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USING A TRAIT COMPLEX MODEL TO PREDICT TYPES OF ACADEMIC PERFORMANCE IN UNDERGRADUATE MEDICAL EDUCATION IN THE UK

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ABSTRACT

There is a growing interest in determining whether factors other than cognitive ability and previous academic performance can influence academic success in medical school (Ferguson, James, & Madeley, 2002). This is due to the limited number of places available on a medical degree and the focus upon personal qualities that are expected of medical students when they graduate and become practicing physicians (Powis, Bore, Munro, & Lumsden, 2005). There are a large numbers of potential characteristics that may be useful in medical school. However, few have attempted to reduce this number into more meaningful dimensions. In addition, the academic performance literature has focussed on the psychometric properties of assessments and largely overlooked the structure of academic performance.

The aim is to combine the two divergent literatures and explore the dimensionality of medical student's dispositional characteristics, and the underlying structure of medical school assessments. This is in order to determine whether dimensions of dispositional characteristics are predictive of different types of assessment.

181 medical students completed a battery of questionnaires during the first week of term in Year 1. Academic performance variables consisted of assessment undertaken by students during the first two years of medical school.

Chapter 5 presents a Principal Components Analysis of assessments. Results suggest that there are three underlying dimensions in the data corresponding to Scientific Knowledge Assessment, Interpersonal Skills Assessment, and Practical Skills Assessment. The results are discussed in terms of current models of desired outcomes in education.

Chatper 6 presents a Principal Components Analysis of dispositional characteristics in medical students. The results suggest that the 21 measured dispositions had three underlying dimensions corresponding to Emotionality, Intrinsic Motivation, and Interpersonal Traits. The results are discussed in terms of how the traits might theoretically combine in addition to the statistical combination of traits.

Chapter 7 presents a series of five Hierarchical Linear Regressions to determine if the trait complexes identified in chapter 6 differentially predict performance on traditional measures of academic performance, and the three dimensions of performance identified in chapter six.

Overall results suggest that previous academic performance and cognitive ability are consistent predictors of academic performance in medical school as such their continued use in selection procedures seems appropriate. Both GCSE and A-Levels differentially predicted types of performance. In addition, emotionality significantly predicted Year 1 performance and performance in practical skills assessment. This study therefore provided support for a three dimensional model of medical student academic performance. However the influence of trait complexes warrants further investigation later in a medical career.

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LIST OF ABBREVIATIONS.

MCQ	Multiple Choice Question Examination
OSCE	Observed Structured Clinical Examination
TFA	True/False/Abstain examination
CW	Coursework Assessment
SA	Short Answer Examination
ICA	In Course Assessment
OSCE	Observed Structured Clinical Examination
Spotter	Spotter Examination
PRAC X	Practical Examination
GCSE	General Certificate of Secondary Education
A-Level	Advanced Level Certificate of Education
BMedSci	Batchelor of Medical Sciences degree
BMBS	Bachelor of Medicine, Bachelor of Surgery
gf	Fluid intelligence
gc	Crystallized intelligence

1. INTRODUCTION.

1.1 BACKGROUND

Over the past thirty years there has been a vast amount of research that has examined the undergraduate academic performance of students, and in particular medical students (e.g. Arulampalam, Naylor, & Smith, 2004; Blumberg & Flaherty, 1985; Mitchell, 1990). Predicting medical student performance is particularly important as the research findings could be applied to selection procedures. This may facilitate the accuracy in assessing the suitability of individuals for a medical career (McManus, Iqbal, Chandrarajan, Ferguson, & Leaviss, 2005). The interest in medical student performance has arisen from a necessity to constantly improve, refine, and update medical student selection procedures, the medical school curriculum, and the assessment methods used. This is in order to maintain and update a system that matches the rapidly changing requirements and demands for a career in medicine and match with potentially suitable candidates (Eva & Reiter, 2004).

Every year there is approximately twice the number of applicants for entry to UK medical schools than there are places available (Richardson, Winder, Briggs, and Tydeman, 1998). It is therefore essential that the system used to select students, and the tools employed for selecting candidates are not only as fair as possible (Maxwell, and Arvey, 1993), but are able to detect the candidates that possess the qualities necessary for academic success and desirable for a career in medicine (Neame, Powis, and Bristow, 1992). It is argued that a broad spectrum of analytical, clinical, personal and social attributes are necessary qualities for successful completion of medical training and for a career in medicine (Ferguson, Sanders, O'Hehir, & James, 2000). Fox and West, (1983) argued that medical doctors should be able and capable of efficient and effective lifelong learning skills and practices in addition to possessing the necessary caring disposition. Some of these desirable attributes can be taught in medical school, however, some are dispositional factors such

as personality, learning styles or motivation which the student inherently possesses (e.g. Conard, 2006; Schmeck & Geisler-Brenstein, 1989). Therefore it can be seen that is necessary to consider the impact of a number of personal characteristics on medical student academic performance as a single characteristic is rarely solely responsible for academic success (Leeson, Ciarrochi, & Heaven, 2008).

There have been two major approaches to the examination of academic performance in medical school; predictor-centric, and outcome-centric. It should be noted that there is an important distinction between a predictor-centric approach and an outcome-centric approach. A predictor centric approach focuses upon predicting academic performance from a variety of personal characteristics. Whereas an outcome-centric approach typically involves a focus upon the examination and evaluation of assessment methods used to measure student performance (Kuper, Reeves, Albert, & Hodges, 2007).

Typically the literature examining performance from a predictor-centric approach has examined a variety of personal characteristics; such as previous academic performance (Arulampalam et al., 2004; Lumb & Vail, 2004; Markert, 1985; McManus, 2005), cognitive ability (e.g. McManus, Smithers, Partridge, Keeling, & Fleming, 2003; Shen & Comrey, 1997), personality (e.g. Ferguson et al., 2000; Shen & Comrey, 1997), and learning styles (e.g. Davidson, 2002; Martenson, 1986; McManus, Richards, Winder, & Sproston, 2004; Newble & Entwistle, 1986; Newble & Gordon, 1985). A large proportion of this research has tended to examine single predictors in conjunction with previous academic performance. This is in order to examine whether other factors provide incremental predictive validity over previous academic performance variables (e.g. Hart, Payne, & Lewis, 1981; Martin, Montgomery, & Saphian, 2006; Shen & Comrey, 1997) as previous academic performance has been shown to be a consistent

predictor of at least the first year of medical school (McManus et al., 2005). Whilst determining incremental predictive validity of predictors is important, it needs to be recognised that a broad range of a number of personal attributes are required for a career in medicine. It is therefore imperative that researchers recognise the importance of examining the structure of the relationships not only between particular characteristics and academic performance, but also the underlying structure of the interrelations between characteristics themselves (Snow & Swanson, 1992). This could then be used to create a framework for understanding the organisation of personal characteristics that are predictive of academic performance in medical school. The construction of a framework of personal characteristics is therefore necessary for parsimoniously explaining individual differences in academic performance in medical school (Lievens, Coetsier, De Fruyt, & De Maeseneer, 2002).

To date, it appears that only a relatively small number of researchers have attempted to create a model of the dispositional predictors of academic performance (Ackerman, 1996; Chamoro-Premuzic & Furnham, 2005; Snow, 1989). However, these models are not without their problems. It can be seen that the theoretical models that have been proposed have typically been in relation to general academic performance rather than focusing on medical students (e.g. Ackerman, 1996; Chamoro-Premuzic & Furnham, 2005; Snow & Swanson, 1992). Therefore an understanding of the dimensionality of dispositional characteristics in medical students, necessary for performance, has been overlooked. It is possible therefore, that general models may lack the specificity that is necessary when predicting performance in medical school. Additionally, none of the models have attempted to integrate models of determinants of academic performance with models of the structure of academic performance. Therefore the predictor-centric approach to performance in medical school is in need of a framework that describes the interrelations between important determinants of different types of performance.

In addition, the predictor-centric approach appears to have adopted an inconsistent approach to measuring outcome in medical education. As the focus has been upon the predictors, the outcome measure has been operationalised as either a general performance outcome measure such as overall degree grade, or a specific module assessment component such as multiple choice examination score (Morgan, Clarke, Weidmann, Laidlaw, & Law, 2007). This could obscure the potential explanatory value of some dispositional characteristics in predicting different aspects of medical school performance. It is possible that particular dispositional characteristics are influential for particular types of assessment that are related to particular skills or competencies, however the research has yet to appreciate this possibility. Therefore it can be seen that the main focus of the predictor-centric approach is the predictor, with little consideration of the impact of the outcome measure itself.

The literature that adopts an outcome-centric approach to examining academic performance typically focuses upon the examination and evaluation of assessment methods used to measure student performance. This has taken the form of examining the reliability and validity of assessment methods (e.g. Schuwirth & Van Der Vleuten, 2006b) development of more realistic measures for assessment of clinical skills (e.g. Harden & Gleeson, 1979), ensuring that assessment methods encourage good study practices (Sisson, Swartz, & Wolf, 1992), or examination of the impact of assessment methods on student performance (Kuper et al., 2007), all with relatively little regard for the impact of the personal characteristics of the students on academic performance. Research from an outcome-centric approach has attempted to classify academic performance in terms of the learning outcomes that they are designed to match, or the particular competencies that they are designed to measure (e.g. Anderson & Krathwohl, 2001). However, the literature that takes an outcome-centric approach has based these decisions on

models that have been proposed without a strong scientifically tested research evidence base (e.g. Miller, 1990). Therefore it can be seen that the key distinction between the outcome-centric approach and the predictor centric approach is that the outcome-centric approach mainly focuses upon the assessment methods used in medical education.

The predictor-centric, and the outcome-centric approaches to academic performance have tended to remain relatively independent, even though conceptually they are examining the same area, but from different perspectives. This may be due to each approach having developed in response to differing demands. The predictor-centric approach has developed in response to the need to improve the selection procedures for the medical degree and reduce attrition (e.g. Parker, 1993), and the outcome-centric approach has developed in response to upholding the quality and standards of medical education (Miller, 1990). Therefore this may have influenced the focus of the two research fields. Although these two approaches have developed from arguably the same area, it appears that they have branched off into different directions. As a result, each approach may have overlooked the potentially useful information provided by the other approach. Therefore it would be useful to combine both the predictor-centric and outcome-centric approach when predicting medical student academic performance within the same research in order to more comprehensively understand the nature of academic performance in medical school.

The synthesis between the predictor-centric approach and the outcome-centric approach that this thesis aims to present is long overdue. The lack of an integrated model of predictors and outcomes specific to medical education warrants attention. Attempting to combine personal characteristics into a set of broad dimensions in order to parsimoniously explain individual differences in academic performance has largely been overlooked. In addition, there is a necessity

to appreciate the idea that academic performance could potentially reflect more than a simple examination grade, or an aggregated measure of general performance.

From a theoretical perspective, it is of interest to explore the basic dimensions underlying the dispositional predictors of academic performance. This is in order to more clearly understand how personal characteristics are differentially related to and predictive of, performance on various different assessment types (Chamorro-Premuzic, Furnham, Dissou, & Heaven, 2005). From an applied perspective, exploring the dimensions of cognitive, affective and motivational processes in an ecologically valid setting such as the medical education setting may identify the combinations of traits that produce the highest grades on the different aspects of medical student assessment (Powis et al., 2005). This may then benefit selection procedures by helping to provide a taxonomy of core personal characteristics to be measured at selection, and help to select those candidates most likely to be successful and perform well in the medical school setting (Busato, Prins, Elshout, & Hamaker, 1999). Therefore the key aim of this research is to test the thesis that clustering academic performance and clustering dispositional characteristics into more parsimonious components provides a more comprehensive explanation of the different qualities necessary to be successful in medical school.

The purpose of this thesis therefore is to answer the main research questions;

What is the most explanatory number of components that adequately summarises academic performance in medical school.

What is the most explanatory number of components that adequately summarises student's personal characteristics measured at entry to medical school

What combination of characteristics best predicts different types of academic performance in medical school.

1.2 THESIS STRUCTURE.

This thesis will firstly provide two chapters that review the existing literature on predicting academic performance and the assessment of academic performance. The main focus of these chapters will be on student's academic performance in the first two years of medical school.

The first chapter will review the literature that has previously examined academic performance. It will begin by examining the definition of academic performance, then move onto a critical discussion of how academic performance has traditionally been measured and used in research as an outcome measure. The discussion will then focus more specifically upon how academic performance is assessed in medical school and the different methods of assessment used. It will also incorporate a critical discussion of how medical student academic performance is typically operationalised and used as an outcome measure for research, and will provide an overview of the models that have been proposed to explain desired outcomes in education.

The second of the literature review chapters will focus upon determinants of academic performance, and will outline and critically evaluate the research that has previously examined determinants of academic performance. This chapter will first focus upon the importance of predicting academic performance in medical school. It will then discuss both cognitive and non cognitive factors that have previously been shown to be related to performance. This will involve a discussion of the literature that has examined previous academic performance, cognitive ability, personality traits, and learning styles as determinants of academic performance, and in particular performance in medical school. The chapter will then proceed to evaluate nine dispositional characteristics that have not previously been examined within the context of medical education. It will be outlined why these constructs could potentially be influential in medical school performance. This will include a critical discussion of the potential of need for cognition,

motivational traits, social desirability, dispositional negative affectivity; trait stress, anxiety, and depression, narcissism and empathy in predicting performance in medical school. This chapter will also critically discuss the current theories and models of the determinants of academic performance. Each of the models will be critically discussed and evaluated for their explanatory value in relation to medical school academic performance in medical school.

The fourth chapter is the methods chapter and will outline the methodology used in this research. Firstly, it will provide an overview of the design of the study and outline all variables that are included in the research. It will then provide a detailed overview of the participant's characteristics, which will cover the sampling techniques used, and the representativeness of the sample used in this research. The psychometric properties of the scales used to measure the predictor variables and the composition of the assessment methods used to assess medical student performance will be summarised. The procedures for data collection and ethical considerations will then be outlined. The statistical methodology that is used in this thesis will be discussed, and the reasons for their use in thesis will be justified.

The fifth chapter will be the first of the results chapters and will examine the underlying structure of medical school assessment. It will use Principal Components Analysis to explore the number of broad underlying dimensions of assessment in the first two years of medical school. It will then briefly discuss the implications of the findings of the analysis, and make suggestions as to the number of broad basic dimensions underlying assessment. It will then discuss the model in relation to previous research findings.

The sixth chapter will constitute the second of the results chapters, and will examine the interrelationships between cognitive ability, personality traits, learning styles, need for cognition, and motivational traits. It will report the findings of a Principal Components Analysis that will explore the broad basic dimensions that underlie the dispositional predictors of academic performance in medical school. This chapter will then discuss the implications of the results in relation to the number and structure of the dimensions underlying the personal characteristics of medical students.

The seventh chapter will be the final results chapter and will present the results of five Hierarchical Multiple Regression Analyses. This analysis will predict performance in Year 1, and performance in Year 2. It will then analyse the dispositional dimensions in relation to the types of academic performance identified in Chapter 5. The results will be discussed in relation to the differential predictive validity of trait complexes in relation to different types of performance.

Chapter eight will form the final chapter which will be the overall discussion. This chapter will synthesise the findings from chapter five, six and seven, and will critically discuss the results in relation to the medical student performance literature. The implications of the findings will be outlined and evaluated, and a critique of the strengths and weaknesses of the research will be presented. Finally future directions for research in the medical student performance literature will be outlined.

