011). The Cronbach’s alpha statistic is the average value of the reliability coefficients that could be obtained for all possible combinations of items when split into two half-tests. Cronbach’s alpha as a measure of internal consistency of the R-SPQ-2F is expressed as a number between 0 and 1. The closer the alpha value is to 1, the greater the internal consistency of scale items is assumed to be. This describes the extent to which all the items in the test measure the same concept and is therefore representative of the inter-relatedness of test items (Gliem & Gliem, 2003, Tavakol & Dennick, 2011). A high rate of correlation between items measuring the same construct will result in a greater alpha value (Gliem & Gliem, 2003, Tavakol & Dennick, 2011). The alpha value at which reliability is regarded as acceptable differs between publications. Gliem and Gliem (2003) and Rattray and Jones (2007) report that $\alpha > 0.80$ indicates questionnaire reliability for established questionnaires. However, Tavakol and Dennick (2011) recommend a maximum alpha value of 0.9, suggesting that alpha values higher than this could indicate redundancy of some questionnaire items. Rattray and Jones (2007)
further suggest that if \( \alpha < 0.70 \), the items in a questionnaire or subscale are poorly grouped. Tavakol and Dennick (2011) suggest that a low alpha value could be due to a low number of questions or poor interrelatedness of items. Cohen et al.’s (2011) guidelines for interpretation of Cronbach’s alpha analysis data in educational research are summarised in Table 4.1.

<table>
<thead>
<tr>
<th>Cronbach alpha coefficient score</th>
<th>Interpretation</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt;0.90</td>
<td>Very highly reliable</td>
</tr>
<tr>
<td>0.80-0.90</td>
<td>Highly reliable</td>
</tr>
<tr>
<td>0.70-0.79</td>
<td>Reliable</td>
</tr>
<tr>
<td>0.60-0.69</td>
<td>Marginally/minimally reliable</td>
</tr>
<tr>
<td>&lt;0.60</td>
<td>Unacceptably low reliability</td>
</tr>
</tbody>
</table>

Table 4.1. Cronbach’s alpha coefficient interpretation guidelines

The Cronbach’s alpha statistic was calculated for each of the main scales and subscales of the R-SPQ-2F questionnaire in this study in order to establish the reliability of questionnaire responses and measurement scales prior to employing the R-SPQ-2F survey results for further analysis. This measure of internal consistency for the R-SPQ-2F scale has been employed in previous studies R-SPQ-2F (Biggs et al., 2001; Yonker, 2011; Socha & Sigler, 2014). This is in keeping with Gliem and Gliem’s (2003) recommendation that only summated scale values be used for this analysis, as the Cronbach alpha statistic for individual items is likely to be low and unreliable. Furthermore, Rattray and Jones (2007) recommended the calculation of this statistic only for separate domains within a questionnaire, rather than for the entire questionnaire. Therefore, for this study, this analysis was performed individually for each stage of the programme, then for all data pooled together across all stages of the programme.

There is some debate as to the appropriateness of the use of the Cronbach’s alpha statistic for Likert-type questionnaires. Calculation of the alpha statistic is a parametric test and its use violates the statistical requirement to use only non-parametric analyses methods on data from Likert-type tests (Jamieson, 2004) such as the R-SPQ-2F, which generate ordinal data. However, the application of Cronbach’s alpha analyses to ordinal data generated by a Likert test is supported by Gliem and
Gliem (2003, p. 81), who maintain that “when using Likert-type scales it is imperative to calculate and report Cronbach’s alpha coefficient for internal consistency reliability for any scales and subscales one may be using.” This recommendation, together with the application of Cronbach alpha’s statistic to analysis of internal consistency of the R-SPQ-2F main scales in previous studies (Table 4.2) supported the use of Cronbach’s alpha analysis in this study.

<table>
<thead>
<tr>
<th>Study</th>
<th>DA</th>
<th>SA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biggs et al. (2001)</td>
<td>0.73</td>
<td>0.64</td>
</tr>
<tr>
<td>Yonker (2011)</td>
<td>0.74</td>
<td>0.68</td>
</tr>
<tr>
<td>Weller et al. (2013)</td>
<td>0.82</td>
<td>0.74</td>
</tr>
<tr>
<td>Kyndt et al. (2013)</td>
<td>0.81</td>
<td>0.79</td>
</tr>
<tr>
<td>Henoch et al. (2014)</td>
<td>0.75</td>
<td>0.67</td>
</tr>
</tbody>
</table>

Table 4.2. Cronbach alpha values reported for previous studies using the R-SPQ-2F

4.2.2 Results

The Cronbach’s alpha ($\alpha$) values for the scales and subscales of the R-SPQ-2F for all four stages of the programme are summarised in Table 4.3.

<table>
<thead>
<tr>
<th>Stage</th>
<th>R-SPQ-2F scales</th>
<th>R-SPQ-2F subscales</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.854*</td>
<td>0.759*</td>
</tr>
<tr>
<td>2</td>
<td>0.610^</td>
<td>0.878*</td>
</tr>
<tr>
<td>3</td>
<td>0.674^</td>
<td>0.713*</td>
</tr>
<tr>
<td>4</td>
<td>0.821*</td>
<td>0.776*</td>
</tr>
<tr>
<td>All</td>
<td>0.766*</td>
<td>0.791*</td>
</tr>
</tbody>
</table>

* scales demonstrating internal reliability and consistency (Rattray & Jones, 2007; Cohen et al., 2011)
^ scales demonstrating marginal internal reliability and consistency (Cohen et al., 2011)

Table 4.3. Cronbach’s alpha coefficients for R-SPQ-2F main scales and subscales

Cronbach alpha values of above 0.70 indicate that a questionnaire is reliable and internally consistent for a participant sample (Cohen et al., 2011). Using this criterion, the DA Cronbach’s alpha coefficient values indicate that these DA data are reliable for the stages 1, 4 and combined DA scores, with marginal reliability for the stages 2 and 3 DA scores. All stages considered separately and in combination meet
the criterion for being considered reliable for SA scores. The Cronbach’s alpha values for subscales show variable reliability, with many not meeting the reliability criterion. Due to the lack of overall support for internal reliability and consistency of sub-scale (DM, DS, SM and SS) R-SPQ-2F scores, only main scale scores of DA and SA were used for inferential statistical analyses in this study. This is also in keeping with Socha and Sigler’s (2014, p. 49) conclusion that “…the R-SPQ-2F should only be used to create scores for deep approach and surface approach. The R-SPQ-2F should not be used to score the motive and strategy factors.” Weller et al. (2013) also adopted this two-factor application of the R-SPQ-2F scores.

4.3 R-SPQ-2F scores

4.3.1 Scoring of questionnaire responses

The R-SPQ-2F responses were scored according to the developer’s instructions (Biggs et al., 2001). As this is a multi-item questionnaire consisting of items that can be grouped into main and subscales, a composite (summed) score was calculated for each participant for each of the two main scales, DA and SA, and four sub-scales measured by this instrument (Appendix C).

Participant response data to Likert-type questions is regarded as ordinal data, as letters are used to identify the rank of the data (McCrum-Gardner, 2008). Analysis of individual scale items in Likert-type scales is therefore not recognised as being statistically valid (Gliem & Gliem, 2003). However, when four or more question responses are combined, the resultant scale is regarded as quantitative interval data for the purposes of further analyses (Rattray & Jones, 2007; Boone & Boone, 2012; Wigley, 2013). Therefore, composite questionnaire scores, DA, SA, DM, DS, SM and SS, were treated as interval data for further analyses, thereby validating the application of parametric analysis methods. This method was further supported by Norman (2010, p. 631), who concluded that “parametric statistics can be used with Likert data, with small sample sizes, with unequal variances, and with non-normal distributions, with no fear of ‘coming to the wrong conclusion’”. Parametric data analyses have been applied to SAL questionnaire data in past studies (Biggs et al., 2001; Zeegers, 2011;
Yonker, 2011; Weller et al., 2013), but it should be cautioned that this is only appropriate where data is distributed normally (Ghasemi & Zahediasl, 2008).

Participant DA and SA (R-SPQ-2F main scale) scores are summarised in Figures 4.1 to 4.5.

**Figure 4.1.** R-SPQ-2F main scale scores (stage 1), n = 19

Most stage 1 participants had higher DA scores than SA scores, with 95% (18 out of 19) showing a DA preference, and only 5% (1 out of 19) showing a SA preference (Figure 4.1).

**Figure 4.2.** R-SPQ-2F main scale scores (stage 2), n = 13
Stage 2 participants showed an equal distribution of DA and SA preferences, with 46% (6 out of 13) showing a DA preference and 46% (6 out of 13) showing a SA preference (Figure 4.2). There were equal DA and SA scores for 8% (1 out of 13 participants).

Figure 4.3. R-SPQ-2F main scale scores (stage 3), n = 18

Most stage 3 participants had higher DA scores than SA scores, with 72% (13 out of 18) showing a DA preference, and 28% (5 out of 18) showing and SA preference (Figure 4.3).

Figure 4.4. R-SPQ-2F main scale scores (stage 4), n = 23
Most stage 4 participants had a marginally higher DA preference, with 48% (11 out of 23) having higher DA scores and 43% (10 out of 23) showing a SA preference (Figure 4.4). There was an equal preference between DA and SA scores for 9% (2 out of 23) of the participants.

Overall, the DA prevailed, with 66% (48 out of 73) participants showing a DA preference, 30% (22 out of 73) participants showing a SA preference and 4% (3 out of 73) showing an equal preference for DA and SA (Figure 4.5).