NEXT CHAPTER

The next chapter will be the first of the literature review chapters. The aim of the chapter is to review the literature that has previously examined academic performance from an outcome-centric perspective. It will begin by examining the definition of academic performance, then move onto a critical discussion of how academic performance has traditionally been measured and used in research as an outcome measure. The discussion will then focus more specifically upon how academic performance is assessed in medical school and the different methods of assessment used. It will also incorporate a critical discussion of how medical student academic performance is typically operationalised and used as an outcome measure for research.

2 LITERATURE REVIEW: ASSESSMENT, COMPETENCE, AND ACADEMIC PERFORMANCE IN MEDICAL SCHOOL.

Academic performance by medical students is a key factor in the medical education system as it serves a number of very important purposes (Pellegrino, Chudowsky, & Glasser, 2001). Academic performance is the means by which governing bodies assess whether a medical graduate is sufficiently competent and fit to practice medicine (Amin, Yap Seng, & Eng, 2006). It is used by faculty as a method to determine which students are displaying the appropriate level of competence as defined by academic standards. It is also used by students to ascertain their academic progression; whether they are passing or failing in any specific areas (Shumway & Harden, 2003). Performance on assessment can also be used as measure to predict the future performance of students (Amin et al., 2006), and be used as an outcome variable for educational research purposes (e.g. Blumberg & Flaherty, 1985; Duckworth & Seligman, 2005; Parker, 1993). Consequently it can be argued that assessment, competence, and academic performance are the key components of the outcome of medical education (Kuper et al., 2007). Although academic performance is a key component of medical education, a thorough analytical investigation of the structure and nature of academic performance is lacking. In order to address this, this section will critically review the research that has examined academic performance in medical school.

Academic performance, competence, and assessment are concepts that are intertwined, therefore a thorough discussion of academic performance merits the inclusion of a discussion and definition of both competence and assessment (Wass, McGibbon, & Van Der Vleuten, 2001). The next section will define and discuss the interrelations between assessment, competence, and academic performance, and will provide a definition that sets the scope on the nature of academic performance in order that it can be operationalised as an outcome variable for research.

2.1 DEFINING ASSESSMENT, COMPETENCE, AND PERFORMANCE.

Assessment refers to the methods used by educators to determine student's level of knowledge, skills, and learning (Amin et al., 2006). Assessment methods usually consists of tests that ascertain whether an appropriate level of competence has been reached by students (Cronbach & Snow, 1977). This level of competence is determined by the university academic boards as to what is required in order to fulfil the duties of a physician (Van Der Vleuten & Schuwirth, 2005). The outcome of performance on assessment reflects a student's academic performance and is taken as an indicator of the student's competence after an educational phase (Pellegrino et al., 2001). All assessment instruments are designed to measure latent competencies. Performance on an assessment is assumed to reflect the latent construct it was designed to measure, that is; a competence in a particular area (Beckman, Cook, & Mandrekar, 2006). It can be argued that assessment methods are only the realisation of competence through performance, and it suggested that it is performance that is reflective of the level of competence (Schuwirth & Van Der Vleuten, 2004a). It can be seen that assessment, competence, and performance are inextricably linked; assessment is a tool that measures competence, and performance is a demonstration of competence that is measured through assessment. As such, when discussing and defining academic performance and assessment it is necessary to also consider competence (Amin et al., 2006).

Medical graduate competence has been defined by Wass, Van Der Vleuten, Shatzer, and Jones, (2001, p. 226) as "a foundation of basic clinical skills, scientific knowledge and moral development" it might be argued that this definition of competence seems a little broad, as it does not seem to cover some of the key elements of medical competence (c.f. Miller, 1990). Schuwirth and Van Der Vleuten, (2004a, p. 808) therefore defined competence as "the ability to assume a combination of well defined roles; provider of direct patient care, worker in the health care

system, scientist, educator, and a person" and suggest that competent graduates should have "the ability to handle complex professional tasks, by integrating the relevant cognitive, psychomotor, and affective skills" (Van Der Vleuten & Schuwirth, 2005, p. 313). Therefore medical student competence comprises elements of knowledge, skills and attitudes and personal capabilities and responsibilities. Epstein and Hundert, (2002) suggest that competence comprises, a cognitive element, an integrative element, an inter-relational component, and an attitudes component. They suggest that the cognitive element includes an ability to acquire and use knowledge, the integration element involves utilising knowledge effectively in clinical reasoning and judgement, the inter-relational element involves inter-personal skills such as empathy, communication skills, and team work, and the attitudes element incorporates a reflective ability, and emotional intelligence. The outcome of medical education should therefore be that students are ethically, clinically, technically, and scientifically competent, and should demonstrate attitudes and capabilities that are expected of a good doctor (Macpherson & Kenny, 2008). Assessment methods should therefore test and evaluate a student's mastery of all of these important competencies.

These definitions of competence all capture key aspects of the essence of competence, therefore when all the definitions are considered together, they provide a better explanatory description that defines the nature and scope of competence. Therefore competence refers to the possession of the necessary attributes (such as knowledge, skills, abilities, and attitudes) in order to assume the role of a professional physician who can select, apply, and integrate the relevant competencies in any given situation that may arise.

Andrich, (2002) argues that for clarity in educational research, it is important that constructs are distinguished from the manifestations of the construct. In this case, it is important to distinguish

between competence, performance, and assessment. Performance represents the manifestation of competence and assessment is the methodology through which performance is measured. It is also important to note that competence reflects more than just a performance that has happened on a single occasion: multiple performances on different assessment measures are necessary in order to demonstrate competence in a truly accurate manner (Andrich, 2002).

Performance can be divided into a hierarchy of components where each can be distinguished in terms of its underlying property (Bartram, 2005). Campbell (1990) suggests that there are three essential components to performance; requirements, standards, and measurements. Performance requirement refers to the level of behaviour that is required in order to achieve the desired goal. Performance standards refer to the quality levels that must be achieved in order to achieve the goal. Performance measurement refers to the methods used to obtain an indicator of the performance standard, which in turn is reflective of the performance requirement (Campbell, 1990). In this case, the goal for the student is to demonstrate competence by performing above a threshold score (as determined by the academic standard set by the relevant academic authorities) when assessed.

There is a tendency within the educational literature to omit an adequate definition of academic performance as it is deemed intuitive as to what the concept pertains to (Chamorro-Premuzic, 2005). However, it can be argued that in order that an outcome variable can be effectively operationalised as a meaningful variable in research, it is essential that a concise, comprehensive definition is outlined (Schuwirth & Van Der Vleuten, 2006a). Therefore the lack of attention to operationalising a definition in the current literature is surprising considering its wide use as an outcome variable in educational research. Academic performance has been simply defined by Chamorro-Premuzic, (2005, p. 68) as "performance in academic settings". However, this

definition may be too simplistic and may not accurately represent the complexities of academic performance in medical school, as it does not acknowledge nor reflect what is being measured (competence) or what tool is being used to assess it (assessment) (Schuwirth & Van Der Vleuten, 2004a). In order to accurately represent the dimensions of academic performance, it is essential to use a definition that incorporates elements of assessment and competence because the constructs are interdependent (Rethans et al., 2002). This would provide a clear, general, and comprehensive definition of academic performance that can be applied to medical educational settings.

In order to accurately represent the complexities of academic performance in medical school, academic performance will be defined as a demonstration of a student's level of competence and mastery of a subject through completion of multiple tests of competence in a particular domain of education (Anderson & Krathwohl, 2001). Using this definition to operationalise academic performance for research purposes provides a clear scope of what academic performance is, and provides a comprehensive definition of the nature of academic performance by combining all three crucial elements of assessment, competence, and performance. For research purposes then it can be seen that competence reflects what a student can do, assessment is a method used to determine level of competence, and performance reflects what the student actually demonstrates on the assessments (Wilkinson & Frampton, 2004).

As there are a wide range of methods used to assess performance in medical education, and that competence in medical education consists of multiple components, it is necessary to outline the different assessment methods that are used in medical education. It is also important to consider the competencies that assessments are designed to measure. For that reason, the next section will outline the different types of assessments used, will discuss the competencies that the tests are

designed to measure, and discuss how academic performance has previously been operationalised as an outcome variable in research.

2.2 MEDICAL SCHOOL ASSESSMENT AND PERFORMANCE MEASURES.

In undergraduate education, a number of tools are used to assess student academic performance, and competence. These methods are typically sampled from a wide range of potential assessment techniques, however the most common methods used for assessment in undergraduate education are written assessments (Chamorro-Premuzic, Furnham et al., 2005). These methods include; multiple choice exams, written coursework essays, and short essay answer examinations (Chamorro-Premuzic, 2005). Therefore, in typical undergraduate educational settings it is difficult to make comparisons and examine covariance between performance on different assessment types (Bloom, Engelhart, Furst, Hill, & Krathwohl, 1956). This is because the assessments used are mainly written tests so are similar in format, and similar in what they are designed to measure in that they are usually designed to measure knowledge. Therefore it is likely that they share the same explanatory variance in academic performance.

Medical education on the other hand, uses a wider range of assessment methods than typical undergraduate courses. This is because a diverse range of assessment measures are required in order to assess the broad range of different competencies that are relevant to the practice of medicine (Furnham & Medhurst, 1995). Therefore it can be seen that medical education provides a unique opportunity that allows for an analytical examination of the structure of performance on different types of assessments. The assessment methods typically used in medical school vary in structure, function, and the competence that they are intended to measure. This can be separated

into four categories; according to mode of assessment, time constraints placed for completion of assessments, and the competence or the subject area they are designed to measure.

There are three modes of assessment used in medical education; written, observed, and practical. Written assessments include written coursework, and written examinations where participants are required to demonstrate their competence using written forms of communication (Amin et al., 2006). Observed assessments include observed structured clinical examinations where students are expected to behaviourally demonstrate their competence, and their behaviour is rated by observers (Harden & Gleeson, 1979). Practical assessment such as a spotter examination involves demonstration of competence through completion of practical tasks that are set by instructors and assessed either from observer rating, or from the accuracy of the completed task.

Assessment methods can also be separated into two forms of time constraints placed on assessments; short and long duration. Short duration assessments require students to complete an assessment in a short strictly limited time duration. This usually involves examinations, which are generally limited to a few hours. Longer duration assessment typically involves a longer time period allowed in order to complete assessment. This can vary from between a week to an academic year. Longer duration assessments are typically set in the form of coursework, where students are set a task to complete, or a question to answer, and then are provided with a date in the future by which they have to submit their completed task or answer. Both mode and time constraints are structural, physical characteristics of assessment, which are directly measurable.

Unlike physical measurements, competencies cannot be measured directly, but only inferred from performance on assessments. Therefore competencies are considered latent hypothetical constructs (Van Der Vleuten & Schuwirth, 2005). For example, a written examination is usually designed to measure a knowledge-based competence, a practical examination is designed to test

technical skills, and an observed assessment is be designed to assess the attitudes and clinical skills of a student (Hodges, 2003). It can be seen that assessment instruments by their nature are designed to assess competence in different ways. Therefore the difference between the structure of assessment and the underlying competence that they are designed to measure may be an important distinction when attempting to determine the underlying structure of academic performance in medical school.

As medical school typically employs a variety of assessment methods that utilise a variety of structures in order to assess student competence, it is likely that each type of assessment may require different competencies based upon either the structural element of assessment or the underlying competency that they are designed to measure (Schuwirth & Van Der Vleuten, 2004b). To date, however, the research examining medical school assessment has been overwhelmed by a focus on the psychometric properties of these assessment methods (Wass, McGibbon et al., 2001).

Research has typically focussed upon whether the assessment tool reliably measures the competence it is designed to measure (e.g. Wass, McGibbon et al., 2001) or whether it is actually measuring the underlying competence that it was designed to measure (validity) (e.g. Harden & Gleeson, 1979; Hodges, 2003). Van Der Vleuten and Schuwirth, (2005) note that in medical educational assessment research, competence has tended to be delineated into smaller component parts that are separately assessed using individual assessment methods. Following this, the research typically attempts to determine the most reliable and valid single assessment measure for assessing a particular competence. While this type of reductionist approach may be useful for ensuring the accuracy of assessment measurement tools, it can be argued that this approach to measuring competence is erroneous as it is too simplistic (Van Der Vleuten & Schuwirth, 2005).

Wagerman and Funder (2007) argue that there is a lack of consistency in the use of academic performance as an outcome variable, where a variety of measures have been used. There is clearly a need to take a more holistic approach which utilises multi-methods for assessing the different components of competence. This would ensure a more accurate and valid measure of medical student's overall academic performance that may be used consistently in future research.

Whilst the current focus on the psychometric properties of assessment has been useful for maintaining quality control in assessing student performance, it has resulted in the relative neglect of analysis of the underlying structure of performance on assessment. This neglect is particularly apparent in relation to a lack of an evidence-based theoretical account of actual academic performance (Schuwirth & Van Der Vleuten, 2004b). More specifically, the idea of the underlying structure of assessment has been largely neglected in research that uses academic performance as an outcome variable. Research that has examined undergraduate academic performance as an outcome variable as a result, has typically taken one of three approaches when operationalising performance as an outcome measure. These include a macro approach, a micro approach, and an approach inferring competence from scores on final exams. A macro approach uses composite measures that aggregate assessments into one score which reflects total overall academic performance. A micro-approach involves using a single assessment score as an outcome measure of academic performance. Lastly, performance on a final end of degree examinations has been used as an indicator of overall academic performance.

Salvatori, (2001) in her review of the student selection literature, identified that end of year one scores, and overall degree classification were the outcome measures used most often in the literature that examines the prediction of academic performance. This apparent focus on the first year, and the overall degree grade may be for a number of reasons unrelated to aggregation

issues. It is possible that obtaining scores from the first year of undergraduate education is logistically easier. Collecting data on a first year examination is relatively less time consuming and less costly than following the same cohort across the full three years of study. In the case of examining academic performance in medical school, this problem may be exacerbated, as this duration of study for medical students ranges from 3-7 years. In the case of using overall degree grades may be viewed as the most reflective of a student's general overall performance therefore researchers have tended to focus on general academic performance rather than delineating academic performance into narrower variables that may prove more difficult to analyse (Arya & Mittendorf, 2008).

Overall year score, and overall degree score generally comprises a combination of scores on a diverse range of assessments (Chamorro-Premuzic, Furnham et al., 2005). These overall performance grades may reflect an aggregated, macro approach to measuring performance; that is an overall general view of a student's academic performance. This macro approach has its benefits in that it can provide a single indicator, that is easy to quantify (Arya & Mittendorf, 2008). It could also be argued that a variety of performance indicators combined into an aggregated measure of performance may accurately reflect the diverse range of knowledge and skills necessary for successful academic performance. This approach increases the validity of the performance outcome measure as a general measure of academic performance (Richardson, Winder, Briggs, & Tydeman, 1998).

However, combining the diverse range of assessment measures into one aggregate score in this manner may potentially obscure theoretically important differences in academic performance. This may result in a significant loss of potentially rich and useful information regarding individual differences in performance on assessments of different competencies (Snow, 1994).

Thus the explanation of essential predictive power and variance may have been diminished when an aggregated measure of all assessments is used. Consequently, using aggregated measures of academic performance as outcome variables may omit essential explanatory variance (Amin et al., 2006). Researchers that have used a more specific approach to academic performance have facilitated comparisons between different time points on a single assessment (e.g. Furnham & Chamorro-Premuzic, 2004; Furnham, Chamorro-Premuzic, & McDougall, 2003; Sisson et al., 1992). This approach may also facilitate comparisons of prediction of performance using different types of assessment. For example, Chamorro-Premuzic and Furnham, (2003a) examined predictors such as cognitive ability and personality in relation to; academic performance on a composite score of examinations, and a score for a final year project. They found that different individual difference variables were differentially related to each of the different academic performance outcomes. Their findings demonstrate that using a more specific approach can determine more specific differences in performance. This therefore shows that combining all scores achieved across an undergraduate degree may lose some explanatory power, and the use of a more specific approach such as using performance on a single assessment as an outcome variable can be sensitive enough to determine differential relations with predictors. Therefore, using a single specific assessment score can provide a useful and sensitive indicator of a particular level of academic performance.

It may be that academic performance is best conceptualised using a more analytical approach that takes into consideration the type and method of assessment, and the competence being measured (Schuwirth & Van Der Vleuten, 2006b). It may be more beneficial therefore to differentiate outcome measures in terms of types of assessment, or types of competencies in order that they more accurately reflect the nature of academic performance (Furnham & Medhurst, 1995). This approach has previously been overlooked as a method of analysing academic performance both in

the assessment research and the educational research that utilises academic performance as an outcome variable.

Nonetheless, it is important to know that the use of performance on a specific assessment measure as a reflection of competence in medical education may be particularly unreliable (Furnham & Medhurst, 1995). A single test may be more susceptible to extraneous unwanted influences related to the student, the environment, or test specific idiosyncrasies (Ferguson et al., 2002). Amin et al., (2006) argues that using a single assessment measure in assessing medical student competence is neither a valid nor a reliable method as medical competence is a multifaceted and complex phenomenon. Therefore a multitude of measures that test the different competencies involved is necessary if a comprehensive account of academic performance is to be obtained. If this is the case, then using a single assessment result as an outcome measure for predicting performance is both weak, and unreliable.

The third method that is typically used in the research literature is the use of performance on final examinations. Furnham and Medhurst, (1995) argue that there are essentially two justifiable reasons why the utilisation of final examination grades may not comprehensively explain academic performance. They argue that because academic performance consists of measurement using a wide range of multifaceted assessment methods throughout a degree, firstly the explanation of predictive power may diminish, and secondly, explanation of the variance in academic performance may be compromised if final examination measures of performance are used as outcome variables. Furnham and Medhurst, (1995) suggest that the reliability of final examination grades may be at best dubious. They suggest instead that it may be better to use a variety of different academic assessment outcomes throughout the course of study in order to provide a more global robust representative measure of academic performance.

Whilst aggregation of all academic performance variables undertaken during the undergraduate degree is the most common method of measuring performance, Schuwirth and Van Der Vleuten, (2004b) argue that it is necessary for academic performance research to examine whether there are other more meaningful ways that scores can be combined. Schuwirth and Cantillon, (2005) argue that using oversimplified composite academic outcome measures cannot give an accurate representation of competence and may lack the sensitivity necessary for detecting differences. They suggest that there is a need for a multivariate approach to predicting outcome measures. Combining academic performance measures into a set of scores that considers the individual facets of academic performance which also provides more global information, may provide a rich but manageable quantity of information (Wass, McGibbon et al., 2001). Thus achieving a balance between both single assessment scores, and multi-microlevel scores seems to be a more useful approach to defining academic performance as an outcome variable for research purposes. Analysis of the structure of academic performance variables is necessary in order to develop academic outcome variables that are more representative of specific competencies that underlie medical student performance.

Examination of academic performance at the interface between aggregated and single measures approaches in research however, has largely been neglected. It can be seen then that although it is important to maintain some level of generality, it is also necessary to incorporate specificity in order to detect subtle nuances in competencies and performance (Schuwirth & Cantillon, 2005). Therefore it can be argued that a balanced approach to outcome measures is much needed. Up to now, using a more balanced, and analytical approach to operationalising academic performance as an outcome variable has been overlooked in both the educational research literature and the medical education literature.

It would be most beneficial if account was taken of the usefulness of micro-level aggregation of scores in order that the measure is reliable and valid. In addition, it is necessary to use a more analytic approach when operationalising performance as an outcome variable. This can be achieved by taking account of the underlying dimensions of performance on assessment. If these two factors are taken into consideration then the loss of potentially rich and useful information regarding individual differences in performance on assessments of different competencies may be minimised. In order to avoid becoming atomistic and reductionist in the approach to the assessment of performance on measures of competence, it is necessary to determine the structural and functional relationships between the underlying components and also to recognise that there may be qualitative differences between competencies (Andrich, 2002). This is where a critical analysis of the models of assessment competence and academic performance would be useful in order to determine the structure of academic performance. The following section will outline and evaluate relevant models of academic performance from education research and the medical education literature.

2.3 CURRENT MODELS OF MEDICAL SCHOOL PERFORMANCE.

Few studies have examined the structure underlying academic performance, or hypothesized about whether there is an underlying latent structure to assessment methods in medical education. As previously noted in the last section, the common method that is used to operationalise academic performance as an outcome variable is to utilise an aggregate measure of overall academic performance. This approach to measuring and using academic performance may be due to a lack of evidential studies that have examined the structure of performance. As such the focus of interest has tended to cover only general academic performance as an outcome measure. Only a few groups of medical education researchers have used statistical methods to assess the structure of performance, and their findings demonstrated a single underlying dimension in

academic performance. For example, McManus, Richards, Winder, and Sproston, (1998) conducted a principal components analysis on medical school assessments including mostly multiple choice question examinations (MCQ) a few practical elements, and a viva voce exam. They found a single underlying factor that they used as a performance indicator. Although they found a single underlying factor, this could be due to the inclusion of more MCQ examinations than other assessments, which may influence the proportion of variance explained by a single factor. Nonetheless, it needs to be recognised that the single factor structure has also been shown in other studies. For example, Ferguson et al., (2000) conducted a principal components analysis on twenty one medical student assessments and found evidence to support the one factor solution which explained a large proportion of the variance in assessment. Therefore it is possible that a single factor may underlie academic performance in medical school.

These findings are in accordance with others who have examined the structure for psychometric reasons (e.g. McManus, Richards, Winder, & Sproston, 2004). However, it can be argued that assessment can reflect both a single underlying construct, and still have further underlying dimensions, structured into a hierarchy that make up a general factor that is academic performance (Miller, 1990). Therefore it is still possible that further analysis of assessment may reveal more than one underlying construct and performance may potentially be hierarchical in structure. As noted previously, defining academic performance in terms of a single underlying construct may not be an accurate nor sensitive representation of the performance on assessments of competence. Hart, Payne, and Lewis, (1981) report the findings of one study that attempted to categorise academic performance. They categorised their assessment outcome variables into categories of learning which they defined as memory, translation, interpretation and application. However, they did not make clear the model upon which they were basing this categorisation and it seems an arbitrary categorisation system based upon intuition rather than on sound scientific

statistical evidence. In addition, the categories were derived from scores on two examinations from physiology and biochemistry. It has been argued in previous research that assessments involving written types of examinations such as MCQ are useful for only measuring knowledge (Harden, Crosby, Davis, & Friedman, 1999). Therefore it is unlikely that the other learning categories would have been assessed by these methods of assessment. Therefore it is essential to examine academic performance in terms of structure. Snow and Swanson, (1992) explicitly call for research to examine the structure of assessment. They argue that the development of a theory of assessment, competence and performance is imperative in order that a clear understanding of the nature of academic performance can be elucidated. This is particularly the case when utilising academic performance as an outcome variable.

Unfortunately, as there are no clear models of the underlying structure of academic performance per se (apart from the general overall composite measure of performance), it is necessary to examine the assessment and medical competence literature as it has previously been shown that these constructs are linked to academic performance. The assessment and medical competence literature may have equivalent models that may be useful as an explanation of the underlying structure of academic performance. These models include the taxonomy of educational objectives devised by Bloom and colleagues (1956), and Miller's (1990) Pyramid Model of assessment/competence. The following section will examine and evaluate Bloom's Taxonomic Model and Miller's Pyramid Model as potential explanatory models for academic performance in medical school.

2.3.1 BLOOM'S TAXONOMY OF EDUCATIONAL OBJECTIVES (BLOOM ET AL., 1956).

Bloom et al., (1956) were one of the first group of educators to attempt to categorise the process and desired outcome of education into a comprehensive coherent structured framework. Previous to their work, the educational context, expected outcomes, and teaching strategies were vague, subject specific, and fairly subjective (Anderson & Krathwohl, 2001). Therefore they identified that there was a need to develop a classification system for educational objectives. This taxonomy attempted to organise educational processes into a coherent framework in order that the goals of the education system could be more accurately represented. Bloom et al. (1956) recognised the usefulness of classifying educational processes and desired outcomes of education into a taxonomy. They suggested that the organisation, and interrelations between desired outcomes and measurement of desired outcomes could be more accurately represented and understood in a coherent hierarchical framework (Bloom et al., 1956). The taxonomy was developed in order to provide a set of standards to facilitate curriculum development and organisation of evaluation and assessment methods in education generally.

Bloom et al, (1956) argue that educational goals can be divided into three distinct categories reflecting knowledge, attitudes, and skills. 'Knowledge' in this context reflects cognitive processes indicating development of knowledge recall and recognition, and intellectual abilities. 'Attitudes' refers to particular interpersonal skills, moral development, and values. The 'Skills' category refers to more practical skills and applications of knowledge such as reasoning ability and synthesis of information. Bloom (1956) states that the taxonomy is an attempt to classify "the intended behaviour of students; the way in which individuals are to act, think, or feel, as a result of participating in some unit of instruction" (p12). This can be seen to reflect an attempt to classify competence in a particular domain after being instructed in that area. Therefore it is the

desired outcome of the educational process that Bloom and colleagues attempted to classify. Bloom recognised that the taxonomy was a reflection of the desired behaviours rather than the actual behaviours of students that they were classifying which is different from attempts to classify actual behaviour, or actual outcome.

Bloom et al's (1956) taxonomy of educational objectives provides a framework that allows for the construction of assessment tasks based upon the learning objectives specified by the goals of the educational process (Andrich, 2002). This model of competence suggests that there is a hierarchy, consisting of more than one construct underlying academic performance. At the top of the hierarchy is overall performance, then it is divided into three sub-components; cognitive, affective, and psychomotor skills (Anderson & Krathwohl, 2001). Each of these subcomponents has more specific facets associated with it. For example the cognitive component subsumes knowledge, comprehension, analysis, application, synthesis, and evaluation. Each of these more specific components have methods for measurement, which is the assessment of performance (Bloom et al., 1956).

This taxonomic structure is acknowledged as very useful and important in the literature on medical education. Albanese, Mejicano, Mullan, Kokotailo, and Gruppen, (2008) recognise that knowledge, skills, and attitudes, are the key underpinning qualities of competence in medical students. They suggest that these three underlying dimensions of competency are reflected in the aims of training medical practitioners. Knowledge is said to incorporate the scientific, technical, and intellectual capabilities required of the graduating students. Attitudes on the other hand are said to involve the underlying ethics, morals, empathy, and communication ability. Technical skills are said to involve investigative skills, and clinical skills, and use of technology. It is argued that it is essential that these qualities are instilled by medical education, and therefore should

underpin assessment. They suggest that any outcome based model of educational outcome should identify, define, and communicate the knowledge skills and attitudes that doctors need to possess. Wass, Van Der Vleuten, Shatzer, and Jones, (2001) concur and suggest that that the educational objectives of medical education typically follow the assessment of knowledge, skills, and attitudes which require multiple assessment methods in order to measure competence.

Bloom's (1956) taxonomic model is not affiliated to any particular subject in education. Instead it is designed as an overarching framework on which to base general curriculum decisions. It is a widely known and used by educators from many different disciplines including medical education, however this model is not without its weaknesses (Andrich, 2002). Bloom's taxonomic model has not been subjected to rigorous scientific examination as a model of student competence. Whilst it is widely accepted by medical educators that particular methods of assessment are assessing the underlying component of competence, this has not been previously subjected to systematic empirical testing. Schuwirth and Van Der Vleuten, (2006b) argue that this type of Knowledge, Skills, and Attitudes model of competence was abandoned in the 1980's however, more recent publications seem to still use it and acknowledge it as the accepted model of competence (e.g. Epstein & Hundert, 2002; Harden, Crosby, Davis et al., 1999). This is surprising considering the model has not been subjected to rigorous examination as a model of student competence. Nor has it been recognised as potentially important in educational research that uses academic performance as an outcome variable. Hence it can be seen that using a structured approach such as the taxomony may increase the precision of the outcome variables, and promote understanding of the nature of academic performance both for educators and research purposes (Anderson & Krothwohl 2001). Bloom's taxonomic model may be a useful basis for examining the structure of academic performance as it sets the limits for the desired

outcome of medical education; that is the optimal requirements in terms of the competencies required at the end of medical education.

This model has been used as a structure of the desired (or intended) outcomes of education as such, it has not previously examined in terms of actual academic performance. It can be argued that there is a difference between the intended outcomes of education and actual outcome of the educational process. If there were no differences then all students would perform at the same level of achievement and display the same qualities and competencies at the end of the process. The reality is that there is still variation in academic performance between students (Utzman, Riddle, & Jewell, 2007). Consequently although the intended outcome of education may be to develop competent and professional medical practitioners, the reality may be quite different.

The overall generality of the taxonomy can be seen to be both a strength and a weakness. The general nature of the taxonomy means that it is easily applicable across different disciplines (Anderson & Krothwohl, 2001). However, because it is so general, it does not consider the importance of content/subject matter. Therefore if this model was to be used as a method to model performance outcome variables in terms of research it may potentially omit nuances of the specific educational content and context. This may be particularly pertinent in professional education such as medical education, where ranges of competencies not covered by the taxonomy need to be assessed and understood (Wass, 2005). Therefore it may be useful to consider a model that is more specific to medical education and medical student academic performance.

2.3.2 MILLER'S PYRAMID MODEL OF COMPETENCE/ASSESSMENT. (MILLER, 1990)

A more recent attempt at classifying medical competence and assessment was devised by Miller (1990). The pyramid model proposed by Miller (1990) suggests that the underlying structure of assessment/competence consists of four hierarchical levels, 'knows', 'knows how', 'shows how', and 'does' (See Figure 2:1). At the base of the pyramid is the construct 'knows', which reflects scientific knowledge on which all other levels of the pyramid are based. Second is 'knows how' which reflects an ability to demonstrate and apply knowledge to decision making, and medical problem solving. The third level of the pyramid is the 'shows' which is where students demonstrate their skills and practical or procedural knowledge. Lastly at the top of the pyramid is the 'does' level which Miller hypothesised is the occurrence within medical practice after qualification. Each level corresponds with knowledge, competence, performance and action.

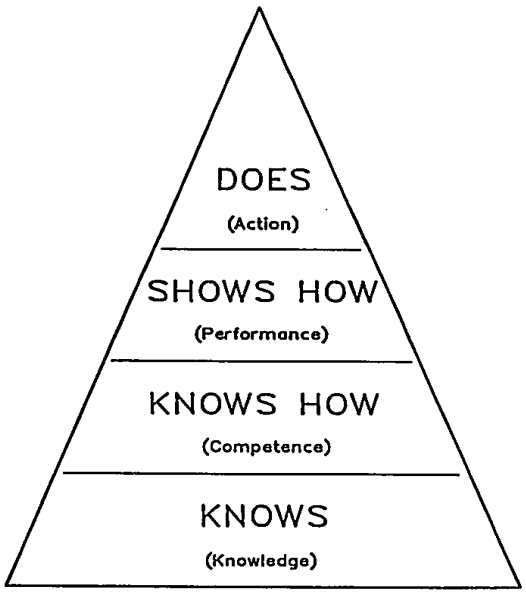


Figure 2-1 Miller's (1990) Pyramid Model of Assessment

It has been suggested that the four components can be represented by two overarching constructs; cognition and behaviour. It has been suggested that the top two levels of the pyramid reflect a behavioural aspect, and the bottom two levels reflecting a cognitive aspect (Wass, Van Der Vleuten et al., 2001). The cognitive components include the knowledge and competence, and is said to underpin the behaviour component, which consists of the performance and action. This makes sense as the top two levels of the pyramid require action and performance which are both forms of behaviour that can be directly observed in order to demonstrate competence (Pellegrino et al., 2001). The bottom two levels of the pyramid reflect more cognitive processes that may not be directly observable, but may be inferred from responses given to a representative sample of test items reflecting the area of expertise (Crossley, Humphris, & Jolly, 2002).