4.3.2 Normality testing of SAL data
The DA and SA scores were analysed to establish whether the data were normally distributed (indicating a need for parametric data analysis) or non-normally distributed (requiring non-parametric data analysis methods) (Ghasemi & Zahediasl, 2008). The main feature of normally-distributed data is that the frequency curve has a bell-shaped distribution, with a data tailing to infinity in both directions. Clustering of data values around the mean is the defining feature of such a distribution. Non-normally distributed data either shows no pattern of data distribution, or a cluster of data at either end of the data range (Watkins, Sheaffer & Cobb, 2011). The Shapiro-Wilks normality test (McCrum-Gardner, 2008) was applied to SAL scores in this study (Appendix D). This was undertaken for each stage separately and for data from all
stages combined. The null hypothesis ($H_0$) for this analysis was that the data was normally distributed. Calculated values of less than alpha (5%), where $p < 0.05$, would indicate that the $H_0$ was not supported, concluding that the data is non-normally distributed. A normal distribution was identified by $p > 0.05$ for Shapiro-Wilks normality testing, supporting the $H_0$ for normality testing, indicating the existence of a normal data distribution (Watkins et al., 2011).

Normal data distributions were found for all DA and SA scores for stages 1, 2, 3 and all stages combined. Stage 4 SA scores were normally distributed. The stage 4 DA score distribution did not meet the exact criterion for normality, but with $p=0.049$, it was assumed that this approximates a score representing a normal distribution, so was considered to be normally-distributed for the purposes of further analyses. These normal distributions of DA and SA scores indicated that parametric analysis methods were appropriate to the inferential statistical analyses in this study. All findings were tested and reported for statistical significance at a 5% alpha value.

### 4.3.3 Descriptive statistics

Descriptive statistics were calculated for the DA and SA scores for each stage separately, and for all stages combined. These are summarised in Tables 4.4 and 4.5.

<table>
<thead>
<tr>
<th>Stage</th>
<th>Mean</th>
<th>Standard Deviation (SD)</th>
<th>Minimum</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 (n=19)</td>
<td>31.2</td>
<td>6.00</td>
<td>22.0</td>
<td>43.0</td>
</tr>
<tr>
<td>2 (n=13)</td>
<td>28.3</td>
<td>4.53</td>
<td>21.0</td>
<td>35.0</td>
</tr>
<tr>
<td>3 (n=18)</td>
<td>29.2</td>
<td>5.75</td>
<td>19.0</td>
<td>41.0</td>
</tr>
<tr>
<td>4 (n=23)</td>
<td>29.1</td>
<td>6.48</td>
<td>20.0</td>
<td>47.0</td>
</tr>
<tr>
<td>All (n=73)</td>
<td>29.5</td>
<td>5.85</td>
<td>19.0</td>
<td>47.0</td>
</tr>
</tbody>
</table>

**Table 4.4.** Descriptive statistics for R-SPQ-2F Deep Approach (DA) scale scores
<table>
<thead>
<tr>
<th>Stage</th>
<th>Mean (SD)</th>
<th>Standard Deviation (SD)</th>
<th>Minimum</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 (n=19)</td>
<td>22.5 (5.50)</td>
<td>5.50</td>
<td>14.0</td>
<td>36.0</td>
</tr>
<tr>
<td>2 (n=13)</td>
<td>26.8 (7.55)</td>
<td>7.55</td>
<td>16.0</td>
<td>40.0</td>
</tr>
<tr>
<td>3 (n=18)</td>
<td>23.1 (5.75)</td>
<td>5.75</td>
<td>13.0</td>
<td>35.0</td>
</tr>
<tr>
<td>4 (n=23)</td>
<td>26.8 (6.43)</td>
<td>6.43</td>
<td>16.0</td>
<td>45.0</td>
</tr>
<tr>
<td>All (n=73)</td>
<td>24.8 (6.46)</td>
<td>6.46</td>
<td>13.0</td>
<td>45.0</td>
</tr>
</tbody>
</table>

Table 4.5. Descriptive statistics for R-SPQ-2F Surface Approach (SA) scale scores

Mean DA scores were highest for stage 1, and the lowest for stage 2. Similar mean DA scores were obtained for stages 3 and 4, and all stages combined. The mean SA scores for stages 2 and 4 were similar, with only their standard deviations differing. These stage 2 and 4 scores were the highest, followed by scores for stages 1 and 3 respectively.

4.3.4 Intra-stage comparison of DA and SA scores

Correlational analyses using the Pearson product moment coefficient was undertaken to identify whether a relationship existed between DA and SA scores. This was done for each stage and for all stages combined.

The Pearson’s product moment correlation coefficient (Zeegers, 2001) is one of the most widely used measures of variable association. The coefficient is expressed by the symbol, r, which is a statistical value ranging from -1.0 to +1.0 and is used as an indicator of inter-variable covariation. A negative sign indicates a negative correlational association between variables, where the value of one variable increases while the other one decreases. A positive sign indicates that both variable values move in the same direction. As one variable increases, the other variable increases. Or, alternatively, as one variable decreases, so does the other variable. Where the plus sign is omitted, a positive correlational value is assumed. A correlational statistic of zero indicates that there is no relationship at all between the two variables (Cohen et al., 2011). Table 4.6 summarises Cohen et al.’s (2011) recommendations for the interpretation of the Pearson product moment correlation coefficient.
Pearson product moment correlation coefficient | Interpretation
--- | ---
0.20 to 0.35 (-0.25 to -0.35) | Very slight relationship between variables. Values in this range have no value in individual or group prediction studies.
0.35 to 0.65 (-0.35 to -0.65) | Correlations statistically significant beyond the 1% level. Values in this range have no value in individual prediction studies, but crude group prediction may be possible.
0.65 to 0.85 (-0.65 to -0.85) | Statistically significant correlation. Individual and group predictions based on correlations in this range are accurate for most purposes.
> 0.85 (< -0.85) | High correlation indicating a close relationship between variables. Very useful for individual or group predictions. Rare in education studies.

Table 4.6. Pearson product moment correlation coefficient interpretation (r) (Cohen et al., 2011)

No statistically significant correlations were found between the DA score and the SA score for stage 1 \( (r = -0.18, p = 0.466) \), stage 2 \( (r = 0.05, p = 0.883) \) and stage 3 \( (r = -0.35, p = 0.157) \). Statistically significant correlations were found between the DA score and the SA score for stage 4 participants \( (r = -0.46, p = 0.027) \) and for all stages combined \( (r = -0.303, p = 0.009) \). These significant correlations are shown in Figures 4.6 and 4.7 respectively. (Note that the curvilinear lines in these figures represent a confidence interval of 95%).

![Figure 4.6. Scatterplot of DA score v. SA score (stage 4)](image)
Further statistical analysis was undertaken to determine whether the mean differences between DA and SA scores were significant within each stage and across all stages. As each participant’s DA and SA scores are related variables, the paired t-test was used to establish whether the differences in mean DA and SA scores obtained within each stage and all stages combined were statistically significant. The paired t-test results are summarised in Table 4.7 below.

<table>
<thead>
<tr>
<th>Stage</th>
<th>t</th>
<th>df</th>
<th>Sig. (2-tailed)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stage 1</td>
<td>4.309</td>
<td>18</td>
<td>.000*</td>
</tr>
<tr>
<td>Stage 2</td>
<td>0.611</td>
<td>12</td>
<td>.553</td>
</tr>
<tr>
<td>Stage 3</td>
<td>2.723</td>
<td>17</td>
<td>.014*</td>
</tr>
<tr>
<td>Stage 4</td>
<td>0.982</td>
<td>22</td>
<td>.337</td>
</tr>
<tr>
<td>All Stages</td>
<td>4.075</td>
<td>72</td>
<td>.000*</td>
</tr>
</tbody>
</table>

*significant at 5% level

Table 4.7. Paired t-test results for DA v. SA scores

These findings show that the differences between DA and SA scores are significant for Stages 1 \((p < 0.001)\) and 3 \((p = 0.014)\) and all stages combined \((p < 0.001)\), while the differences between DA and SA scores were not significant for Stages 2 and 3.
4.3.5 Inter-stage comparison of DA and SA scores

The inter-stage differences in DA and SA scores were analysed using a one-way analysis of variance (ANOVA). This was selected as it is the recommended parametric analysis method for the comparison of three or more independent samples (Cohen et al., 2011).

Inter-stage DA and SA scores are shown in Figures 4.8 and 4.9 below. The results for the one-way ANOVA analyses are summarised in Tables 4.8 and 4.9 respectively.

![Figure 4.8. Inter-stage comparison of R-SPQ-2F Deep Approach (DA) data](image_url)
Figure 4.9. Inter-stage comparison of R-SPQ-2F Surface Approach (SA) data

<table>
<thead>
<tr>
<th></th>
<th>Sum of Squares</th>
<th>df</th>
<th>Mean Square</th>
<th>F</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>DA</td>
<td>Between Groups</td>
<td>79.966</td>
<td>3</td>
<td>26.655</td>
<td>.772</td>
</tr>
<tr>
<td></td>
<td>Within Groups</td>
<td>2382.253</td>
<td>69</td>
<td>34.525</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>2462.219</td>
<td>72</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 4.8. One-way ANOVA results for inter-stage comparison of DA scores

<table>
<thead>
<tr>
<th></th>
<th>Sum of Squares</th>
<th>df</th>
<th>Mean Square</th>
<th>F</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>SA</td>
<td>Between Groups</td>
<td>302.982</td>
<td>3</td>
<td>100.994</td>
<td>2.581</td>
</tr>
<tr>
<td></td>
<td>Within Groups</td>
<td>2699.511</td>
<td>69</td>
<td>39.123</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>3002.493</td>
<td>72</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 4.9. One-way ANOVA results for inter-stage comparison of SA scores

The inter-stage differences in DA and SA scores were not significant. No post-hoc analyses of inter-stage DA and SA scores with respect to stage were therefore required.

4.3.6 Inter-gender comparison of DA and SA scores

A one-way ANOVA was also performed on pooled SAL data across all stages to establish whether there was a significant inter-gender difference in DA and SA. Pooling of SAL data for this analysis was necessary, given the relatively small number...
of participants at each stage, and the high female-to-male participant ratio throughout all stages.

The one-way ANOVA results for comparison of DA and SA scores obtained by male and female participants are summarised in Tables 4.10 and 4.11.