Miller (1990) argued that in order to be able to show or perform an action the student must first have the knowledge underpinnings, and have the necessary procedural knowledge. That is, a student must first possess the necessary knowledge, before they can know how to use that knowledge effectively. Following on from this, the student must know how to effectively use their knowledge before they can demonstrate (or show) how they effectively use their knowledge. According to Miller, at the top of the pyramid is the action level. This refers to when the student has graduated, and suggests that the students then go on to actually *use* their competences effectively in actual medical practice. Miller hypothesised that this pyramid framework underpins medical school competence and should be used to build assessment tools to match the competencies.

Miller (1990) suggested that there are particular assessment methods that assess the levels of this framework. This has been specified by more recent researchers (e.g. Harden, Crosby, Davis et al., 1999). It has been suggested that written tests such as multiple choice examinations are measures

of the 'knows' level, as they require students to have the necessary underpinning knowledge in order to perform successfully on the assessments. On the other hand, modified essay questions and short case histories, and patient management programs are tests of the competence level as they assess the students' ability to utilise knowledge for diagnostic purposes, and therapeutic procedures. Harden, et al., (1999) suggested that the performance level is assessed using observed structured clinical examinations (OSCE), patient simulators, and model devices designed for testing technical skills, because these tests measure a students ability to demonstrate competence in technical and clinical skills. (See figure 2:2).

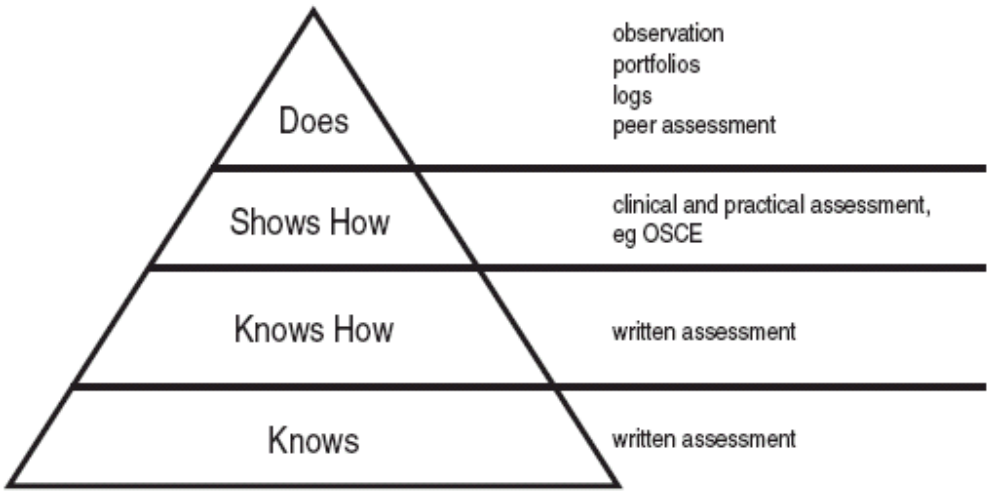


Figure 2-2 Miller's Model of Assessment with type of assessment proposed by Harden et al., (1999)

The Pyramid model has been recognised as a valuable and useful model for testing desired medical competence (Amin et al., 2006). It has been argued that the simplicity and intuitiveness of the model makes it a good model on which judgements about which assessment methods are appropriate can be based (Amin et al., 2006). It also provides guidance as to what students should be capable of achieving by the time they graduate from medical school (Rushforth, 2007). The

model is intuitive and has indeed been used as a basis for the development of assessment procedures and refinement of existing methods of assessment (Amin et al., 2006; e.g. Shumway & Harden, 2003).

There has been acknowledgement in the literature that assessment instruments are designed to assess different elements of desired competency in the manner suggested by Miller (1990). For example, Schuwirth, Verheggen, Van Der Vleuten, Boshuizen, and Dinant, (2001) compared short case exams to multiple choice exams in order to determine if the processes underlying these assessments were different. They found that short case history exams seemed to be measuring reasoning processes that correspond to the competence level of Miller's (1990) pyramid model of assessment. They found that this was in contrast to MCQ examinations which seemed to be measuring only factual knowledge, thereby further supporting Millers model. However, there were a number of weaknesses to the study. The researchers were examining newly devised measures of performance in the form of a short case history and an MCQ. They used a small sample size and compared scores between Year 5 medical students and practicing physicians. Therefore these findings may not be generalisable, nor reflective of the differences between the two types of examination in the first two pre-clinical years of medical school. However, having said that, Wilkinson and Frampton (2004) found evidence to support the distinctions between assessments. They used a more appropriate sample size, and also assessments that are currently in use in the undergraduate curriculum in order to examine the predictive validity of pre-clinical examinations. They found that performance on an observed structured clinical examination (OSCE) was predictive of clinical performance in medical interns. From their results they suggest that this reflects a distinction between written tests and OSCE's in that the written tests assess the competence level of Miller's pyramid, and OSCEs measure performance level of the pyramid.

This therefore can be seen to support the hypothesised levels of Miller's model of assessment/competence.

It appears that this model has been generally accepted as a model of assessment and competence in medical education without detailed scrutiny. However, the model is not without its limitations. The model uses confused definitions of both competence and performance, and does not clearly outline what is meant by the terms. It also has not been subjected to rigorous statistical testing to assess whether this model and the assessments associated with the levels of the model actually reflect the hypothesised underlying structure of competence or assessment (Rethans et al., 2002). In addition, as with Bloom's Taxonomic Model, Miller's Pyramid Model has not been used to explain actual medical student performance, it has only been used to explain the intended outcome of medical education. There are even books that set out which assessments should be used to assess which levels of Miller's Pyramid Model (e.g. Amin et al., 2006).

Miller's pyramid model of assessment seems intuitive, and is widely used as a structure for understanding what assessment measures are testing (McKinley et al., 2008). It is surprising to note that, whilst this has been used as a model for medical school assessment in determining the reliability and validity of specific assessment methods, this model has been ignored as a potential structure to organise academic performance outcome variables in research examining predicting performance. Typically, studies that examine the prediction of performance utilise single outcome measures without taking consideration of the potential for more underlying dimensions to medical school assessment. Miller's (1990) model may well provide a useful framework for the examination of individual differences in relation to different aspects of medical school performance. However, the framework itself first needs assessing as to its structure when examining actual performance rather than the desired outcome of medical education.

Therefore it appears that there are a number of potential models including Bloom's Taxonomic Model, and Miller's Pyramid Model, for describing the underlying structure of competence and assessment that may potentially be applied to academic performance. Nonetheless, these have not been rigorously tested when discussing actual academic performance instead, only desired outcomes have been examined. Therefore there is clearly a need to explore the structure of academic performance. In addition there are a number of weaknesses to the research literature examining both assessment, and academic performance as an outcome variable.

The following section will draw together and critically review the assessment literature and the educational outcome research literature to date. It will discuss the lack of an adequate definition of academic performance, and will criticise the heavy focus on the psychometric properties of tests at the expense of examining the structure of academic performance. It will discuss the result of the lack of discussion on the structure of academic performance in the educational outcome literature and the medical education literature, and will criticise the lack of testing of proposed models of assessment and competence and will suggest that these models can be tested by examining actual academic performance. It will conclude by stating that in order to utilise academic performance as an outcome variable, there is a need to determine the structure of academic performance in order that an accurate picture of what academic performance consists of in terms of its dimensions may be captured.

2.4 LIMITATIONS OF THE ACADEMIC PERFORMANCE RESEARCH TO DATE

There are a number of weaknesses and omissions within the research literature that only become apparent when three different but related academic research literatures are consulted. After synthesis of the educational assessment literature, the educational research that uses academic performance as an outcome variable, and the medical education literature, it becomes apparent that there has been a lack of communication, coherence or synthesis between these three disciplines and approaches to examining and defining educational performance outcomes.

Firstly, as has previously been noted, there has been a lack of adequately operationalisable definitions of academic performance. This is the case in both the educational literature and the assessment literature. Only the literature on competence has tended to incorporate elements of the three interlinked concepts of assessment, competence, and performance. Rethans et al., (2002) argues that a model for assessment should have clear definitions of concepts, have consideration of current levels of understanding of assessment and consider current theories and models of assessment. Whilst Rethans et al., (2002) were particularly focussed on assessment of actual medical practice; this argument can also be applied to academic performance as these considerations are applicable to any type of model. This thesis has provided a definition of academic performance that can be used as a basis for understanding the nature of academic assessment. Academic performance is therefore defined as a demonstration of a student's level of competence and mastery of a subject through completion of multiple assessment tests of competence in a particular domain of education (Anderson & Krathwohl, 2001).

In the literature that has taken an outcome-centric approach to examining academic performance, the focus has been the psychometric issues of reliability and validity of individual assessments,

and has tended to focus individual assessment methods rather than examining the commonalities between the different types of assessment (e.g. Wass, McGibbon et al., 2001). Whilst this research approach is useful as a check for quality in terms of whether a test is accurately measuring what it is supposed to be measuring, this focus has resulted in the relative neglect of an examination of the underlying structure of assessment (Van Der Vleuten & Schuwirth, 2005).

It is argued that the psychometric focus on assessment and competency has led to singularity in the assessment literature and that there has been a predominant focus upon developing a single assessment measure that is tested for reliability and validity in order to determine if the measure is superior to all others for assessing the particular level of competence (Schuwirth & Van Der Vleuten, 2004a). This approach is spurious as it is generally accepted in psychometrics that multi-methods are a more valid and reliable approach to assess a construct of interest (Schuwirth & Van Der Vleuten, 2006b).

At present, there are theoretical tensions regarding the level of analysis most appropriate and beneficial to the understanding of the educational process. Nonetheless it is important to take into consideration that a model of academic performance should maintain a level of generality that can enhance the understanding of assessment and ensure data handling are made more manageable, but also maintain a level of specificity that protects the richness of information (Schuwirth & Van Der Vleuten, 2004b). Andrich (2002) notes that the level of analysis of performance is important. They suggest that taking a construct such as a particular competency and dividing it into smaller components can increase the explanatory value of the construct. Andrich argues that at this finer level of analysis, the components can be used as outcome measures as single units or as part of an interactive hierarchy as this may provide more explanatory value. This principle could be applied

to academic performance as an outcome variable, in that it could be subdivided into component parts in order to increase the understanding of the complexities of academic performance.

Previous medical educational research has examined academic performance from a predictor-centric and largely atheoretical position generally identifying factors that only predict overall academic performance (Bartram, 2005). Although this has provided useful information about which individual differences may be important in predicting general outcomes, Bartram, (2005) argues that there is a necessity to refocus analysis on a more outcome-centred approach and instead identify individual difference variables that predict relevant outcomes. In addition, investigation should focus on the nature of the outcome and the way in which a particular predictor is relevant to that outcome. Accordingly outcome measures need to be differentiated in a meaningful way.

Although assessment methods and intended educational objectives have been classified into a taxonomical classification models (e.g. Bloom et al., 1956; Miller, 1990) there has been no attempt to classify actual academic performance according to such a model. It is therefore essential that academic performance is analysed in order to determine the underlying structure of actual academic performance. This may provide a basis for facilitating more accurate measurement and a more comprehensive understanding of the result of educational processes (Bloom et al., 1956). Shumway and Harden, (2003) explicitly call for research to examine medical school assessment and its underlying components as there is a distinct lack of focus on whether the assessment methods are reflecting the hypothesised underlying constructs.

In addition, it would also be useful to refine and incorporate the vast array of outcome measures into a model of performance in order that academic performance measures may be standardised

for research purposes. Creating a model of performance could potentially be useful in order to standardise performance outcome measures for the purpose of research. It may be able to provide a framework that can be used to make comparisons between various models of cognitive and non-cognitive predictors of performance.

It can be seen that there has been a lack of attention to the underlying structure of academic performance. Few studies have hypothesized about or examined whether there is an underlying latent structure to assessment methods in medical education. Typically when any type of analysis has been used on assessment methods, it has been in a psychometric manner in order to develop a composite academic performance score, rather than examining the structure of performance per se (e.g. McManus, Richards, Winder, & Sproston, 1996). The findings of a study by McManus, Richards, Winder, and Sproston, (1998) demonstrated a single underlying factor using principal components analysis. However, they also categorised their outcome variables according to modes of assessment and also according to subject. They therefore recognised that there may be more explanatory power from using more specific measures as outcome variables than only using general composite measures. It can be argued then that assessment can reflect a single underlying construct, reflecting level of competence however it is still possible that a more fine-grained analysis of assessment may reveal more than one underlying construct and have more explanatory value.

Although it is suggested that taking a latent construct approach to assessment may be a spurious approach to the development of assessment tools (cf. Schuwirth & Van Der Vleuten, 2006a) it can be argued that it is important to identify common elements within assessment. The vast majority of the literature has focused upon general outcomes and overall marks, and has generally neglected to consider assessment in terms of a multidimensional construct. Therefore a latent

structure approach may be an appropriate method for examination of assessment as a research outcome variable. This type of classification may provide framework of assessment as a basis for the examination of individual differences in performance.

Therefore it can be argued that it is necessary to delineate assessment into meaningful components that can be generally applied and tested and may inform instructional theory and design and medical education research (Bartram, 2005). It is recognised that using every single assessment method as outcome variables in an analysis is not feasible. Snow (1989) suggest that it might instead be useful to reduce the multivariate description of performance to a few more parsimonious dimensions using techniques such as factor analysis with little loss of the richness of information.

Medical education provides a unique opportunity to examine assessment types as a wide variety of modes of assessment are used to measure medical school performance (Furnham & Medhurst, 1995). Therefore it is essential to examine the potential for an underlying structure of assessment that best describes the covariance between modes of assessment. Traditionally, the objectives of assessments in medical training have been divided into three components that correspond to Bloom's (1956) taxonomic classification of knowledge, skills, and attitude. Although Wass, (2005) argues that the three general dimensions of competence are interlinked, they make no suggestions as to *how* these competencies are interrelated.

Studies have also made key assumptions about the outcome measures that have been used as indicators of medical student performance. It has been assumed that a composite measure of overall medical school academic performance is an adequate reflection of what constitutes

performance. In medical education, there are a number of methods that are used to assess medical student's skills and knowledge. Each of these assessment methods may require different competencies in order to succeed. Therefore it can be argued that utilizing an overall composite score may potentially overlook key information regarding the importance of particular characteristics that influence performance (Cronbach & Snow, 1977).

There is also a need to ensure that assessment methods in their sum total have clearly addressed the goals of medical education and have appropriately assessed all of the relevant competencies for a graduate to begin a career in medicine (Wass, 2005). By assessing the underlying structure of assessment, it may be possible to determine whether the assessment methods used in medical school reflect the competencies on which assessment is meant to be based. In addition, when performance has been operationalised as an outcome variable, the typical approach has been to use a composite measure of overall performance (e.g. McDonough, Horgan, Codd, & Casey, 2000) or performance on a single examination (e.g. Furnham & Chamorro-Premuzic, 2004). It is argued that this approach may have concealed important differences in assessment types and academic performance variables that may be relevant in predictive validity studies.

There is a need to take a multidimensional approach to assessment, and incorporate it into a competence based, outcome based approach to medical school outcomes (Shumway & Harden, 2003). This type of approach would help improve the understanding of the processes and concepts underlying assessment and performance of competencies. This means that there is a clear need to assess the underlying structure of assessment, and clarify the interrelations and commonalities between assessment methods. This may also help to demonstrate how each assessment strategy is mapped onto each competence.

Due to the heavy focus on the psychometric properties of assessment methods, there has been very little attention paid to the development of theories of assessment and explanatory models of assessment (Schuwirth & Van Der Vleuten, 2004a). The only models that have been proposed have tended to be accepted based on face validity, and not yet subjected to rigorous scientific statistical testing. It is noted also that there seems to be a curious paradox within the assessment research literature. Whilst there has been the focus upon the psychometric properties of individual assessment methods, and rigorous testing of the methods, there has been a notable lack of the same rigor applied to the discussion of models of assessment and performance. It seems that models of assessment have been loosely proposed and then accepted as accurate models on which curricula decisions and learning outcomes should be based (e.g. Miller, 1990). Although these models have been proposed by eminent researchers in the field and based upon years of experience in the field of medical education assessment, it seems that these models have not been subjected to the necessary structural or statistical scrutiny. This type of scrutiny is imperative in order to determine whether assessment methods are actually measuring the competencies, and the hypothesised underlying structure of competencies, and actual academic performance.

Schuwirth and Van Der Vleuten, (2006a) argue that there is a need for medical education research to improve the scientific rigor by which it is conducted, particularly where assessment of competence is concerned. They argue that there needs to be clear strong research questions, supported by clearly operationalised definitions, with the use of appropriate methodology and analysis in order to provide strong scientific research evidence. There has been a recognition within the literature that some assessment methods can be representative of more than one general competence dimension, and that assessment methods sometimes do not reflect the obvious competence (e.g. Wass, 2005). However, there has been very little statistical analysis that has

examined the structure of the underlying components of assessment. Therefore it appears that to date, models of assessment, competence, and academic performance have suffered due to the lack of the necessary development and testing process. In addition, the focus has been on individual assessments rather than consideration of the structure of academic performance. It is also evident in the literature that has examined predicting performance that there has been no clear operationalisation of what the outcome measure is actually measuring, rather that it claimed to be measuring 'performance' of which it was undefined.

Snow and Swanson (1992) explicitly call for research to examine assessment in the instructional situation. They argue that the development of a theory of assessment is imperative, in order that a comprehensive understanding of academic outcome can be achieved. Campbell, (1990) suggests that outcome measures need to be defined and structured in a meaningful way in order to provide a richer understanding of the structure of academic performance variables, and allow a more thorough investigation of their interactions with predictor variables. Developing a classification of assessment may aid the structuring of educational planning and provide a basis for examining the role of assessment in the educational context (Bloom et al., 1956). Nonetheless, examining the dimensionality of academic performance has not had the attention from the research community at a level that it merits. If academic performance is to be used as an outcome variable it is essential that the constitution of variables; the structure and function are clearly determined. It may then be possible to elucidate the relationship between personal characteristics and academic performance. Therefore it is important to examine assessment types in order that an accurate representation of academic performance can be achieved.

The synthesis between the assessment literature, the medical education literature and the educational outcome literature that this thesis provides is long overdue. The assessment literature

has attempted to classify academic performance in terms of learning outcomes that they are designed to measure, or the particular competencies that they are designed to measure. However, the assessment literature has based these decisions on models that have been proposed without strong research evidence to either support or refute such models. In addition, the educational outcomes literature, and the medical education literature appears to struggle in grasping the idea that academic performance may be anything other than either a simple examination grade or an aggregated measure of general overall performance. This has been as a result of the tendency to focus more on the predictors of performance rather than the performance variables themselves (Hough & Oswald, 2000).

In order to more accurately represent academic performance, it is necessary that the structure of performance is analysed, and that models of performance are proposed and subjected to rigorous statistical analysis. This would clarify the dimensional construction of academic performance; that is whether or not it is a multidimensional construct. The following section will present potential models of actual academic performance in medical school. These models will be based upon either the competencies being measured by assessment, the structure of assessment, or the subject being taught prior to assessment.

2.5 POTENTIAL STRUCTURE OF ACADEMIC PERFORMANCE IN MEDICAL SCHOOL

Based on the preceding literature review, this section will outline the competing potential models of the structure of academic performance and assessment in medical school. These models form the basis for the analysis presented in the first two results chapters that explore the number of dimensions underlying academic performance in the first two years of medical school.

It can be argued that using a hierarchical facet approach to assessment may be beneficial for understanding the underlying nature of assessment (Cronbach & Snow, 1977). This approach suggests that a construct can be described in terms of a single super-ordinate construct that subsumes two or three facets, and within each facet there may be different operational levels (Corno et al., 2002). In relation to academic performance, this might mean that one overarching construct may reflect overall academic performance however this may be delineated into separate facets of competence. It may be that the underlying latent structure may reflect; content, operation, or product, or may reflect some combination of all three concepts (Guilford, 1972). It could be argued that content could reflect the themes taught in medical education; that is the subject matter that is taught and consequently assessed. Operation could reflect the mode and type of assessment used. This could refer to the structure of assessment such as written, observed, or practical, and time constraints placed on assessment. Product may reflect competency demonstrated by performance on assessment. Before the underlying structure of academic performance is examined, it is necessary to determine the common features of assessment. Table 2-1 shows how the assessments are similar, in mode, time constraints and competence that it is designed to assess. A cross in the box denotes the presence of this feature for that assessment method. It can be argued that all assessments have a common element of an assessment of the knowledge of the student in addition to having differential features (Anderson & Krathwohl, 2001). These categorisations are based upon the categorisation of assessments by Harden et al., (1999). It can be seen from Table 2-1 that the assessment methods have features that are similar such as the length of the time constraint, assessment of knowledge, assessment of skills such as written communication, verbal communication, and practical skills. The assessments can also be categorised according to type of assessment in addition to the competencies that they are designed to measure.

Table 2-1 Categorisation of assessment methods according to time, competency and assessment type

	Mode: Time		Competency					Mode: Assessment Type		
Assessment method	**Short time constrained (max. 2hrs)**	**Long time constraint (days/weeks)**	**Assessment of knowledge**	**Assessment of Attitude**	**Assessment of practical skills**	**Assessment of verbal communication skills**	**Assessment of written communication skills**	**Written**	**Observed**	**Practical**
Multiple choice exam	♦		♦					♦		
True/false/abstain exam	♦		♦					♦		
Short essay exam	♦		♦				♦	♦		
Short notes exam	♦		♦				♦	♦		
Practical exam	♦		♦		♦	♦				♦
Seen case history analysis	♦		♦		♦		♦			♦
Observed structured clinical exam	♦		♦	♦	♦	♦	♦		♦	♦
Oral presentation	♦		♦	♦	♦	♦			♦	
Practical coursework		♦	♦		♦				♦	♦
Written coursework		♦	♦				♦	♦		

2.5.1 SUBJECT CONTENT MODEL OF ACADEMIC PERFORMANCE

Norman et al., (1987) argued that content is the most important factor underlying assessment methods. As assessment methods are used to measure academic performance, it is therefore possible that the content of the assessments may provide the framework for understanding the dimensions underlying academic performance (Willett, Marshall, Broudo, & Clarke, 2008). Therefore it is possible that the underlying structure of academic performance might logically be clustered together based upon the content of the tests. However this is yet to be determined.

It is therefore possible that performance on assessment may cluster in terms of either themes, or modules. Potentially, the underlying structure of assessment could be reflective of the content of the taught curriculum, and therefore performance may represent competence in the content that has been taught. However, classifying the dimensions underlying performance according to the module being taught would reduce academic performance to a level that could be considered too specific. On some modules, only a single examination is used to assess the student's competency in the area of study. Therefore this approach would suffer from the same methodological criticisms of it being weak and unreliable as suggested by Furnham and Medhurst (1995). It may be therefore more beneficial to model performance based on the themes underlying medical education.

An example of how the content of assessment may cluster assessments together may be derived from a study undertaken by Ferguson, James, O'Hehir, and Sanders, (2003). They categorised preclinical performance outcomes according to four themes because these themes represent the structure of teaching and content of the undergraduate curriculum at Nottingham University Medical School. Theme A represents "the cell", incorporating molecular and cellular aspects of medicine, Theme B represents "the person", incorporating human structure

and function, Theme C represents "the community", incorporating health care in the community, and Theme D represents "the doctor", incorporating early clinical and professional development. Although it was not explicitly examined whether this structure of the performance measures is an accurate reflection of the latent constructs underlying academic performance and assessment, it does not rule out the possibility that analysis of the latent structure of assessment may demonstrate this type of structure.

If the structure underlying academic performance in medical school was reflective of content, then course modules and the assessments associated with those modules would be expected to share common variance using Principal Components Analysis. Theme A (the cell) would consist of Clinical Laboratory Sciences, and Molecular Basis of Medicine. Theme B (the person) would consist of Musculoskeletal System, Human Development, Cardiovascular Haematology and the Respiratory System, Structure Function and Pharmacology of Excitable Tissues, Functional and Behavioural Neuroscience, Alimentary System and Nutrition, General and Biochemical Pharmacology, Metabolism and Nutrition; Endocrine and Kidney. Theme C (the community) would consist of Behavioural Sciences and Public Health Medicine, and Theme D (the Doctor) would consist of Communication Skills, and Early Clinical and Professional Development. It can be seen that there is higher proportion of modules that are related to theme B. There is a heavy focus of teaching of the biomedical sciences in the first two preclinical years of medical school. This is due to the basic biomedical sciences being the knowledge base that underpins the practice of medicine (Donnon & Violato, 2006).

2.5.2 MODE OF ASSESSMENT MODEL OF ACADEMIC PERFORMANCE.

Mode of assessment can be categorised in two ways; duration of assessment, and type of assessment. If the underlying structure of academic performance was reflective of time constraints, then this would likely show a distinction between short time constrained examinations and coursework that allows longer duration for completion. Therefore a two factor solution to a Principal Components Analysis would be found if time constraints reflected the underlying dimensions of academic performance. However, it seems that this model may be too simplistic in its explanatory value in medical education. As Hough and Oswald, (2000) argue, medical education is a multifaceted and therefore such a simplistic model may obfuscate the true nature and structure of performance on assessment.

It is possible that the mode of assessment may reflect the underlying structure of academic performance. Mode of assessment can be categorised as either; written, practical, or observed. Written tests include tests using pen and paper, such as multiple choice exams, and written coursework. The practical mode could incorporate assessment methods that involve assessing practical skills such as spotter exams and clinical reasoning tasks. The observed mode could incorporate assessment methods that are rated by independent observers including oral presentations, and OSCE's. As a structure for medical school academic performance, this has not previously been examined.

2.5.3 COMPETENCY MODEL OF ACADEMIC PERFORMANCE.

Epstein and Hundert, (2002) argue that it is important to establish whether assessment methods matches the objectives of medical training, and identify the features of competency that the assessment methods measure. Competence can only be inferred from directly measured performance variables, therefore it would be useful to determine which aspects of competence that the performance variables reflect (Pellegrino et al., 2001). A clearer picture

of the nature of assessment and its underlying structure of components would be gained as a result.

Based on the previous research that has modelled intended competence and assessment as discussed earlier, there are potentially two models of competence that may explain the underlying structure of academic performance; Bloom's (1956) Taxonomic Model and Miller's (1990) Pyramid Model. By examination of Table 2-1, and from the dimensions proposed by Bloom, it can be seen that it is likely that written assessments such as multiple choice exams, true/false/abstain exams, short essay exams, short notes exams, and written coursework would be reflective of the dimension of knowledge. Skills would contain assessments such as practical exams, OSCE's, practical coursework, and seen case history analysis. Attitudes would contain oral presentations, OSCE's are likely to have some relationship with this factor also as OSCE's involve interaction with simulated patients and therefore attitudes could be an influential factor in OSCE performance.

If Miller's (1990) Pyramid Model explained the underlying structure of academic performance, it is likely that model proposed by Harden, et al., (1999) would be reflective of how the performance variables would be interrelated. That is, "Knows" would involve written assessments such as multiple choice exams, true/false/abstain exams and written essays both under exam conditions, and coursework. "Knows how" would also involve written assessments. However they would be more likely to involve case history analysis, and short notes exams which require students to demonstrate that they can diagnose a problem based upon a short vignette. The "Shows how" level would incorporate practical exams, practical coursework, oral presentations, and OSCE's as these all require students to behaviourally demonstrate their competencies.

There is a need to determine which of the potential models presented is representative of the underlying latent dimensions of academic performance. Determining the underlying structure of academic performance would allow a clearer understanding of academic performance as an outcome variable and what academic performance actually pertains to. The first results chapters will examine the underlying structure of academic performance. It will explore the whether academic performance is a multidimensional construct using a principal components analysis.

2.6 SUMMARY AIMS AND RESEARCH QUESTIONS

The preceding discussion has shown that there is a discrepancy between the educational literature, the medical educational literature, and the assessment literature as to the dimensionality and structure of academic performance. The educational and medical educational literature viewed academic performance as a unidimensional construct. There has been a tendency to aggregate scores on assessments into a composite score to reflect overall performance, or used single examination scores to reflect performance. The assessment literature however, has suggested that performance on assessment is multidimensional by nature. They specify that performance on assessment is determined by competency and assessment type. They have specified models according to learning outcomes, and the desired educational objectives of medical education. However, they have neither rigorously tested these models of performance, nor specified models for the underlying structure of actual academic performance on assessments. Instead there has been a tendency to focus on the psychometric properties of individual assessment methods in the main, but not assessed the models with the same statistical rigor. Therefore it can be seen that there is a need to determine the underlying structure of academic performance for four key reasons; It is important to determine if the underlying structure of performance on assessment measures corresponds to existing models of competence, or whether the structure corresponds to the content of the assessments, or the mode of assessment. It is important to understand the

commonalities and the relationships between performances on different assessment methods, as this could have implications for using academic performance as an outcome variable. It is necessary to determine which assessments are reflective of which medical competencies, in order to identify how each assessment is reflective of, and maps onto medical competencies. This would provide a clearer picture of the relationships between competency, assessment, and performance and to provide a more sensitive measure of academic performance that has more explanatory value than a unidimensional view of academic performance.

Finally, it is essential to examine the structure of performance, in order to provide a clearer understanding of the nature of the outcome variable used for predicting performance. This is in order to provide the same level of generality and specificity when predicting performance from individual difference variables.

There is a necessity to refocus analysis of academic performance in medical school to a more outcome-centred approach and explore the structure of performance. This may help explain why a predictor is particularly predictive of a particular type of outcome. Accordingly outcome measures need to be differentiated in a meaningful way. The structure of assessment and the performance outcome variables have not been previously considered in this manner in medical educational research studies. Therefore, this thesis aims to examine the underlying latent structure of performance on assessments that are designed to measure medical student levels of competence in order to outline academic performance as a multidimensional hierarchical construct.

The first research question that is going to be examined is:

What is the most explanatory number of components that summarises academic performance during the first two years of medical school.

2.7 NEXT CHAPTER

The next chapter will provide the second literature review chapter. It will critically discuss the research that has examined performance in medical school from a predictor-centric approach. This chapter will first focus upon what is meant by predictor of academic performance, it will then discuss both cognitive and non cognitive characteristics that have previously been shown to be related to performance. Previous academic performance, cognitive ability, personality traits, and learning styles will be discussed as predictors of academic performance, and in particular performance in medical school.

This chapter will then critically discuss the current theories and models of the predictors of academic performance. Each of the models will be critically discussed and evaluated for their explanatory value in relation to medical school academic performance. This chapter will then evaluate two psychological constructs, and five dispositional characteristics that have not previously been examined within the context of medical education. It will be outlined why these constructs could potentially be influential in medical school performance.