<table>
<thead>
<tr>
<th></th>
<th>Sum of Squares</th>
<th>df</th>
<th>Mean Square</th>
<th>F</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>DA</td>
<td>Between Groups</td>
<td>2.273</td>
<td>1</td>
<td>2.273</td>
<td>.066</td>
</tr>
<tr>
<td></td>
<td>Within Groups</td>
<td>2459.946</td>
<td>71</td>
<td>34.647</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>2462.219</td>
<td>72</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 4.10. One-way ANOVA results for inter-gender comparison of DA scores

<table>
<thead>
<tr>
<th></th>
<th>Sum of Squares</th>
<th>df</th>
<th>Mean Square</th>
<th>F</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>SA</td>
<td>Between Groups</td>
<td>48.073</td>
<td>1</td>
<td>48.073</td>
<td>1.155</td>
</tr>
<tr>
<td></td>
<td>Within Groups</td>
<td>2954.420</td>
<td>71</td>
<td>41.612</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>3002.493</td>
<td>72</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 4.11. One-way ANOVA results for inter-gender comparison of SA scores

The inter-gender differences in DA and SA scores were not significant. No post-hoc analyses of inter-stage DA and SA scores with respect to stage were therefore required.

4.3.7 Comparison of DA and SA scores by age
Correlational analysis using the Pearson product moment coefficient was undertaken to ascertain whether any relationship existed between SAL and participant age. Data for all four stages was pooled for this analysis, as there were insufficient participant numbers for intra-stage analyses of age-related data.

No statistically significant correlation was found between age and DA, and age and SA.
4.4 Module assessment scores

4.4.1 Normality testing of assessment data
The Shapiro-Wilk normality test (McCrum-Gardner, 2008) was applied to assessment data in this study. This analysis was undertaken separately for each stage module (Appendix D).

All stage 1 and 2 assessment data were normally distributed. Stage 3 assessment data was normally distributed with the exception of the Literature Review Assignment score, which showed a non-normal distribution. Stage 4 assessment scores were normally distributed for MCQ (Written) and Case Study Question data, and non-normally distributed for MCQ (Online) and Written Theory Questions scores. Although there were mixed distributions of data, the majority of assessment data were normally distributed. Parametric data analysis procedures were therefore selected for further data analyses.

No intra-stage assessment data differences were explored as the assessment scores were for a range of different types of assessments, which would normally deliver different results due to the nature of the assessment type. Similarly, no inter-stage assessment data differences were explored as the assessment scores were associated with marks from different modules. Such an inter-stage comparative analysis would therefore not be considered to be valid as SAL is considered to be learning context-specific.

4.4.2 Descriptive statistics
Descriptive statistics were calculated for each of the assessment types within each stage.

Descriptive statistics for assessment scores for each stage are presented in Tables 4.12 to 4.15. All scores are given as percentage values.
Table 4.12. Descriptive statistics for stage 1 assessment scores

<table>
<thead>
<tr>
<th>Assessment Type</th>
<th>Mean</th>
<th>Standard Deviation (SD)</th>
<th>Minimum</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>MCQ (Online)</td>
<td>79.2</td>
<td>10.3</td>
<td>55.0</td>
<td>95.0</td>
</tr>
<tr>
<td>MCQ (written)</td>
<td>68.4</td>
<td>16.3</td>
<td>40.0</td>
<td>91.0</td>
</tr>
<tr>
<td>Written Theory Questions</td>
<td>54.1</td>
<td>14.2</td>
<td>21.0</td>
<td>76.0</td>
</tr>
<tr>
<td>Lab Report</td>
<td>63.4</td>
<td>8.2</td>
<td>50.0</td>
<td>80.0</td>
</tr>
</tbody>
</table>

Table 4.13. Descriptive statistics for stage 2 assessment scores

<table>
<thead>
<tr>
<th>Assessment Type</th>
<th>Mean</th>
<th>Standard Deviation (SD)</th>
<th>Minimum</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>MCQ (written)</td>
<td>71.2</td>
<td>11.4</td>
<td>45.0</td>
<td>85.0</td>
</tr>
<tr>
<td>Written Theory Questions</td>
<td>76.9</td>
<td>11.0</td>
<td>51.0</td>
<td>91.0</td>
</tr>
<tr>
<td>Practical Skills Assessment</td>
<td>82.2</td>
<td>6.3</td>
<td>71.0</td>
<td>91.0</td>
</tr>
</tbody>
</table>

Table 4.14. Descriptive statistics for stage 3 assessment scores

<table>
<thead>
<tr>
<th>Assessment Type</th>
<th>Mean</th>
<th>Standard Deviation (SD)</th>
<th>Minimum</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>MCQ (Online)</td>
<td>91.1</td>
<td>6.7</td>
<td>80.0</td>
<td>100.0</td>
</tr>
<tr>
<td>MCQ (Written)</td>
<td>77.0</td>
<td>8.7</td>
<td>60.0</td>
<td>90.0</td>
</tr>
<tr>
<td>Written Theory Questions</td>
<td>74.2</td>
<td>12.3</td>
<td>47.0</td>
<td>89.0</td>
</tr>
<tr>
<td>Case Study Questions</td>
<td>58.0</td>
<td>11.9</td>
<td>42.0</td>
<td>84.0</td>
</tr>
</tbody>
</table>

Table 4.15. Descriptive statistics for stage 4 assessment scores

4.5 Analysis of SAL by assessment score

Correlational analysis using the Pearson product moment coefficient was carried out to identify and quantify the relationship between SAL scores and assessment scores associated with each type of assessment in each stage. The assessment scores are presented as composite percentage-based scores obtained by a participant for each of
a range of assessment types within a stage. Such correlational analyses to explore the relationship between SAL and assessment scores had previously been undertaken by Byrne et al. (2002), Gijbels et al. (2005), Yonker (2011), Jayawardena et al. (2013), Weller et al. (2013) and Henoch et al. (2014). The reporting of the Pearson’s product moment correlation coefficient results as presented here follow the recommended format of Cohen et al. (2011). Data is also presented graphically in the form of scatterplots where the correlational relationship between variables is calculated as significant.

4.5.1 Stage 1 analyses

The ‘MCQ (Online)’ score represents the composite mark, expressed in percentage form, for open-book, timed online (electronic) MCQ assessments. The ‘MCQ (Written)’ score represents the composite percentage mark calculated for the results of hand-answered MCQs from both the in-class written assessment and those in the end-of-module examination. Similarly, the ‘Written Theory Questions’ score represents a composite mark from short theory questions in the in class written assessment and the end-of-module examination. The ‘Lab Report’ score represents the percentage mark obtained for a single lab report for one laboratory session only.

Only one significant result was obtained for this stage. A statistically significant positive correlation was found between the DA score and the MCQ (Online) score ($r = 0.489, p = 0.034$). Therefore, higher DA scores are associated with higher MCQ (Online) scores. The converse may also hold true, where lower DA scores may be associated with lower MCQ (Online) scores. This is represented by Figure 4.10.
No statistically significant correlation was identified between the DA score and the following assessment scores: the MCQ (Written) score ($r = -0.008, p = 0.974$); the Written Theory Question score ($r = -0.055, p = 0.822$); the Lab Report score ($r = 0.262, p = 0.279$). There was no statistically significant correlation between the SA score and the following assessment scores: MCQ (Online) score ($r = -0.018, p = 0.941$); MCQ (Written) score ($r = -0.216, p = 0.375$); Written Theory Question score ($r = -0.121, p = 0.621$); Lab Report score ($r = -0.116, p = 0.635$).

### 4.5.2 Stage 2 analyses

The ‘MCQ (Written)’ score represents the composite percentage mark calculated for the results of hand-answered MCQs from both the in-class written assessment and those in the end-of-module examination. Similarly, the ‘Written Theory Questions’ score represents a composite mark from short theory questions in the in class written assessment and the end-of-module examination. The ‘Practical Skills Assessment’ mark is percentage mark from a single practical laboratory skills assessment, as there was only one such assessment offered during this module.

There were no statistically significant correlations identified between the DA score and the following assessment scores: the MCQ (Written) score ($r = 0.226, p = 0.049$); the Written Theory Question score ($r = -0.055, p = 0.822$); the Lab Report score ($r = 0.262, p = 0.279$). There was no statistically significant correlation between the SA score and the following assessment scores: MCQ (Online) score ($r = -0.018, p = 0.941$); MCQ (Written) score ($r = -0.216, p = 0.375$); Written Theory Question score ($r = -0.121, p = 0.621$); Lab Report score ($r = -0.116, p = 0.635$).
the Written Theory Question score (\( r = 0.145, p = 0.637 \)); the Practical Skills Assessment score (\( r = 0.127, p = 0.679 \)). Similarly, there were no statistically significant correlations between the SA score and the following assessment scores: the MCQ (Written) score (\( r = -0.250, p = 0.411 \)); Written Theory Question score (\( r = 0.045, p = 0.883 \)); Practical Skills Assessment score (\( r = 0.303, p = 0.313 \)).

4.5.3 Stage 3 analyses

The ‘Written Theory Questions’ score represents a composite mark from short theory questions in the in class written assessment and the end-of-module examination. The ‘Lab Report’ score represents the percentage mark obtained for a single lab report. The ‘Literature Review Assignment’ result reflects the percentage mark obtained for a written submission of scientific literature analysis and review.

A statistically significant positive correlation was found between the DA score and the Written Theory Questions score (\( r = 0.516, p = 0.028 \)). Therefore, higher DA scores are likely to be associated with higher Written Theory Question scores. The converse would also apply where lower DA scores are likely to be associated with lower Written Theory Question scores. This is represented by Figure 4.11.

**Figure 4.11.** Scatterplot of Deep Approach (DA) score v. Written Theory Question score
There was a statistically significant positive correlation found between the DA score and the Literature Review Assignment score ($r = 0.532, p = 0.027$). Therefore, higher DA scores are likely to be associated with higher Literature Review Assignment scores, while lower DA scores are likely to be associated with lower Literature Review Assignment scores. This is shown by the scatterplot in Figure 4.12.

![Scatterplot of Deep Approach (DA) score v. literature review assignment score](image)

**Figure 4.12.** Scatterplot of Deep Approach (DA) score v. literature review assignment score

There was no statistically significant correlation between the DA score and the Lab Report score ($r = 0.101, p = 0.689$). There was no statistically significant correlation found between the SA score and the following assessment scores: the Written Theory Question score ($r = -0.145, p = 0.567$); the Literature Review Assignment score ($r = -0.116, p = 0.635$); the Lab Report score ($r = 0.108, p = 0.670$).

### 4.5.4 Stage 4 analyses

The ‘MCQ (Online)’ score represents the composite mark represented in percentage form for open-book, timed online (electronic) MCQ assessments. The ‘MCQ (Written)’ score represents the composite percentage mark calculated for the results of hand-anwered MCQs from both the in-class written assessment and those in the
end-of-module examination. Similarly, the ‘Written Theory Questions’ score represents a composite mark from short theory questions in the in class written assessment and the end-of-module examination. The ‘Case Study Question’ mark represents a composite percentage mark from case study-style application-of-theory questions from the in class written assessment and the end-of-module examination.

A statistically significant negative correlation was found between the SA score and the MCQ (Written) score \((r = -0.459, p = 0.028)\). Therefore, lower SA scores may be associated with higher MCQ (Written) scores. The opposite may also apply where higher SA scores are associated with lower MCQ (Written) scores. This is illustrated in Figure 4.13.

![Figure 4.13. Scatterplot of Surface Approach (SA) score v. MCQ (written) score](image)

A statistically significant negative correlation was also found between the SA score and the Case Study Question score \((r = -0.518, p = 0.011)\). Therefore, lower SA scores may be associated with higher Case Study Question scores. The opposite may also hold true in that higher SA scores are associated with lower Case Study Question scores. This is illustrated in Figure 4.14.

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No statistically significant correlations were found between the DA score and the following assessment scores: the MCQ (Online) score ($r = -0.143$, $p = 0.515$); MCQ (Written) score ($r = 0.341$, $p = 0.112$); Written Theory Question score ($r = 0.241$, $p = 0.269$); Case Study Question score ($r = 0.371$, $p = 0.081$). No statistically significant correlations were found between the SA score and the MCQ (Online) score ($r = 0.020$, $p = 0.927$); Written Theory Question score ($r = -0.113$, $p = 0.606$).

These findings are further explored in relation to the findings of previous studies in the next chapter.

**Figure 4.14.** Scatterplot of Surface Approach (SA) score v. Case Study Question score
Chapter 5: Discussion

The main aim of this study was to use the R-SPQ-2F questionnaire (Biggs et al., 2001) to investigate undergraduate optometry student deep and surface approaches to learning (SALs). The relationship between SAL and participant gender, age and academic achievement was also explored. This chapter commences with a discussion of methodological considerations, then proceeds to describe the results of the data analysis, examining the significance of these findings relative to the literature, and ends with a description of the limitations and delimitations of this study.

5.1 Methodological considerations

An overall participant response rate of 89% was achieved. This is slightly higher than that of Emilia et al. (2012), who achieved a response rate of 82% in their investigation of medical student SALs. The 89% response rate here is well in excess of Weller et al.’s (2013) response rate of 34% in their study of SALs in anaesthetics students. Higher response rates lead to smaller condense intervals around sample statistics. The response rate is one indicator that can be used to determine the potential contribution of a study to a specific body of knowledge (Baruch & Holtom, 2008). The participant response rate as achieved for this study is high and it can therefore be assumed that the information arising from this study provides a significant insight into the SALs of optometry students. This high response rate is used to justify the extrapolation of findings from this study to the general population of optometry undergraduate students, despite the fact that convenience, instead of random, sampling was used. The use of this latter method of sampling would not have been appropriate to this study, as it would have rendered a participant study sample that is too small for the results to be regarded as valid. The use of convenience sampling ensured that the participant sample was sufficiently large to justify the use of further statistical analysis of results and the interpretation of such.

The validity and internal consistency of the R-SPQ-2F questionnaire main scales: deep approach (DA) and surface approach (SA), was established using Cronbach’s alpha coefficient. The Cronbach’s alpha statistic for the DA scale ranged
from 0.61 to 0.85 when considering questionnaire responses for each of the stages individually and in combination in this study. The DA scale Cronbach alpha statistic, 0.77, obtained here for pooled data across all stages, is similar to that of Biggs et al. (2001), Yonker (2011), Henoch et al. (2014), Mogre & Amalba (2014) and Kyndt et al. (2012), reporting DA scores of 0.73, 0.74, 0.75, 0.80 and 0.83 respectively. The Cronbach’s alpha statistic of 0.82 for the DA score for stage 4 participants in this study is similar to that of Weller et al. (2013), who recorded an alpha value of 0.82 and Kyndt et al. (2012), recording an alpha value of 0.81. The Cronbach’s alpha statistic for the SA scores in this study ranged from 0.71 to 0.88. The stage 3 Cronbach’s alpha statistic was 0.71, which is similar to Weller et al.’s (2013) alpha value of 0.74 and less than Mogre and Amalba (2014) and Kyndt et al.’s (2012) alpha values of 0.76 and 0.79 respectively. However, the SA scale Cronbach’s alpha in this study was higher than the alpha statistics calculated by Biggs et al. (2001), Yonker (2011) and Henoch et al. (2014), who recorded alpha values of 0.64, 0.68 and 0.67 respectively. According to Cohen et al. (2011), Cronbach alpha statistic values above 0.70, such as with the R-SPQ-2F main scale scores in this study, are indicative of good internal consistency of data. It is therefore assumed that a clear distinction is made within the questionnaire between the items relating to deep and surface learning approaches (Weller et al., 2013).

Using Cohen et al.’s (2011) guidelines for interpretation of the Cronbach alpha statistic (Table 4.1), all Cronbach alpha statistics for all DA and SA scores met the requirement of full or marginal reliability. No internal validity was established for participant responses related to the subscales of the R-SPQ-2F, deep motive (DM), deep strategic (DS), surface motive (SM) and surface strategic (SS) scores in this study. Yonker (2011) also demonstrated internal consistency of the R-SPQ-2F main scales only, while failing to validate the subscale measures. These subscales consist of the same questions as used in the main scales, used in different combinations. All participant responses therefore remain valid in this study, but only in the combinations presented by DA and SA (R-SPQ-2Fmain scale) combinations. As this study investigated the implementation of the R-SPQ-2F, and not the development of it, further discussion as to why subscale scores were found to lack internal validity is beyond the scope of this study. Once the validity and internal consistency of the R-
SPQ-2F main scales had been confirmed, only the DA and SA scores were analysed in relation to participant stage of study, gender, and age and assessment scores.

5.2 Discussion of results

Some of the data analyses in this study included pooling of data from all stages and exploring the inter-stage differences for other analyses. It should however be noted that the context of learning and teaching has a strong influence on the SAL adopted when studying (Marton & Säljö, 1976; Entwistle, 1991; Almeida et al., 2011; Emilia et al., 2012). Therefore, the results that arise from pooled data across all stages and inter-stage differences should be considered with this in mind. These analyses were undertaken to explore whether such differences may exist, regardless of the context of delivery and assessment. It is the intention that these analyses be applied in future iterations and extensions of this study when the SALs of undergraduate optometry students are investigated within the framework of a longitudinal study. The results are discussed with reference to the original stated study hypotheses and how these findings relate to those published previously.

Hypothesis H1
A statistically significant correlation exists between SAL scores for each stage separately and for all stages combined.

The average DA scores were slightly higher than the SA scores for each stage considered separately and all stages combined in this study when the R-SPQ-2F was administered to undergraduate optometry students. The overall mean DA score in this study was 29.5 ± 5.85 (range 28.3 – 31.2), with an overall mean SA score of 24.8 ± 6.46 (range 23.5 – 26.8). Mogre and Amalba (2014) recorded a mean DA score of 31.23 ± 7.19 and mean SA score of 22.62 ± 6.48. Jayawardena et al. (2013) similarly reported mean DA and SA scores of 31.79 ± 6.1 and 22.74 ± 5.5 respectively. The DA preference of optometry students is therefore similar to that shown in medical and dental students in these latter two studies. However, Weller et al.’s (2013) conclusion differed, finding these mean scores as 10.18 ± 5.69 and 10.82 ± 6.49 respectively, showing a marginal preference for SA in medical students. Following this analysis,
the first hypothesis (H1) was not supported for participants in stages 1, 2 and 3, where no significant correlation was found between DA and SA scores. The associated null hypothesis (H10) is therefore supported for these stages. The H1 was however supported by the significant negative correlation found between the DA and SA scores for stage 4 participants ($r = -0.46, p = 0.027$). The H1 was also supported for all stages combined, as evidenced by the significant negative correlation between DA and SA scores ($r = -0.303, p = 0.009$). The associated H10 therefore lacks support for stage 4 and combined stage DA and SA participant data. This negative correlation between DA and SA is in keeping with the findings of Jayawardena et al. (2013), but their study lacked evidence in proving the significance of this correlation. This negative correlational relationship between DA and SA in this study supports Henoch et al. (2014)’s proposal that it would be expected that students adopting a higher level of DA would have an associated lower level of SA, and that the opposite assumption would also hold true. However, the correlational analyses for stages 1, 2 and 3 suggest that this is not the case. Henoch et al. (2014) suggest that the Cronbach’s alpha statistic be included in the interpretation of these correlations in that a lower alpha statistic would indicate less reliability. There is not a large difference in the Cronbach alpha statistics obtained for both DA and SA scores across all stages in this study. Henoch et al.’s (2014) assumption of lesser reliability of one of the scale scores cannot be applied to the interpretation of the results of the correlational analyses in this study.