3 LITERATURE REVIEW: PREDICTORS OF ACADEMIC PERFORMANCE

The purpose of this chapter is to critically review the research that has examined academic performance from a predictor centric approach. This review will focus on outlining and critically evaluating the research that has previously examined determinants of academic performance. It will be argued that predicting performance needs to be approached using an integrative framework in order to maximise the understanding of factors that influence academic performance (Chamoro-Premuzic & Furnham, 2005). This will be argued in terms of recognising that it is important to examine the determinants of academic performance within an integrative framework instead of taking the individualistic approach that seems to have occurred thus far within the field (Ofori & Charlton, 2002). The chapter will finish by arguing that it is important to also consider the structure of assessment in predicting academic performance. And will be concluded that it is important to develop an integrative framework incorporating both a model of determinants and a model of academic performance (Snow, 1996a).

This chapter will first outline the importance of examining predictors of academic performance in medical school. It will then discuss and evaluate the research that has examined the relationship between various cognitive and non cognitive factors and academic performance. This will involve a discussion of the literature that has examined previous academic performance, cognitive ability, personality traits, and learning styles as determinants of academic performance as these are the most commonly identified predictors within the medical education literature (Ferguson et al., 2002). The discussion will focus upon the research that has examined the prediction of undergraduate academic performance in medical school, however, it will also integrate research that has examined academic performance in undergraduate education in general as it is intuitive that there are distinct but overlapping issues that would relate to academic performance in medical school.

This chapter will then proceed to present and evaluate eight dispositional characteristics that have not previously been examined within the context of medical education. It will be outlined why these characteristics could potentially be influential in medical school performance. This will include a critical discussion of the potential usefulness of; need for cognition, motivational traits, social desirability, dispositional negative affectivity; (incorporating dispositional stress, anxiety, and depression) narcissism, and empathy in predicting performance in medical school.

The review will then critically discuss the theories and models of the determinants proposed to explain general academic performance. This will incorporate a discussion of, Aptitude Complex Model (Snow, 1989; Wagner, 2000), PPIK (Ackerman, 1996), and Intellectual Competence Theory, (e.g. Chamorro-Premuzic & Furnham, 2005; Furnham et al., 2003). Although it is notable that the majority of these theoretical models are intended to explain general academic performance, each of these models will be critically discussed and evaluated for their explanatory value in relation to medical school academic performance in particular.

3.1 THE IMPORTANCE OF PREDICTING ACADEMIC PERFORMANCE IN MEDICAL SCHOOL.

Researchers have long been interested in factors that may be predictive of, or be related to, academic performance in medical school (e.g. Ferguson et al., 2002; Hart et al., 1981; Melton, 1955; Mitchell, 1990; Payne, Davidson, & Sloane, 1966). This interest stems from theoretical as well as practical reasons. Practically, it is useful to understand factors that can influence academic performance in order to inform and improve selection procedures. It may also inform pastoral care to support those students that are likely to struggle on the rigorous and demanding medical degree course (e.g. Yates & James, 2006). This is important as every year there is approximately twice the number of applicants for entry to UK medical schools than places available (Richardson et al., 1998). Therefore it is essential that the system used and the tools employed for selecting candidates are not only as fair as possible (Maxwell & Arvey, 1993), but are able to detect the candidates that possess the qualities necessary for academic success and desirable for a career in medicine (Neame, Powis, & Bristow, 1992).

Although the selection procedures are designed to select those students who are likely to succeed, attrition still occurs in medical school. A substantial number of students fail the course, drop out, or transfer before completion. Parkhouse, (2001) estimated that approximately 11% of medical students failed to qualify between 1990 and 2000. Therefore, it is essential that the selection procedures can determine who is most likely to succeed on the course (Hendren, 1988). Naturally, attrition is of some concern, as this is a waste, not only for the student's time, effort, and money, but also for the university and the British taxpayer (Grover & Smith, 1981). Theoretically, it is useful to understand the factors that are likely to influence success in a particular domain of life such as academic settings in order to understand why some people become more successful than others in particular life domains such as education or occupation (Barrett & Depinet, 1991).

3.2 INDIVIDUAL DETERMINANTS OF ACADEMIC PERFORMANCE

Previous research has identified numerous factors both cognitive and non-cognitive that are predictive of academic performance (Ferguson et al., 2002). Usually, these characteristics have been examined as independent entities, or in arbitrary combinations. Typically, the impact of such characteristics on academic performance have been reported in isolation within the literature (Ofori & Charlton, 2002). These characteristics include; previous academic performance, cognitive ability, personality, and learning styles. Each of these characteristics will now be discussed in turn in relation to performance on the medical undergraduate degree. It has more recently been recognised by researchers that other less traditional dispositional characteristics are also worth investigating in relation to academic performance in medical school (e.g. Bore, Munro, Kerridge, & Powis, 2005; Munro, Bore, & Powis, 2005; Neame et al., 1992). This is in response to the requirement that the selection process needs to distinguish dispositional characteristics that are desirable for a career in medicine (Powis, 2003). Therefore this discussion will present potentially useful dispositional characteristics that have previously been overlooked.

3.2.1 PREVIOUS ACADEMIC PERFORMANCE

In undergraduate education, it is assumed that prior academic performance reliably predicts future academic performance (Green, Peters, & Webster, 1993). Indeed, research spanning fifty years has demonstrated the predictive validity of prior academic achievement on future performance (e.g. James & Chilvers, 2001; McManus et al., 2003; Melton, 1955; Payne et al., 1966). Research across the world has demonstrated the predictive validity of academic performance prior to entry into medical school (e.g. Kreiter & Kreiter, 2007; Markert, 1985) and has shown that high scores on qualifications obtained prior to medical school predict higher scores throughout the academic component in medical school (e.g. McManus et al., James & Chilvers, 2001; McManus, Powis et al., 2005).

Hewer, (1956) examined the usefulness of school Grade Point Average (GPA) in predicting medical student performance, he found that GPA was predictive of overall medical school performance. Collins, White, and Kennedy, (1995) examined scores on school leaving examinations in New Zealand in relation to academic performance in medical school. They found that school examination score was significantly related to and predictive of medical school GPA in the preclinical academic component of the course. However, only 16% of the variance in medical school GPA was explained by previous academic performance. Also previous academic performance was not predictive of performance on Observed Structured Clinical Examinations (OSCE's) which form an integral part of assessment in medical school (Rushforth, 2007).

These findings show that a large proportion of the variance in academic performance in medical school is left unexplained if only academic grades are examined as predictors. Shen and Comrey, (1997) examined the academic performance of students in an American medical school, they utilised premedical GPAs to predict performance alongside the entry examination required in the USA; the medical college admissions test (MCAT). They found that both premedical GPAs and scores in the MCAT were significantly positively related to medical school GPA. When entered into a multivariate analysis however, only scores on the MCAT were strongly predictive of the sciences element of the course. They also found a weak effect of the MCAT and premedical GPA on the clinical aspects of the course.

In his review of the literature, Anderson, (1990) noted that research has shown that science GPA in college was the best predictor of preclinical performance in medical school. He also acknowledges the lack of predictive validity of college GPA for clinical performance. It has been shown that the predictive power of premedical GPA is reduced with each passing undergraduate year, and therefore is most relevant for predicting performance in the first couple of years at medical school (Powis, Hamilton, & McManus, 2007). It must be noted

however, that the findings of non-UK research (e.g. Shen & Comrey, 1997) may not be as applicable to academic performance in medical school in the UK, as the educational system varies in a number of important ways. In the USA, students attend high school, then they obtain an undergraduate degree before they are allowed to specialise in medicine as a postgraduate (Evans & Wen, 2007). Therefore when GPA is discussed in American studies, preclinical GPA actually refers to undergraduate performance rather than school performance. Therefore the system may not be comparable to UK undergraduate medical student performance.

In the UK, the qualifications that students take at school are the General Certificate of Secondary Education (GCSE), and at further education level, students take the Advanced Level Qualification (A-Level) prior to undertaking an undergraduate medical degree at university. Research examining the predictive validity of GCSE's has shown that GCSE grades are predictive of A-level grades (Richardson et al., 1998), and GCSE grades are related to passing the preclinical medical course, getting a first class honours and passing the BMBS clinical aspect of the medical course (James & Chilvers, 2001). Thus it seems that GCSEs influence medical school performance both directly and indirectly through its relationship with A-Levels. Directly, it seems that GCSE scores are predictive of both the preclinical and the clinical aspects of the medical course. This supports the assertion that previous academic performance is an important predictor of academic performance in medical school (McManus et al., 2005).

Richardson et al., (1998) argues that previous academic attainment should be considered one of the most valid and reliable indicator of the academic potential of a candidate. Indeed, A-Levels have been shown to be predictive of final year examination performance and career outcomes in doctors (e.g. McManus et al, 2003). High A-level grades, particularly in the sciences subjects, have been shown to be related to passing the final examinations in the

BMedSci and obtaining a first class honours degree (e.g. James and Chilvers, 2001). Large cross institutional studies have also demonstrated that there are strong correlations between A-Level performance and university performance, (e.g. McManus et al, 2005; Montague & Odds, 1990) and these findings are robust even when the inevitable range restriction and statistical artefacts are controlled for (e.g. Roth, BeVier, Switzer, and Schipmann 1996). Nonetheless, A-levels have only shown weak or no relationship with clinical experience in medical students (McManus, Richards, Winder, and Sproston, 1998). Therefore in the UK, previous academic performance as measured by A-Level scores have been shown to be in predictive of, and related to the academic and scientific component of the medical degree but not always of the clinical component.

Although performance at A-level in the UK seems to only be strongly predictive of the academic components of the medical degree, in order to progress to the clinical aspects of the course, it is first necessary to pass the preclinical academic components (Richardson et al., 1998). Therefore it is still important to include academic performance as a predictor as it is clearly a precondition to progression. McManus et al., (2003) argues strongly that previous academic achievement is a reliable predictor of student performance and should continue to be used to select students for medical courses. Previous academic achievement shows that the candidate can demonstrate a minimum level of competence and has the basic knowledge on which to build and integrate new knowledge. Previous academic achievement is also considered by some researchers as an indirect measure of ability (e.g. Roth, BeVier, Schipmann, & Switzer, 1996). It is argued that a reasonably high level of cognitive ability is necessary for a candidate to be capable of scoring high grades at A-Level and GCSE. In addition to demonstrating levels of cognitive ability, previous academic performance may also demonstrate the motivation and study skills that may be necessary to be successful in an undergraduate medical course.

Although it can be seen that previous academic performance is predictive of performance in the preclinical years of the medical degree, the validity of using academic criteria alone for selecting the right candidates for a career in medicine has been called into question (Neame et al 1992, Powis, 1998, Rahbar, Vellani, Sajan, Zaidi, and Akbarali, 2001, Patterson, Ferguson, Lane, Farrell, Martlew, and Wells, 2000). Selecting students on the basis of academic grades may be a cost effective and efficient method for assessing suitable candidates. However, it is well recognised that it is not sufficient in isolation for assessing suitable candidates who are potentially going to become practicing physicians (Powis and Rolfe, 1997). It is argued that having the ability to achieve high academic grades does not necessarily mean that the candidate will have suitable personal attributes such as a caring disposition, and the appropriate motivation for a successful career in medicine (Powis et al., 2007). McManus et al (2003) argue that although A-levels are predictive of academic performance on the preclinical medical course, other personal facets must be considered that may be predictive of other relevant outcomes. Powis and Rolfe (1997) suggest that a more ecologically valid approach would be a consideration of a combination of both cognitive and non-cognitive factors in predicting academic performance in medical school.

3.2.2 COGNITIVE ABILITY

General cognitive ability is argued to be a complex mix of constituent abilities incorporating numerical, verbal, spatial, reasoning and problem solving abilities which can be defined in terms of one underlying factor relating to the ability to learn (Masunaga & Horn, 2000). Each constituent factor is argued to be required in varying degrees, dependent upon the demands of the task or situation, thus cognitive ability is a capacity measure of maximal performance (Lubinski, 2000). There is consensus amongst some researchers that cognitive abilities can be represented in a hierarchical theoretical framework which consists of a general intelligence factor and specific ability factors (Mustafa, Farnham and Crump, 2003). The general ability factor was first proposed by Spearman in 1927 as the underlying general ability factor (g) that

underlies all types of ability (Moutafi, Furnham, & Crump, 2003). Cattell (1987) extended this theory and suggested that ability can be divided into two types; fluid and crystallized. Fluid intelligence represents an optimum efficient level of processing capacity, and reflects all types of reasoning ability (Robinson, 1999). Crystallized intelligence represents the ability to structure, organise and acquire knowledge which is dependent upon education (Undheim & Gustafsson, 1987). Fluid intelligence is the factor that tends to be inferred from traditional cognitive ability measures, whereas crystallized intelligence can be inferred from academic achievement (Chamorro-Premuzic and Furnham, 2004) therefore representing typical and maximal cognitive functioning. Evidence from correlational research examining both fluid and crystallized intelligence suggests that both factors have one common underlying element; a general intelligence factor (g) (Hunt, 2000).

Cognitive ability measures have been shown to be a consistently significant predictor of training performance (e.g. Hough & Oswald, 2000; Kuncel, Hezlett, & Ones, 2004; Salas & Cannon-Bowers, 2001) academic performance (e.g. Petrides, Chamorro-Premuzic, Frederickson, & Furnham, 2005) and consequently job performance in a number of occupations (Bartram, 2005; Furnham & Chamorro-Premuzic, 2004; Lievens, & Coetsier, 2002; Schmidt & Hunter, 2004) High levels of cognitive ability have been shown to be related to better performance both academically and occupationally, and related to higher occupational level, and higher income level (Schmidt & Hunter, 2004). These findings have been consistently shown in both longitudinal, and cross-sectional studies, demonstrating the pervasive influence of cognitive ability on performance outcomes (e.g. Bartram, 2005). Cognitive ability has also been shown to be related to a wide variety of life outcomes, is relatively stable over the lifespan and has been shown to have a genetic basis (Sternberg & Kaufman, 1998).

It has been argued that utilising a general cognitive ability measure when selecting students is a simple and efficient method that can provide generalised information on an individual's

ability capacity regardless of background (Kuncel et al., 2004). It could be considered a valid and reliable tool for discriminating between the able and less capable students (Oswald, Schmitt, Kim, Ramsay, & Gillespie, 2004). Indeed, Salas, and Canon-Bowers, (2001) argues that general cognitive ability is influential in skill acquisition and job knowledge acquisition, therefore those individuals who score highly on cognitive ability are more likely to learn more, be more efficient learners, and be more effective at knowledge integration leading these individuals to be more successful in job training. Therefore it can be considered an important predictor of academic performance in medical school and necessitates inclusion in studies that predict academic performance in medical school.

3.2.3 PERSONALITY

Guilford, (1959) defined personality traits as "any distinguishable, relatively enduring way in which one individual varies from another". This definition describes traits as a descriptive summary of an individual's personal characteristics, that is, a personality trait can describe the expressed behaviour of a person (Larsen & Buss, 2005). Although this definition acknowledges the individual differences in explanations for behaviour, and can be useful for describing differences between groups of individuals, it does not take into consideration the potentially causal nature of personality traits (G. Matthews, Deary, & Whiteman, 2003). A more recent definition of personality traits was proposed by Funder, (1997) who suggested that personality traits can be defined as "an individual's characteristic pattern of thought, emotion, and behaviour, together with the psychological mechanisms-hidden–or-not-behind those patterns" (Funder, 1997, pp1-2). This definition is more comprehensive than that proposed by Guilford, (1959) in that it refers to both the descriptive and the causal nature of personality traits.