**Hypothesis H2**

A statistically significant difference exists between SAL scores within each stage.

The second hypothesis (H2) was supported for stages 1 ($p < 0.001$), 3 ($p = 0.014$) and all stages combined ($p < 0.001$), as the difference between the DA and SA scores were shown to be statistically significant for these groups. This is consistent with Jayawardena et al.’s (2013) findings of a statistically significant difference between DA and SA scores of medical students. The null hypothesis (H20) was not supported for either of these stages. The H2 was not supported for stages 2 and 4 as the differences between DA and SA scores for these stages were found to be statistically insignificant, thereby lending support for the associated H20. The context of questionnaire completion should be considered when interpreting the SAL scores for
stage 1 participants. In this study, 18 out of 19 participants (95%) in stage 1 showed a DA preference. This is contradictory to the assumptions that students tend to be very goal-orientated, often entering higher education from a secondary school background that encourages rote learning, and therefore, adopting a SA to learning, as the basis for academic success. Students who enter higher education with such a restricted conception of learning as an activity that emphasises reproduction of information are therefore likely also to adopt ineffective ways of studying, including adoption of a SA. Such students are likely to transfer the perceptions of their learning environment at school to learning in tertiary education (Entwistle, 1991).

Hypothesis H3
A statistically significant inter-stage difference exists between SAL scores.

The third hypothesis (H3) was not supported by the findings of this study, in that there were no statistically significant inter-stage differences between participant SALs. This instead suggests that the null hypothesis (H30) should be adopted. The literature does not provide comparative analyses. This is likely due to the assumption that as SALs are context-related, such an inter-stage analysis constituting a between-participants design is not likely to deliver informative results. Although not significant, the overall mean DA scores for stage 1 participants could be explained by a subjective response bias for this participant group. The results of the cross-sectional study discussed here are not directly comparable to those of Fox et al. (2001), as this latter study was a longitudinal study, where the R-SPQ-2F was used over a period of time to monitor the temporal stability of the SALs of 1,349 medical students.

Hypothesis H4
A statistically significant difference exists between SAL scores of male and female participants for all stages combined.

In testing the fourth hypothesis (H4), it was found that there were no statistically significant differences in SALs for male and female participants, suggesting that there was no support for H4, and instead, that the associated null hypothesis (H40) should be adopted. This is consistent with Byrne et al.’s (2002) finding when studying SALs of accounting students using the R-SPQ-2F, but is not consistent with Chiou et
al.’s (2012) finding of differences between male and female nursing students when measuring SALs using the Conceptions of Learning Biology (COLB) and Approaches to Learning Biology (ALB) instruments. Gijbels et al. (2005) noted that male law students generally had higher mean DA scores than female law students. However, Chiou et al. (2012) mentions that there is considerable variability in results of studies which have attempted to relate learning approach and gender (Chiou et al., 2012).

**Hypothesis H5**

A statistically significant correlation exists between SAL scores and participant age for all stages combined.

The fifth hypothesis (H5) was not supported as there was no statistically significant correlation between SAL scores and participant age. This suggests support for the associated null hypothesis (H50). This finding is in contrast with that of previous published findings. Zeegers (2001) used the Study Process Questionnaire to study the SALs of 227 chemistry students, aged 17-55, with an average age of 22.2 years. Zeeger’s (2001) results show a positive correlation between age and deeper approaches to learning. Gijbels et al. (2005), using the R-SPQ-2F instrument, found that older students had a higher mean DA score in a sample of 133 second-year law students, with an average age of 20.6 years. Gijbel et al.’s (2005) study did not include the range of participant ages. Yonker’s (2011) study of 56 psychology students, aged 18-52 years, with an average age of 22.2 years, showed a strong positive correlation between age and MCQ performance, which in turn was found to be negatively correlated with the surface approach to learning, as measured using the R-SPQ-2F instrument.

As the sample in each stage is relatively small for such statistical analyses, the SAL data were combined across all stages during the exploration of gender-based and age-based differences in DA and SA. This contradicts the assumption that the SAL is context-specific and can account for the lack of significance of the results obtained for these analyses in this study. This apparent lack of a relationship between gender and age with SAL, as shown by the results of this study should therefore not be assumed to be representative of the DA and SA relationship to gender and age for all undergraduate optometry students. This lack of a large enough sample – in
comparison with previous studies – at each stage, is the likely cause of a lack of significant correlations between age and SAL scores, and possibly also influences the lack of gender differences in SALs noted in this study.

**Hypothesis H6**  
*A statistically significant correlation exists between SAL scores and assessment scores for each stage.*

The sixth hypothesis (H6) is partially supported by the findings of this study for stages 1, 3 and 4, but was not supported for stage 2 participants. The discussion of results here is presented for each stage separately, as the module representing each stage was associated with unique assessments for that module. The results of the statistical analyses related to this hypothesis are summarised in Tables 5.1 to 5.4 for stages 1, 2, 3 and 4 respectively.

Stage 1 analysis in relation to testing hypothesis H6 show that the DA scores are positively correlated with the MCQ (Online) score (Table 5.1).

<table>
<thead>
<tr>
<th>Stage 1</th>
<th>DA score</th>
<th>SA score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Significant findings (supporting H6)</td>
<td>MCQ (Online) score</td>
<td></td>
</tr>
<tr>
<td></td>
<td>( r = 0.489, p = 0.034 )</td>
<td></td>
</tr>
<tr>
<td>Non-significant findings (supporting H6( _0 ))</td>
<td>MCQ (Written) score</td>
<td>MCQ (Online) score</td>
</tr>
<tr>
<td></td>
<td>Written Theory Questions score</td>
<td>MCQ (Written) score</td>
</tr>
<tr>
<td></td>
<td>Lab Report score</td>
<td>Written Theory Questions score</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Lab Report score</td>
</tr>
</tbody>
</table>

**Table 5.1. Summary of statistical analyses related to H6 (stage 1)**

The MCQ (Online) score was the average score for a number of open-book, timed online assessments where students had to study lecture notes and review online resources, such as short videos, prior to completing the assessments. Jayawardena et al. (2013) proposed that open-book tests are expected to stimulate the use of a DA. The positive correlation of the MCQ (Online) scores with DA score could be explained by the fact that more visual learning tools, such as videos, were used to consolidate and support material delivered in class. Students could access this supporting material
multiple times before attempted the timed assessment. The stronger correlation with DA measures for this assessment could also be due to students feeling under less pressure undertaking these assessments, as they were focussed on one specific subject area and tested within a context that facilitated students in accessing the material that they needed to answer the questions. Although a review of the literature has revealed studies of the use of MCQs as an effective academic assessment tool to promote higher-order thinking and assessment thereof (e.g. Fellenz, 2004; Brady, 2005; Donnelly, 2014) and the context of delivery of MCQs, including through e-assessment (e.g. Nicol, 2007), specific details about the period of time that students have access to support materials and flexibility of the timing of the assessment are not specifically addressed in these studies. As the assessments were made available to students over a period of time where they could manage their own learning and assessment timing, it is likely that this reduced time pressure relative to some of the other assessment types may have encouraged adoption of a DA when learning, as a perceived or real lack of time in relation to the assessment deadline is more likely to lead to the adoption of a SA (Clarke, 1986; Gow & Kember, 1990; Yonker, 2011).

This is in contrast with the MCQs (Written) and Written Theory Questions, which were delivered within the context of a longer assessment, with a fixed time limit, counting more towards the final module mark, and was closed book, in that it did not facilitate students in accessing their learning materials during the assessment. As these were assessments for first year students, with most of them new to the higher education environment, the MCQ (Online) format could have been perceived as being less overwhelming in terms of the shortened format and that the students could undertake them at a time and place that suited them. Whereas, these students were still making the transition to higher education, and the more formalised MCQ (Written) and Written Theory Questions test and examination formats could have created a more stressful environment for these students, with this assessment environment not being conducive to adoption of a deep approach for learning during student preparation for such assessments.

There were no significant correlations between DA and SA scores and assessment scores for stage 2 participants (Table 5.2).
<table>
<thead>
<tr>
<th>Stage 2</th>
<th>DA score</th>
<th>SA score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-significant findings (supporting H6&lt;sub&gt;0&lt;/sub&gt;)</td>
<td>MCQ (Written) score</td>
<td>MCQ (Written) score</td>
</tr>
<tr>
<td></td>
<td>Written Theory Questions score</td>
<td>Written Theory Questions score</td>
</tr>
<tr>
<td></td>
<td>Practical Skills Assessment score</td>
<td>Practical Skills Assessment score</td>
</tr>
</tbody>
</table>

Table 5.2. Summary of statistical analyses related to H6 (stage 2)

This lack of statistical significance could also be related to the fact that a variety of teaching staff were involved in the delivery and assessments for this module, therefore introducing some variability in these factors.

Stage 3 analyses in relation to testing hypothesis H6 show that the DA scores are positively correlated with the Written Theory Questions score and the Literature Review Assignment score (Table 5.3).

<table>
<thead>
<tr>
<th>Stage 3</th>
<th>DA score</th>
<th>SA score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Significant findings (supporting H6)</td>
<td>Written Theory Questions score &lt;br&gt;( r = 0.516, p = 0.028 )</td>
<td>Written Theory Questions score &lt;br&gt;( r = 0.532, p = 0.027 )</td>
</tr>
<tr>
<td></td>
<td>Literature Review Assignment score &lt;br&gt;( r = 0.532, p = 0.027 )</td>
<td>Literature Review Assignment score &lt;br&gt;( r = 0.532, p = 0.027 )</td>
</tr>
<tr>
<td>Non-significant findings (supporting H6&lt;sub&gt;0&lt;/sub&gt;)</td>
<td>Lab Report score</td>
<td>Lab Report score</td>
</tr>
</tbody>
</table>

Table 5.3. Summary of statistical analyses related to H6 (stage 3)

The positive correlation between DA and Written Theory Question score supports Yonker's (2011) and Jayawardena et al.'s (2013) findings that the DA score is positively correlated with written short answer assessment scores. Assignment essays appear to be an assessment method that can effectively distinguish between deep students and surface students in academic performance, and encourages the former while discouraging the latter. Surface learning may, no matter whether it is used as a general approach to learning or a specific approach to preparation for
assessment, lead to poor academic performance in assignment essays (Tian, 2007; Scouller, 2008).