Up until fairly recently, personality psychologists were in disagreement regarding the number and structure of personality traits. Cattell, (1943) believed that there were sixteen core

personality factors, whereas Eysenck (1952) believed that personality traits could be reduced down to three super-ordinate traits that were biologically based. However, Cattell's model has been criticised for lack of supporting evidence for the sixteen personality factors (Eysenck, 1987). Nonetheless, Eysenck's model has also been criticised but for lack of comprehensive coverage of all personality trait descriptors (Goldberg, 1990).

One approach explaining personality traits that has achieved a greater degree of consensus than any other trait taxonomy and the models containing five super-ordinate personality traits (Larsen & Buss, 2005). Within this five trait framework, and using a lexical approach, it is generally accepted that all personality descriptors that exist within language can be parsimoniously explained by five super-ordinate constructs known as the Big Five (Digman, 1990). The Big Five is a lexical taxonomical framework for understanding personality and consist of Surgency (extravert, assertive, adventurous), Agreeableness (kind, co-operative, trustful agreeable), Conscientiousness (responsible, organised, hardworking), Emotional Stability (contented, relaxed, calm), and Intellect (analytical, imaginative, curious). The Big Five approach arranges personality traits into a hierarchy with personality descriptions being arranged according to their similarities and interrelationships. The Big Five factors are determined factor analytically based upon statistical analysis of trait descriptors (Goldberg, 1990).

Trait models such as the Big Five propose that personality consists of broad stable traits and individuals can be characterised as possessing particular levels of these stable traits that in turn can determine a persons actions, reactions, and interactions (Mischel and Shoda, 1998). The Big Five factors have been replicated in studies conducted by more than a dozen researchers using a wide variety of different samples, in different languages (e.g. Saucier & Goldberg, 2001) and using different item formats in every decade for the past half century (Larsen & Buss, 2005). This suggests that the Big Five personality factors are replicable over time and cultures. However, the Big Five model of personality is not without its critics. For

example, Block, (1995) has criticised the model for the over reliance on factor analysis as a method for classifying traits into super-ordinate categories. He has also criticised the interpretation of some of the factors, in particular the discrepancies surrounding the fifth factor of intellect (Block, 2001). Nonetheless, it has been shown to have a robust factor structure across different cultures and languages (Digman, 1990). As such the Big Five model of personality traits still remains the most influential and has a vast amount of support for the Big Five structure of personality (Saucier, 1998).

Lievens, et al., (2002) argues that personality can be reliably measured at the start of a medical student's university academic career (Lievens, Coetsier, De Fruyt, and Maeseneer, 2002) as personality has been shown to remain stable throughout university and beyond (Zeldow, Daugherty, & Laksas, 1987) and is not influenced by medical school (Coombs, Fawzsy, & Daniels, 1993). Therefore it makes sense to examine the predictive validity of personality characteristics as these are unlikely to change throughout medical school. Consequently, the appropriate dispositions for a career in medicine, and for success academically, need to be identified in order that selection procedures can incorporate reliable measures of personality into the selection procedures (Lumsden, Bore, Millar, Jack, & Powis, 2005).

There is a large body of literature exists on the relationship between personality traits and academic performance. Studies have shown that introversion is positively related to academic performance (e.g. Furnham, 1992, Cassidy, and Eachus, 2000), This finding could be explained by the tendency for introverts to be less likely to have as many social distractions in addition to better attention spans (Matthews, Davies, and Lees, 1990). On the other hand, surgency has been shown to be positively related to the clinical performance aspects in medical education (Furnham and Mitchell, 1991). A potential explanation for this could be that extraverts have a tendency to be more externally focussed, engage in more social activities, and have superior interpersonal skills than introverts (Furnham, 1992). Emotional

stability has been shown to be positively related to academic performance in further education with high emotional stability being related to higher A-level grades, (e.g. Entwistle and Ramsden, 1983) and also in higher education where it is related to higher undergraduate GPA (e.g. Furnham, 1992). These findings seem intuitive as low scorers on emotional stability are likely to be highly anxious and stressed and lead to emotional states interfering with academic productivity and cognition (Grover & Smith, 1981).

The most consistent dispositional predictor of both academic performance and job performance across contexts is the trait of conscientiousness (Hochwater, Witt, & Kacmar, 2000). Conscientiousness has been positively linked with high academic achievement in a number of educational settings (e.g. Digman, 1990; Wagerman & Funder, 2007), and has been shown to be predictive of job performance and job proficiency (e.g. Barrick, Mount, & Strauss, 1993). These findings are hardly surprising given that conscientious individuals are hard working, organised, responsible individuals. Conscientiousness therefore may be viewed as an important predictor of general academic performance.

In relation to medical students and their preclinical performance, there is debate as to which personality traits are the best predictors of preclinical performance. It has been suggested that this debate stems from the utilisation of various different measures of personality based on a number of different personality theories (Shen & Comrey, 1997). Lievens et al., (2002) examined the five factor model of personality in medical students. They compared the Big Five personality traits with students from other disciplines, and examined personality in relation to preclinical performance. They found that the more successful students scored higher in conscientiousness than their more unsuccessful counterparts demonstrating that conscientiousness predicts preclinical performance. In comparison to students from other disciplines, Lievens et al., found that medical students tended to score higher on agreeableness and surgency. There are two possible interpretations of these findings; it is possible that individuals who choose to pursue a career in medicine tend to be more agreeable

and outgoing. Or the findings could demonstrate that the higher agreeableness and surgency scores in medical students may reflect the rigorous selection procedures that they go through. It is likely that the rigorous selection procedures may ensure that those individuals with these characteristics are selected at interview as these traits are be viewed as beneficial for the potential medical practitioner (Lievens et al.,2002). This is because agreeableness and surgency reflect sociability and interpersonal skills which are necessary qualities when interacting with patients (Bensing, Schreurs, & De Rijk, 1996).

Thus it appears that the most successful students in academic settings are emotionally stable, conscientious, introverts (Furnham and Mitchell, 1991). However, the Big Five can be seen to be differentially predictive of performance dependent upon the type of task, and characteristics of the task (Lindley and Borgen, 2000). Furnham and Mitchell, (1991) examined the Eysenckian three dimensions of personality in relation to overall year grade, to specific examinations, and to clinical placement in an occupational therapy course. They found that personality accounts for a only a small but they argue; a theoretically important amount of variance in academic performance. They found that extraversion was negatively related to performance in anatomy, in the first year, and positively related to clinical practical performance in the second year and final year. Neuroticism was negatively related to overall second year performance, and negatively related to communication and skills of management. Psychoticism was related to clinical practical performance in the first year and in the final year. Therefore it can be seen that traits related to sociability and confidence are predictive of clinical performance, whereas traits reflecting emotional instability are negatively related to the more scientific and academic components of the course. This demonstrates the necessity to consider both determinants and performance outcomes within the same research.

The Big Five dispositional characteristics have also been shown to be differentially related to other trait variables that are predictive of academic achievement such as motivation (Barrick and Mount, 1993), or cognitive ability (e.g. Ackerman, 1997) therefore it is possible that

personality exerts its influence on performance directly, through its effect on behaviour, and indirectly through mediating variables such as motivation and learning styles (Barrick Mount, and Strauss, 1993).

The validity of utilising personality variables in selection and admission settings has been questioned due to response bias known as socially desirable responding (e.g. Ones, Viswesvaran, and Reiss, 1996). They argue that the context in which a personality scale is presented can influence whether a person wants to portray themselves in a positive manner. Selection settings may be seen as just such a context, but the findings relating to socially desirable responding compromising the usefulness of personality measures have been equivocal. Rosse, Stecher, Levin, and Miller, (1998) examined the effect of response distortion on personality scores in job applicants and job incumbents and found that applicants were more likely to respond in a socially desirable manner than job incumbents, with applicants having higher scores on more 'positive' traits than current employees. Whereas Marshall Fruyt, Rolland and Bagby (2005) argues that socially desirable responding does not compromise the validity of personality measures, and social desirability may in itself be a trait of interest (Schmitt, and Steyer, 1993).

Therefore both in practical terms and from a theoretical perspective it would be useful to identify personality traits that are reliably related to successful academic performance and further, clinical performance. Practically such traits may provide a method for identifying those candidates most likely to succeed, and may be a useful tool for aiding candidates in their career or specialty choices. From a theoretical perspective, identifying interrelationships with measures of other factors such as cognitive ability, motivational traits, and approaches to study would provide a theoretical basis for further investigation into how personality indirectly exerts its influence on different measures of performance (Furnham and Mitchell, 1991).

3.2.4 APPROACH TO STUDY

The concept of learning styles has received much attention within the literature over the past couple of decades (Diseth and Martinsen, 2003). It has been suggested that learning styles provide a useful method of assessing both how students learn, and the effectiveness of teaching practices (Zhang, 2000). In particular, the method in which a student usually approaches learning has been identified as a potentially useful construct when examining the quality of learning, especially in medical students (Newble and Entwistle, 1986).

Marton, and SaIjo (1976), who examined how students approached and understood textual information, first identified the qualitative differences in the manner that students' approach learning and studying. Based upon an information processing approach, utilising the levels of processing distinction (Craik and Lockhart, 1972), they described the way that students approach their study in terms of deep and surface learning. Deep processors were identified as individuals who intended to fully understand the meaning of information presented to them because they are intrinsically motivated to study for personal understanding (Davidson, 2002). They do this by actively engaging with the information and attempting to comprehend the argument that is being communicated. They then integrate the information into a wider context in order to understand the broad implications of the material presented (Entwistle, 2001). Surface processors on the other hand tend to memorise specific facts through rote learning without attempting to integrate or understand the meaning of the material being presented. This is because they are extrinsically motivated by factors other than the task itself such as just passing the course (Biggs, 1993). These individuals tend to 'question spot' for exam revision, and rote learn facts in order get through examinations with minimal effort (Entwistle, 2001).

Researchers from both Europe and Australia further developed the initial distinction of deep and surface approaches to studying and identified another dimension related to how students

approach their learning, which they termed achieving or strategic approach (e.g. Entwistle, 1988, Biggs, 1993). This approach involves students adopting a well organised structured way of approaching their studies. However the focus for these individuals is on extrinsically motivating factors such as achieving the most optimum grade possible and competition with academic peers (Zhang, and Sternberg, 2001). This strategy is unlike the deep or surface approach in that it is not related to one specific strategy; individuals who adopt a strategic approach can adopt either a surface or a deep strategy dependent upon the task demands. It is the underlying motivation that distinguishes the strategic approach from the deep or surface approaches (Diseth and Martinsen, 2003).

The deep, surface and strategic approaches to studying therefore may have implications for both academic achievement and the context in which material is learnt. Studies have demonstrated that approaches to learning tend to be stable but yet can be influenced by the context in which learning takes place (e.g. Gordon and Debus, 2002, Biggs, 1993). Therefore, although students may have a preferential method of tackling learning, their methods may be potentially modifiable through the influence of the learning context. This is particularly relevant to medical education, as it is essential that potential doctors are encouraged to adopt a method of learning that is intrinsic to the task of learning itself. This is in order that they develop a comprehensive understanding of the essential concepts, and ideally continue with self directed learning throughout their career as doctors (Martin, Stark, and Jolly, 2000).

A number of studies have demonstrated that deep, surface and strategic approaches are related to academic outcomes in a variety of different disciplines (e.g. Diseth, and Martinsen, 2003, McManus, Richards, Winder, and Sproston, 1998, Davidson, 2002, Zeegers, 2001, Prosser, 1987). However, the findings are equivocal. In medical students, McManus et al (1998) found that approaches to learning were significantly related to overall examination performance. They found that deep and strategic learning was significantly positively related to examination performance, and surface learning was significantly negatively related to

examination performance. This suggests that surface learners perform worse in medical school than deep learners, even though it has been shown that medical students become more surface in their approach to study as their studies progress (Coles, 1985). Nevertheless, Martin, Stark and Jolly, (2000) found that only the strategic approach was significantly related to examination performance, with deep and strategic approaches having no significant relationship to performance. In their review of the literature, Ferguson, James, and Madeley, (2002) found that the evidence for the relationship between approach to learning and academic achievement was not consistent. They reported that some studies found the expected relationship between deep, surface and strategic learning and achievement, whereas other studies did not replicate these findings.

It therefore can be argued that it is necessary to further evaluate and elucidate the nature of the relationship between deep, surface, and strategic approaches to study and academic performance in medical students. It is necessary to examine students' approaches to learning within a larger framework of charateristics that may be predictive of performance and thus may be related to other dispositional factors that have been related to academic performance in medical school.

The preceding section has examined those dispositional characteristics that have previously been examined in relation to predicting academic performance in medical school. it has shown that previous academic performance, cognitive ability, and conscientiousness appear to be significant determinants of academic performance in medical school. However the research examining other dispositional characteristics and approaches to study has been less conclusive. Therefore it is important to further examine these characteristics in relation to academic performance in medical school.

As most of the research literature in predicting academic performance in medical school has focussed on these factors, it has resulted in some potentially important dispositions for

medical education being overlooked (Munro et al., 2005). The following section will examine some potentially important dispositional characteristics that may be influential in predicting differential outcomes in medical education.

3.3 POTENTIAL DETERMINANTS OF ACADEMIC PERFORMANCE IN MEDICAL SCHOOL

This section will examine the dispositional characteristics that have largely been overlooked in the medical education literature. These dispositions include; need for cognition, motivational traits, social desirability, dispositional negative affectivity, empathy and narcissism. It will be argued that each of these dispositional characteristics may be influential in academic performance in medical school as they may all be related to medical educational outcomes of various types. Each of the dispositions will be discussed in turn.

3.3.1 NEED FOR COGNITION

Need for cognition is hypothesised to be a stable personality attribute that reflects an individuals tendency to engage in and enjoy effortful cognitive activity, such as thinking, reasoning, learning, and problem solving (Cacioppo, Petty, Feinstein, & Jarvis, 1996). It is said to reflect a person's inherent need to make sense of and understand the world and their surroundings. In order to make sense of the world, individuals high in need for cognition actively seek out and enjoy effortful cognitive endeavours, whereas individuals low in need for cognition tend to avoid effortful cognitive activity where they can, and actively dislike such practices (Tidwell, Sadowski, & Pate, 2000).

Need for cognition reflects individual differences in information processing and information gathering, which may be differentially related to academic performance of varying types (Nair and Ramnarayan, 2000). Previous research has examined need for cognition in relation

to general academic performance and task performance (Leone & Dalton, 1988), and has been shown to be related to amount of information recalled from a text (e.g. Kardash & Noel, 2000), persistent effort, complex problem solving (e.g. Nair, and Ramnarayan, 2000), information seeking in cognitive tasks (e.g. Espejo, Day, & Scott, 2005) ethical decision making (e.g. Singer, Mitchell, & Turner, 1998) and knowledge acquisition (e.g. Tidwell et al., 2000). Therefore it can be seen that need for cognition might play an important role in medical education due to it being related to complex problem solving, and ethical decision making. As yet, need for cognition has been overlooked as a potentially useful predictor of academic performance in medical school.

Sadowski and Gulgoz, (1996) examined the relationship between need for cognition and academic performance on an undergraduate psychology degree. Performance was defined and measured by summing scores on three multiple choice examinations. They found that those scoring high in need for cognition performed better academically than those scoring low in need for cognition. Therefore as medical school involves this type of examination, it may be an important predictor of academic performance in medical school.