Stage 4 analyses in relation to testing hypothesis H6 show that the SA scores are negatively correlated with the MCQ (Written) Questions score and the Case Study Question scores respectively (Table 5.4).

<table>
<thead>
<tr>
<th>Stage 4</th>
<th>DA score</th>
<th>SA score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Significant findings</td>
<td></td>
<td>MCQ (Written) score</td>
</tr>
<tr>
<td>(supporting H6)</td>
<td></td>
<td>$(r = -0.459, p = 0.028)$ Case Study Question score $(r = -0.518, p = 0.011)$</td>
</tr>
<tr>
<td>Non-significant findings (supporting H6a)</td>
<td>MCQ (Online) score</td>
<td>MCQ (Online) score</td>
</tr>
<tr>
<td></td>
<td>MCQ (Written) score</td>
<td>Written Theory Question score</td>
</tr>
<tr>
<td></td>
<td>Written Theory Question score</td>
<td>Case Study Question score</td>
</tr>
</tbody>
</table>

Table 5.4. Summary of statistical analyses related to H6 (stage 4)

This negative correlation between the SA score and the MCQ (Written) scores was also found by Yonker (2011) who explored the association between SA score and MCQs in psychology students, although the strength of correlation $(r = -0.459)$ in this study was stronger than that $(r = -0.33)$ found by Yonker (2011). Yonker’s (2011) study also showed that this effect was more pronounced than when assessing potential benefits that a DA could have on MCQ assessment scores. These statistically significant relationships where a higher SA score is associated with lower MCQ (Written) and Case Study Question scores supports the conclusion that understanding of learning material is more inhibited by a SA than it is positively associated with a DA (Trigwell & Prosser, 1991a). This was further illustrated by Trigwell and Prosser (1991b) who suggested that measures of learning outcome, such as assessment scores, have been more successful in highlighting the association between SAs and poor academic performance than illustrating the relationship between DA and higher academic scores. These findings are in contrast with those of Weller et al. (2013) who found a positive correlation between SA scores and performance in MCQ assessments. Similar positive correlations between DA scores and academic performance were
shown by researchers using other measures of SALs and learning outcomes in non-
health related disciplines (Newstead, 1992; Sadler-Smith, cited in Diseth & Martinsen,
2003; Diseth & Martinsen, 2003; Diseth, 2007), but it should be noted that the
correlations found in these studies were weak.

The inconsistency of correlations between SAL and MCQ assessment scores
found in this study is most likely due to the lack of differentiation of MCQ questions
within the assessment. Scouller (1998) suggested that students preparing for an MCQ
assessment are more likely to adopt a SA. This was not supported in the findings of
this study. Yonker (2011) further categorised MCQ tests into ‘factual’ and ‘applied’,
with the latter testing higher-level cognitive processing. Similarly, Gijbels et al.
(2005) adopted a sub-classification for MCQ questions along the lines of the three
aspects of knowledge structure: understanding of concepts: understanding of the
principles that link concepts and linking of concepts and principles to application
conditions and procedures. Distinctions such as those made by Yonker (2011) and
Gijbels et al. (2005) were not applied to the MCQs in this study, as all MCQ data was
pooled together for analysis. Adoption of a sub-classification system for MCQs would
likely have elicited more significant correlational findings between SAL and MCQ
assessment outcomes, although the sample size in this study might not have been large
enough to support the statistical viability of such a sub-classification.

Weller et al. (2013) suggests that there are strong arguments to retain MCQs
as an assessment format, as they are considered to be highly reliable and can test higher
levels of learning in the form of assessing problem-solving ability, rather than just
factual recall, facilitating testing of knowledge broadly across a syllabus. The focus
should therefore be on improving the quality of MCQ assessments to facilitate
assessment of both ‘deep’ and ‘surface’ aspects of learning material. However,
Gijbels et al. (2005) argues that there is no evidence that a DA could be more effective
for questions assessing more complex components of problem-solving. Scouller
(1998) suggests that some students may be disadvantaged when employing deep
learning strategies when preparing for some examination formats. A more rigorous
application of Biggs structure of the observed learning outcome (SOLO) taxonomy to
the compilation of MCQ assessments to facilitate closer constructive alignment with
module learning outcomes may be warranted in developing these MCQ assessments
as a means of fostering a DA to learning (Biggs, 1996). However, Biggs et al. (2001) do not refer to the role that the Biggs SOLO taxonomy plays in the relationship between SALs and assessment scores. Further exploration of contextual factors influencing student performance on MCQs (e.g. Nicol, 2007) and how to promote deeper learning through MCQ assessments (e.g. Brady, 2005; Fellenz, 2004; Donnelly, 2014) should be undertaken with a view to enhancing this as a means of assessment for undergraduate optometry students.

Overall, the comparisons of the findings in this study with results obtained using the R-SPQ-2F to elicit SALs in other health science and medical education settings should be used as a general guideline only, as SALs have been shown to be discipline-specific (Chiou et al., 2012). However, this cross-discipline comparison of data was necessary as there is currently a dearth of information relating to SALs in optometric education. The findings of this study show that there is intra-and inter-stage inconsistency regarding both the SAL trends and the relationships between DA and SA. This inconsistency is also apparent in the relationship between SALs and assessment outcomes for similarly-defined assessments in different stages. As the SAL is context-dependent, participants were asked to tailor their R-SPQ-2F responses to their SAL for a particular module which was identified to them. This inconsistency of findings here could be grounded in the differences in the learning contexts that the students encounter for each of these modules, as the SAL is significantly influenced by context, which includes the demands of the assessment format and material being assessed (Marton & Säljö, 1976; Entwistle, 1991; Almeida et al., 2011; Emilia et al., 2012). The DA and SA values from the literature presented here for comparative purposes are for different health professions, so would be expected to differ between health disciplines. The small differences in SALs in this study suggest that contextual or environmental variables as well as individual perceptions of these variables influence students’ use of deep or surface approaches to learning tasks (Emilia et al., 2012).

Overview discussion of findings of study
Student participants in this study were asked to complete the R-SPQ-2F questionnaire with reference to a named module, at a particular point in time. This essentially
provided an instantaneous snapshot of the student’s attitudes and opinions of his or her SALs. This does not necessarily capture the student’s SAL adopted throughout a module of study, taking into account the varied demands of different assessment types. Attempts to quantify the SAL may fail to capture the complexities of the variables, including the context of learning, influencing the adoption of a SAL by a student (Balasooriya et al.; Byrne et al., 2001; Stes et al., 2013). The temporal stability of the SAL for the duration of a module also needs to be considered. As Vermetten et al. (1999) and Zeegers (2001) consider the SAL to be dynamic, it is likely to be temporally variable. The adoption of a DA and SA may thus change as a student works, according to the demands of the materials and the learning environment, including assessment format and deadlines and the associated amount of time that a student has to learn the information. The finding of a SA does not necessarily mean that the student is generally a ‘surface’ learner, but rather, that the student adopts such a SAL on the basis that this is deemed to be the most successful strategy for success. Consecutive adoption of SALs is therefore possible, but simultaneous SAL for the same task at the same moment in time is not possible (University of Oxford, 2014). This method of instantaneous SAL measurement therefore does not facilitate identification of the potential inter-changeability of SALs by a single student in response to the demands of the learning and assessment environment (Chiou et al., 2012; University of Oxford, 2014).

Students engaging in higher-order thinking associated with a DA are more likely to be successful in an HEI environment (Entwistle et al., 2001), although this association between DA and all factors contributing to success in the HEI environment have not been explored comprehensively in the literature. This is likely due to the complexity of the highly individual interactions between personological and environmental factors in these environments. This bodes well for the majority of participants in this study who favoured a DA to learning, but it should be recognised that some participants favoured a SA. The challenge for the lecturer and student is to know when and under what circumstances to promote each SAL, as there is place for both DA and SA in the learning environment (Yonker, 2011). Weller et al. (2013) recognises that the content of some learning material may require memorisation of
material, but that overall a DA to learning, where theory and practice are better integrated, should be encouraged.

It is further suggested that the SALs should be considered as an indication of the quality of a programme of study or assessment, rather than an indication of some stable trait of a student. This is in agreement with Byrne et al.’s (2002) assertion that, given the driving influence of assessment format on SAL selection, all assessments must be appropriately set to achieve the desired learning outcomes. The assessment format differences between stages in this study could account for variability of the results obtained within and across stages when analysing the relationship between SAL and assessment score. The examination procedure and the nature of the curriculum might be partially responsible for the missing relationship between DA and academic achievement (Diseth & Martinsen, 2003), as is evidenced by the lack of an overwhelming association between DA scores and learning outcome across all assessments and stages in this study. However, this is being addressed as the DIT is increasingly requiring a closer alignment between assessments and learning outcomes by the adoption of a new module template, which links specific learning outcomes to assessments. This has not been adopted for all DT224 modules yet, but it is envisaged that there will be an increase in the adoption of such module descriptor formats expected as part of the next routine review of the programme.

The amount of lecturer support that a student receives in preparing for the assessment format and content could also be a factor in the selection of SAL when preparing for assessments (Ramsden, 1979). It is possible that students who are exposed to a bank of past questions and mock assessments prior to the core assessments may favour a SA as they prepare for an examination. Weller et al. (2013) suggested that prior exposure to a database of past MCQ questions could be the reason that students preparing for specialist anaesthetics examinations adopt a SA, as they are only required to memorise the past questions in order to achieve a successful outcome. The level of direct lecturer assistance in the form of databases of past questions and mock assessments was not included in the analysis of SALs in this study, but should be considered for future iterations of such a study.

According to Socha and Sigler (2014), the teaching and learning environment should be adapted to encourage students to move away from a SA to a DA of learning.
Although Reid et al. (2012) found that when addressing the learning environment for medical students, efforts to promote a DA resulted in little significant change in the assessment scores of students, they found a slight tendency towards a reduction in the SA. They concluded that the SALs may be resistant to significant change, or that further significant modifications of the learning environment are needed in order to further encourage the increased adoption of a DA by students. This was further supported by Fox et al. (2001) who showed that SALs are partly stable during medical school undergraduate training and that these are only partly modifiable under the influence of the educational environment. Byrne et al. (2002) suggests that educators should explicitly discuss different SALs with their students, making students aware of how those are linked to specific module requirements, including assessments. Continuous feedback should also be provided to students to orientate their learning and to try to diminish surface approaches to learning (Almeida et al., 2013).

These implications for teaching practice should be considered both within the context of promotion of a suitable learning environment, but also in relation to the resources that are allocated to promoting such an environment. Encouraging student behaviour that favours student adoption of DA, instead of a SA, to learning is challenging for lecturers, as this is often time-consuming (Yonker, 2011). One of the main challenges is that students are often reluctant to engage in the processes involved in a DA to learning. Students often demand sets of notes that clearly specify the material that must be learned and complain if assessments include material that was not directly specified in the notes. This is likely to lead to an increased demand for a review of the assessment format and the marks awarded. Increasing time pressures for academic staff also make this avenue seem more appealing, as directing students to notes that need to be memorised, with their recall of this information assessed, instead of their ability to understand the information is often less time-consuming. The reason for this is that the preparation, delivery and assessment of learning materials fostering a SA are easier and also reduces the amount of time that a lecturer has to dedicate to dealing with student queries and complaints. This mitigates against the need for the learning environment to shift away from being teacher-centred to being learner-centred (Malie & Akir, 2012). This can only be countered by institutional recognition of the quality of learning when addressing academic teaching workloads,
to facilitate staff in the development and implementation of materials and assessments to facilitate an environment that encourages students to adopt a DA to learning. The viability of open-book assessments may be explored (e.g. Block, 2012; Black & William, 2007) as a means of achieving this.

Although not central to this study, the role of technology in delivery and assessment of learning materials (e.g. Nicol, 2007) needs to be considered briefly here. This has implications in terms of the optimisation of the learning and teaching environment, particularly given the increased tendency towards online delivery and assessment of course work. Some of the assessments in this study were electronically administered, and were associated with materials that were electronically delivered prior to the online assessments being undertaken. Better ways of presenting information, conducting tutorials or learning technology do not in themselves guarantee an effective outcome in relation to the fostering of a DA. The success of each of these methods depends on the purpose for which it is used and the way in which it is implemented relative to the subject matter that must be learned. The description of these activities alone does not fully encompass these aspects of the methods adopted (Entwistle, et al., 2001)

5.3 Limitations and delimitations of the study

The first limitation of this study is the size of the participant sample. Ideally, a larger sample would have been desired in order to further explore the statistical differences and relationships between variables. The participant sample was the only undergraduate optometry sample available in the ROI, as the DIT runs the only optometry training programme in the country. Access to a larger potential sample size was therefore not possible without seeking to measure the SALs of students of an optometry programme abroad. This latter option would be associated with complications such as having to cater for participants from a variety of cultural backgrounds, without established validity of the R-SPQ-2F for those cultures. A more obvious complication is that students of another optometry programme would be experiencing different learning, teaching and assessment contexts, making the validity of data arising from such a multicentre study questionable.
Due to the time limitations associated with this research project, data collection was carried out using only semester 1 modules, as this facilitated the access to assessment marks upon completion of the module boards, allowing for sufficient time to analyse data and submit this study by the stated deadline. This time limit led to the exclusion of all clinical skills modules from this study, as these are associated with year-long linked modules. As optometry is a clinical profession, it would be worthwhile and relevant to investigate the relationship between SALs and clinical skills, particularly in stages 3 and 4 of the DT224 programme. The time limit was therefore reduced the scope of relevant assessments that could be included in this study.

A further limitation is that the study was based on a self-report questionnaire, asking students to self-reflect on their SALs. This may not always be a direct measure of the SALs actually used (Abraham et al., 2006), as students may respond to questionnaire items in a way that they perceive it to be desired or expected from them (Byrne et al., 2002). This subjective response bias occurs when participants complete a questionnaire based on what they feel is expected of them, rather than as a truthful reflection of what their own thoughts and feelings are in relation to the questions being asked (Ferrando, Lorenzo-Seva & Chico, 2009). This may have been enhanced in this study by the fact that the questionnaire was completed in the presence of the primary researcher, who was also involved in the delivery of identified modules in stages 1 and 4 for this study.

The lack of consistency of the style of questioning across different module assessments in different stages of the programme could also introduce problems in interpreting how the SAL relates to the amount of cognitive processing associated with a named module and its assessments. This was due to the fact that multiple teaching staff were involved in the delivery of some modules, and not all modules were delivered by the same staff members. Therefore, the construction of questions, corrections and marks allocations of different types of assessments is likely to differ between academic staff. This supports the question of whether the inter-stage comparative analyses as conducted here have any real relevance when describing the SALs of optometry students.
There are some delimitations to this study. As most of the literature analysing the relationship between SALs and assessment outcomes pertains to MCQ assessments, it would have been appropriate to sub-classify the MCQ assessment types in order to further elicit the finding of a relationship between MCQ assessment scores and the adoption of a DA to learning. A further delimitation is that the inclusion of multiple academic modules for each stage of the programme under investigation in this study would have provided data to facilitate comparative analysis across different modules of learning and assessment types for the same cohort of participants in each stage. Such within-participants analyses would have provided useful information about whether the SAL differs in different learning contexts, as each academic module, with its defined learning outcomes and assessments, constitutes a different educational context. It is hoped that some of these limitations and delimitations will be addressed in future iterations of this study.
Chapter 6: Conclusions and Recommendations

Encouraging optometry students to adopt a DA to learning is likely to foster greater levels of career enjoyment and success, as they are likely to retain information for longer (Felder & Brent, 2005), forming the basis for lifelong learning (Abraham et al., 2006) while having the skills to critically analyse and think about learning materials, expanding their body of knowledge (Trigwell & Prosser, 1991a; Zeegers, 2001; Byrne et al., 2002) and be more adaptable and versatile in their approach to learning (Entwistle & McCune, 2013 as cited in Evans et al., 2013). This study has contributed towards understanding of the SALs adopted by a cohort of undergraduate optometry students, but there is a lot more scope for further investigation in this area. This is particularly warranted due to the dearth of information related to the SALs of optometry students that currently exists in the literature.

Recommendations for practice

This study has identified a need for ongoing analysis of SALs in optometric education at both undergraduate and postgraduate levels, with a view to informing best practice in terms of alignment of teaching and assessment methods with learning outcomes. This increased alignment should promote an educational environment where optometry students are encouraged to actively engage with learning materials as part of a deep approach to learning, forming the basis for professional competence and lifelong learning, as is required in modern optometric practice.

It is envisaged that the findings of this study, as well as the future studies arising out of this one, will inform future routine reviews of the DIT optometry programme. This is particularly relevant given the lack of statistically significant differences in the SALs found in this study across all stages of the programme. This study therefore provides little evidence of a higher cognitive progression of student thinking through the stages on the programme. Efforts should therefore be made to encourage deeper thinking as students’ progress through the programme, to create better alignment between the SAL and the assessments to reflect the level and depth of cognitive ability that a student exhibits in relation to their educational development.
on the programme. It is envisaged that the investigation of the SALs of optometry students will better inform educators in charge of programme restructuring and development of the SAL trends of optometry students and their association with assessment outcomes, providing a valuable basis for ongoing development of the training and profession of optometry within the ROI. This is particularly important at the present time, where change in the health care profession regulatory environment is going to have implications for the education, training and professional registration of optometrists in the ROI.

Proposed future research

Recommendations as described here will be considered in future iterations of this and related studies as part of ongoing research into the SALs of undergraduate optometry students, as the SALs adopted by optometry students remains an area that warrants further investigation due to the dearth of literature currently available in this area. The stability or changeability of SALs would be better explored by use of a repeated-measures approach, where students could be asked to complete the questionnaire at two times in a certain study period. This would be of particular interest if one of these times coincided with the imminence of a significant assessment, as students are under time pressure then and could change their SALs as a result. This changeability of SALs could also be explored in a mixed-methods study where student responses elicited using the R-SPQ-2F questionnaire are further explored in an interview setting. The rewording of the R-SPQ-2F to make it more applicable to a health science discipline that involves a significant amount of clinical work would be in keeping with Biggs et al.’s (2001) recommendation that the R-SPQ-2F may be more sensitive when reworded for a particular subject, or assessment tasks. This would then have to be validated through confirmatory factor analysis and internal consistency analysis before data gathered using the re-worded questionnaire format could be considered as valid.

Although the participant sample in this study was largely monocultural, with increasing efforts to attract international students, more emphasis should be placed on investigation of inter-cultural differences with regard to SALs, so as to best cater for all students learning in a multi-cultural environment. Direct translations of the R-
SPQ-2F have shown that this questionnaire is culturally sensitive (Stes et al., 2013), so it would be appropriate to identify target groups of international students to invest in the adaptation and associated validation of an existing SAL questionnaire that can be applied to these international student groups. Biggs et al. (2001) recommends that SAL norms should be obtained intra-institutionally, as they advise that in these days of changing teaching contexts, accountability and concerns with quality assurance and enhancement of quality, SAL measurement instruments like the R-SPQ-2F should have an increasingly important role to play in the higher education environment.

Investigation of trends and associations between SALs and learning style (Eubank & Pitts, 2011; Mohammed et al., 2011; Prajapati, Dunne, Bartlett & Cubbidge, 2011) could potentially inform optometric educators as to the best way in which to present materials in order to promote deeper learning, which is ultimately what is beneficial in a paramedical educational environment where deeper learning fosters better long-term information retention (Weller et al., 2013). It would therefore be relevant to further investigate how SALs change with age and experience (Chiou et al., 2012), which may be possible with the implementation of a longitudinal study.

Research into SALs in higher education has to date predominantly concentrated on undergraduate students. The SAL of graduates and practitioners should also be considered within the postgraduate educational context (Weller et al., 2013). This would provide valuable information to providers of professional training in the form of formal programmes and continuing professional development (CPD) activities, designed to ensure that health professionals remain current with their knowledge and skills. This is particularly relevant given the compulsory requirement for healthcare, including optometric, practitioners to undertake such CPD training as a requirement of ongoing professional registration and insurance provision.
References


Fransson, A. (1976). On qualitative differences in learning, IV. Effects of intrinsic motivation and extrinsic test anxiety on process and outcome. British Journal of Educational Psychology, 47, 244-257.


Appendices

Appendix A. Ethics forms

10th October 2014

Ms. Linda Moore
Dublin Institute of Technology
Optometry
Kevin St
Dublin 8

Re: Ethical Clearance Ref 14-37

Dear Linda

I am pleased to inform you that the following project:

‘Learning styles and assessment outcomes in undergraduate Optometry students’

which you submitted to the Research Ethical Committee has been approved. The committee would like to wish you very best of luck with the rest of research project. If you have any further queries, please do not hesitate to contact Conor McCague on (01) 402 7920 or at conor.mccague@dit.ie.

Yours sincerely

[Signature]
Dublin Institute of Technology
Research Ethics Committee
Participant information sheet

Purpose of the study:
To measure the learning approaches of undergraduate optometry students on the DT224 programme. These will be related to your assessment scores across a range of types of assessments and modules to establish whether there is any correlation between student learning approach and academic performance in assessments used in DT224.

What is a ‘approach to learning’
Your learning approach influences the way in which your mind processes the information that you are attempting to learn.

What will we be doing today?
• You will be invited to complete two surveys, measuring both the sensory and information processing aspects of your individual learning style.
• It should take approximately 20 minutes to complete the survey.
• You will be asked to return your completed questionnaires to an envelope. This envelope will then be sealed and will be re-opened again in February 2015 upon completion of the semester 1 module boards.
• You will be asked to identify your responses using your name and/or student number, so that your learning style can later be analysed in relation to your academic performance in a range of semester 1 assessments.

How are my results presented?
Your anonymity will be ensured by allocation of a participant number to your name and survey response. The coding sheet for these will be kept in a locked filing cabinet in the optometry staff office, and only the numbers will be used for further data analysis. Similarly, each assessment type in semester 1 will be allocated an assessment number, without the specific module being identified.

Will I have access to my results?
• Analysis of your survey will be carried out during February and March 2015. Once the surveys have been analysed and learning styles have been identified, you will be invited by WebCourses notification to contact me to request a review of your individual learning style.
• It is envisaged that the results of this study will form the basis of a paper to be submitted for publication. You will be notified of a link to the publication so that you can review the overall findings of the study.

You are free to withdraw from this study at any time. If this is your intention, then please email Linda Moore at linda.moore@dit.ie to signal your intention to withdraw from the study.
Please address any queries that you have in relation to this study by email to Linda Moore at linda.moore@dit.ie. If you prefer to discuss your queries, then please email me to arrange a meeting to do so.

This study is being conducted in accordance with the guidelines and associated approval of the DIT Research Ethics Committee.

-----Thank you for your time-----
## Participant consent form

<table>
<thead>
<tr>
<th>CONSENT FORM</th>
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| **Researcher’s Name:** LINDA MOORE  
(use block capitals)  
Title: DR |

**Faculty/School/Department:**  
College of Science and Health / School of Physics / Department of Optometry

**Title of Study:**  
Learning approaches and assessment outcomes in undergraduate optometry students

**To be completed by the:**  
subject/patient/volunteer/informant/interviewee/parent/guardian *(delete as necessary)*

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<tr>
<td>3.1 Have you been fully informed/read the information sheet about this study?</td>
<td>YES/NO</td>
</tr>
<tr>
<td>3.2 Have you had an opportunity to ask questions and discuss this study?</td>
<td>YES/NO</td>
</tr>
<tr>
<td>3.3 Have you received satisfactory answers to all your questions?</td>
<td>YES/NO</td>
</tr>
<tr>
<td>3.4 Have you received enough information about this study and any associated health and safety implications if applicable?</td>
<td>YES/NO</td>
</tr>
</tbody>
</table>
| 3.5 Do you understand that you are free to withdraw from this study?  
• at any time  
• without giving a reason for withdrawing  
• without affecting your future relationship with the Institute | YES/NO |
| 3.6 Do you agree to take part in this study the results of which are likely to be published? | YES/NO |
| 3.7 Have you been informed that this consent form shall be kept in the confidence of the researcher? | YES/NO |

Signed_____________________________ Date ________________

Name in Block Letters _________________________________________________________

Signature of Researcher ___________________________ Date ________________
Appendix B. R-SPQ-2F questionnaire and scoring system

<table>
<thead>
<tr>
<th>Revised Study Process Questionnaire (R-SPQ-2F)</th>
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<td>Biggs et al. (2001)</td>
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Student Name (or Student Number) __________________________________________

Date of birth (or age )__________________________________________________

This questionnaire has a number of questions about your attitudes towards your studies and your usual ways of studying.

There is no right way of studying. It depends on what suits your own style and the course you are studying. It is accordingly important that you answer each question as honestly as you can. If you think your answer to a question would depend on the subject being studies, give the answer that would apply to the subject(s) most important to you.

Please circle the letter that most applies to you. The letters stand for the following response:

A – this item is never or only rarely true of me
B – this item is sometimes true of me
C – this item is true of me about half the time
D – this item is frequently true of me
E – this item is always or almost always true of me

Please choose only one most appropriate response to each question. Do not spend a long time on each item. Your first reaction is probably the best one. Please answer each item.

1. I find at times studying gives me a feeling of deep personal satisfaction.
   
   A     B     C     D     E

2. I find that I have to do enough work on a topic so that I can form my own conclusions before I am satisfied.
   
   A     B     C     D     E

3. My aim is to pass the course while doing as little work as possible.
   
   A     B     C     D     E

4. I only study seriously what’s given out in class or in the course outlines.
   
   A     B     C     D     E
5. I feel that virtually any topic can be highly interesting once I get it.
   A  B  C  D  E

6. I find most new topics interesting and often spend extra time trying to obtain more information about them.
   A  B  C  D  E

7. I do not find my course very interesting so I keep my work to the minimum.
   A  B  C  D  E

8. I learn some things by rote, going over and over them until I know them by heart even if I do not understand them.
   A  B  C  D  E

9. I find that studying academic topics can at times be as exciting as a good novel or movie.
   A  B  C  D  E

10. I test myself on important topics until I understand them completely.
    A  B  C  D  E

11. I find I can get by in most assessments by memorising key sections rather than trying to understand them.
    A  B  C  D  E

12. I generally restrict my study to what is specifically set as I think it is unnecessary to do anything extra.
    A  B  C  D  E

13. I work hard at my studies because I find the material interesting.
    A  B  C  D  E

14. I spend a lot of my free time finding out more about interesting topics which have been discussed in different classes.
    A  B  C  D  E
15. I find it is not helpful to study topics in depth. It confuses me and wastes time, when all I need is a passing acquaintance with topics.

A  B  C  D  E

16. I believe that lecturers shouldn’t expect students to spend significant amounts of time studying material everyone knows won’t be examined.

A  B  C  D  E

17. I come to most classes with questions in mind that I want answering.

A  B  C  D  E

18. I make a point of looking at most of the suggested readings that go with the lectures.

A  B  C  D  E

19. I see no point in learning material which is not likely to be in the examination.

A  B  C  D  E

20. I find the best way to pass examinations is to try to remember answers to likely questions.

A  B  C  D  E

---------End of Survey---------

Responses to the items are scored as follows:
A = 1, B = 2, C = 3, D = 4, E = 5
To obtain main scale scores add item scores as follows:
Deep Approach (DA) = 1 + 2 + 5 + 6 + 9 + 10 + 13 + 14 + 17 + 18
Surface Approach (SA) = 3 + 4 + 7 + 8 + 11 + 12 + 15 + 16 + 19 + 20
Subscale scores can be calculated as follows:
Deep Motive (DM) = 1 + 5 + 9 + 13 + 17
Deep Strategic (DS) = 2 + 6 + 10 + 14 + 18
Surface Motive (SM) = 3 + 7 + 11 + 15 + 19
Surface Strategic (SS) = 4 + 8 + 12 + 16 + 20
Appendix C. Participant SAL scores

Figure C1. R-SPQ-2F subscale scores for stage 1

Figure C2. R-SPQ-2F subscale scores for stage 2
Figure C3. R-SPQ-2F subscale scores for stage 3

Figure C4. R-SPQ-2F subscale scores for stage 4
Figure C5. R-SPQ-2F subscale scores for all stages combined
Appendix D. Normality test data

### Table D1. Normality test data for stage 1

<table>
<thead>
<tr>
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<th>Shapiro-Wilk</th>
<th>Statistic</th>
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<th>Sig.</th>
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* normally distributed data

### Table D2. Normality test data for stage 2

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* normally distributed data

### Table D3. Normality test data for stage 3

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* normally distributed data
### Shapiro-Wilk

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* normally distributed data

**Table D4. Normality test data for stage 4**

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* normally distributed data

**Table D5. Normality test data for all stages combined**

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* normally distributed data

**Table D6. Normality test data for assessment scores for stage 1**
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* normally distributed data

**Table D7.** Normality test data for assessment scores for stage 2

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**Table D8.** Normality test data for assessment scores for stage 3

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**Table D9.** Normality test data for assessment scores for stage 4