Gulgoz, (2001) claims that individuals high in need for cognition actively process information in a more elaborative way, resulting in the tendency to perform better in cognitively demanding tasks such as solving anagrams and performance on academic examinations. Although he found that need for cognition influenced the number of anagram solutions generated by participants, no relationship was found between need for cognition and academic performance. Gulgoz (2001) suggested that the non-significant result was a reflection of the potentially multi-factorial influences on something as complex as course performance. He suggested that maybe need for cognition operates and influences performance indirectly through the mediation and influence on other pertinent variables such as motivation, study strategies, or personality.

Need for cognition may be a pertinent trait to examine in relation to predicting medical school academic performance. This is because medical school, and indeed a career in medicine is an environment that demands and necessitates individuals to consistently and persistently engage in effortful thought and complex problem solving (Rochel de Camargo, 2002). It seems logical that a trait that reflects a tendency to engage in and enjoy effortful cognitive processing would be a beneficial characteristic that may aid performance in medical school examinations, as it is likely that it would predict academic performance in medical school.

In addition, it is argued that critical thinking skills such as information searching, asking questions to discern relevant information, deductive and inferential reasoning, and argument evaluation are an important characteristics for medical students to possess (Scott, Markert, & Dunn, 1998). It can be argued that critical thinking is cognitively effortful therefore need for cognition may be relevant to medical student academic performance,. It may also be an indicator of one of the desirable qualities for success in medical school and beyond, as it has also been shown to be related to the accuracy of clinical judgements (Ruscio, 2000). Individuals high in need for cognition are driven by a disposition that is necessary for making accurate judgements such as the tendency to engage in complex problem solving and are more willing to devote time and effort to solving cognitively demanding problems that have no clear outcomes (Scott et al, 1998). This can be seen to describe the types of task that practicing physicians have to face on a daily basis.

Nair and Ramnarayan (2000) also examined need for cognition in relation to complex problem solving behaviours. They defined complex problems as those that contain many interlinked variables with unclear linkages and outcomes of different actions. These types of problems are the ones that typify the situations involved in clinical decision making, with diagnoses and treatment which consist of conceptually similar dimensions (Ruscio, 2000). They found that participants scoring high in need for cognition were more effective problem solvers, they were more successful in crises avoidance, they sought out a larger amount and

more relevant information than those individuals who scored low in need for cognition. However, they also found that individuals who scored unusually high in need for cognition were hampered by gathering too much information; both relevant and irrelevant, and as such became overwhelmed and overloaded by consideration of too many aspects of the problem.

These findings suggest that need for cognition may be particularly relevant to medical education as it is related to important aspects of medical practice such as problem solving skills, and clinical decision making. It may provide a valuable insight into how effort and enjoyment can influence performance in a cognitively demanding course such as medicine. As yet, need for cognition has been overlooked as a potentially important disposition in relation to academic performance in medical school, and as such warrants further investigation in relation to academic performance and other dispositional characteristics.

3.3.2 MOTIVATIONAL TRAITS

Colquitt, LePine, and Noe, (2000) define motivation as "the direction, intensity, and persistence of learning-directed behaviour in training contexts" thus motivation in a learning context can be construed as a product of an individual's underlying drives, perseverance with learning, and the underlying reasons, wants, and needs that makes an individual direct their behaviour towards learning (Elliot & Church, 1997).

Whilst a large proportion of the more recent research examining motivation focuses on motivational processes and situational interactions (e.g. Linnenbrink, 2005; Seegers & Boekaerts, 1993), there is a growing resurgence in interest in motivation as a relatively stable multidimensional individual difference trait (e.g. Kanfer & Ackerman, 1989; Kanfer & Heggestad, 2000). Early research examining motivation as a trait typically employed a single construct approach such as need for achievement, or a dual approach incorporating intrinsic and extrinsic motivation (Spelke, 2005). Ackerman, (1997) argues that although the unitary

construct approach provided a useful starting point in the recognition of the importance of motivational influences, this type of approach is too simplistic, and suggests that trait motivation should be examined as multidimensional individual differences incorporating both drives and associated goals.

The motivational trait framework proposed by Kanfer and Heggestad, (2000) adopts a multidimensional individual differences approach to motivation. The motivational trait framework was devised based upon a review of previous motivation research. They identified that there are stable motivational traits that act as distal influences on behaviour. This was based upon a number of deficiencies within previous work. They argued that there was an inadequate representation of a number of important dimensions of motivational traits, namely competitive tendencies, and motivationally aversive tendencies relating to anxiety (Kanfer & Heggestad, 2000). In addition they found that although types of goals had been related to the level of persistence and behaviour (e.g. Eliot and Church, 1997), they had not been previously related to individual differences in personality. They therefore developed a framework of motivational traits from a person-centred perspective that incorporated these previously omitted dimensions. In addition they incorporated the relatively neglected aspect of the relationships between individual differences in traits and the nature of the associated goals that are implemented (Heggestad and Kanfer, 2000). Three super-ordinate traits were identified through the use of cluster analysis and from consideration of previously disparate research, were labelled as; personal mastery, competitive excellence and motivational anxiety. These dispositions therefore reflect performance-approach and performance-avoidance goals in association with intrinsic and extrinsic achievement motivation (Kanfer & Ackerman, 2000).

Kanfer and Heggestad, (2000) proposed that personal mastery involves an intrinsic motivational desire to learn and reflects an inherent need to achieve, in accordance with previous findings (e.g. Elliot and Church, 1997). They hypothesise that mastery goals are

related to, and influenced by, the desire to learn. It is suggested that individuals who possess high levels of the intrinsic desire to learn will adopt goals based upon self-referent standards, which represent persistent effort aimed at mastery of the task and improvement in performance. It can be seen that both components of personal mastery reflect approach-oriented motivations (Kanfer & Ackerman, 2000).

It is suggested that competitive excellence involves an extrinsic competition seeking motivational drive, labelled competitiveness where the individual is driven by a need to perform better than other social referents (Kanfer & Heggestad, 2000). As such, it is not mastery of the task that is the underlying drive; it is outperforming their social referents. Therefore an individual who scores high on competitiveness adopts goals that are based on comparisons with the socially normative standards of performance labelled other referenced goals. This motivational disposition reflects approach-oriented tendencies, whereas other referenced goals reflects approach and avoidance motivational traits (Kanfer & Ackerman, 2000).

Motivational anxiety is said to involve an inherent fear of failure that results in the individual being apprehensive in performance evaluation contexts (Kanfer & Ackerman, 2000). Through anxiety these individuals will avoid situations where negative evaluation may occur such as achievement oriented situations. The inherent fear of failure leads the individual to focus on the emotions associated with performance and adopt goals that may reduce the associated emotional responses to the achievement situation. This motivational element is labelled emotionality which can clearly be seen to reflect an avoidance-oriented motivational trait (Kanfer & Heggestad, 2000).

It is hypothesised that these traits are relatively stable dispositional characteristics that reflect a person's typical motivational drives and goal orientations in different situations and tasks, particularly in the educational domain (Heggestad and Kanfer, 2000). This framework

attempts to explain how motivation can underlie and influence how an individual utilises their abilities and how they obtain knowledge and skills (Dweck, 1986). Motivation may also influence how a person approaches a task, in that it can determine their persistence and effort in order to complete the task (Dweck, 1986).

Although the motivational trait framework has not been as yet been systematically examined in relation to academic performance in medical school, previous research has examined related components of motivation in relation to academic outcomes (Colquitt et al., 2000). For example, motivation has been linked to outcomes such as skill acquisition and retention of knowledge (Martocchio & Webster, 1992). In particular goal orientation has been linked with performance, in that individuals who score higher on mastery goal orientations are more successful in knowledge-based assessment (Salas, and Cannon-Bowers, 2001, Elliot and Church, 1997). Hinsz and Jundt, (2005) examined whether the motivational traits could predict performance on an idea generation task and found that personal mastery was predictive of personal goals and self efficacy, competitive excellence was predictive of practice, and emotionality was predictive of post-goal performance. These findings demonstrate that motivational traits seem to predict performance in a manner that would be anticipated, based on the underlying theory of motivational traits (Kanfer & Ackerman, 2000).

Motivation has also been shown to influence the reaction to external evaluations of academic performance in children. Elliott and Dweck, (1988) found that children motivated by personal mastery reacted to failure in a more adaptive manner than those children who were motivated by competitive excellence. Mastery oriented children reacted to their failure at a task as a form of constructive criticism and viewed their failure as a learning process. Competitively oriented children on the other hand, viewed failure as a reflection of their lack of ability and developed a form of learned helplessness in response, believing they have no method of altering the outcome in the future.

The findings suggest that motivational traits may not only influence the level of effort exerted in pursuit of completion of an academic task, but also influence the reaction to the process of evaluation. Therefore motivational traits may be an influential factor in academic performance in medical school as they may influence the level of persistence that the students exert in a difficult and rigorous subject. It may also influence how the student reacts to constructive feedback on their performance and determine whether their learning is hindered by their motivation. Consequently, it would be useful to examine the influence of motivational traits on academic performance in medical school.

3.3.3 SOCIAL DESIRABILITY

Research examining social desirability has tended to examine the concept from the perspective that social desirability is a response bias that needs partialling out of any analyses rather than social desirability being a meaningful trait in its own right. Consequently, few studies have explored the potential influence of social desirability as a trait (Helmes & Holden, 2003).

Social desirability can be defined as a tendency to "distort self reports in a favourable direction" (Furnham, 1986). That is a tendency to respond to questionnaires by faking responses in a manner which would make the individual appear good and be viewed in a positive light. They achieve this by denying socially unacceptable traits and endorsing socially acceptable traits. Although some researchers view social desirability as a contaminant to responses on self-report inventories (e.g. Rosse, Stecher, Levin, & Miller, 1998), it has also been viewed as a trait in itself. It is suggested that like personality, it is relatively stable and is related to a number of behaviours indirectly, as it reflects a more agreeable, conscientious and socially acceptable individual (Ones, Viswesvaran, & Reiss, 1996).

Paulhaus, and John, (1998) suggested that social desirability reflects two types of characteristics, impression management and self deception. They argue that impression management is a conscious self presentation bias where individuals deliberately tailor their responses to display themselves in the most positive and competent way in order to impress others. Self deception is argued to be an unconscious bias that acts as a defence mechanism in order to protect self esteem by exaggerating to the self the image of being a good person, thus is an exaggeration of self worth (Furnham, 1986).

It has been suggested that socially desirable responding actually reflects an operational knowledge of social norms (Paulhaus & Reid, 1991). This may be considered to be useful in certain employment settings, dependent on the type of social desirability, and the context where interpersonal interaction is common (Mueller-Hanson, Heggestad, & Thronton, 2003). In particular it has been suggested that impression management can vary according to situational demands, and may be especially influential where social acceptability may be viewed as being necessary (McFarland, Yun, Harold, Viera, & Moore, 2005). However, extremely high scores on impression management may actually reflect maladjustment, poor self esteem and low levels of psychological wellbeing. High scoring individuals tend to have difficulty relating to others in a meaningful way as they attempt to hide their true selves (Hoorens, 1995). In practical terms, social desirability may be an important individual difference variable as the ability to manage other peoples' impressions may actually be a beneficial trait. This may be particularly the case in situations where social conformity and social influence is important. In medicine, the practitioner patient relationship may be such a situation as it may be important to manage impressions in order to gain the trust of a patient (Lautenschlager & Flaherty, 1990). Therefore social desirability can be seen as a potential social aptitude as it reflects the ability to recognise and utilise social norms which may be an indicator of social functioning.

3.3.4 DEPRESSION, ANXIETY AND STRESS- A GENERALIZED SYNDROME OF NEGATIVE AFFECTIVITY.

Within the literature, depression, anxiety and stress tend to be regarded as fluid states that are dynamic and influenced by the situation, and the perceptions of the individual (Lazarus & Folkman, 1984; Spielberger, 1975). However, some researchers argue that these three psychological conditions have an underlying predisposition to react negatively termed a generalised syndrome of negative affectivity (Lovibond, 1998). From this perspective, depression is described as a pervasive loss of self esteem, and a belief in the inability to achieve important life goals and is characterised by symptoms of dysphoria, hopelessness, anhedonia, inertia and a lack of interest (Blumberg & Flaherty, 1985). It is argued that depression is more than just a low mood, in that it is pervasive and does not cease in a short period of time (Lovibond, 1998). Anxiety is characterised as a generalised response to threatening situations. These responses include autonomic arousal, nervousness, and fearfulness (Brown, Chorpita, Korotitsch, & Barlow1997). Stress is defined as a persistent state of high arousal, resulting in a low threshold for behavioural reactions such as irritability, impatience, agitation, and frustration in response to stressful situations (Lovibond & Lovibond, 1995). It is suggested that these three affective states have an underlying predisposing vulnerability, therefore can be considered as a generalised response to life situations. This emotional syndrome exists on a continuum where extremely high levels represent a clinical manifestation of psychological disorder (Lovibond, 1998).

Lovibond and Lovibond, (1998) argue that although there is a conceptual distinction between depression, anxiety, and stress, there is considerable overlap between the three concepts. They suggest that this overlap can be described as a generalised syndrome of negative affectivity. Lovibond, (1998) suggests that some individuals have a predispositional vulnerability to the negative affectivity syndrome, suggesting that this aspect of depression, anxiety and stress

can be conceptualised a stable trait like disposition. This tripartite model has received empirical support in the literature (e.g. Brown et al., 1997; Cole, Truglio, & Peeke, 1997; Lovibond, 1998) and the syndrome has been shown to contain facets such as lack of concentration, an inability to sleep, irritability, and loss of appetite (Szabo & Lovibond, 2006).

It is well documented and recognised that the experience of medical school and the practice of medicine is highly stressful and intense which can invoke depression, anxiety, and high levels of stress and burnout (e.g. Finkelstein, Brownstein, Scott, & Lan, 2007; Hohaus & Berah, 1985; Landau, Hall, Wartman, & Macko, 1986; Linn & Zeppa, 1984; McManus, Winder, & Gordon, 2002). Stress has also been shown to impair medical student trainee's ability to properly care for their patients (Matthews, Classen, Willms, & Cotton, 1988) and negatively affect their motivational levels (Pennebaker, Colder, & Sharp, 1990). Hence it is likely that this type of negative affectivity could adversely impact academic performance in medical school. Indeed, Linn and Zeppa (1984) examined the impact of negative stress on medical student performance and found that unfavourably perceived stress was related to poor academic performance.

Although it should be recognised that a little anxiety is beneficial for optimal levels of performance, a high level of anxiety as is reflected in generalised negative affectivity, is detrimental to performance, as it interferes with and impairs cognitive functioning (Tobias, 1985). Mood and affective states have also been shown to influence the quality and amount of information stored and retrieved during learning (Corno et al., 2002). Therefore it can be seen that negative affectivity needs to be examined in relation to academic performance in medical school to determine how it exerts its influence on performance. In addition, it can be seen that it is essential that those students who have a predisposition to a general negative affectivity

syndrome be identified in order that support and selection mechanisms are put into place to reduce the likelihood of the negative effects of this vulnerability (Matthews et al., 1988).

3.3.5 EMPATHY.

Empathy as a trait is conceptualised as an innate ability to understand and feel the emotions of others, and an ability to communicate an understanding of a persons feelings back to them (Kunyk & Olson, 2001). It is characterised by an ability to recognise, understand, and feel how another person is feeling and is viewed as a key feature in the repertoire of the interpersonal skills of health professionals (White, 1997). Empathy is argued to be a key determinant of the development of meaningful interpersonal relations between a practitioner and a patient. It has been shown that an effective patient practitioner relationship is one of the key determinants of clinical outcomes such as adherence to medication, and patient satisfaction (Bensing & Dronkers, 1992).

Squier, (1990) argues that effective practitioner's empathic skills can help to build a trusting relationship where the patient feels able to express their emotional concerns about their illness without reproach. He suggests that empathy can also be used to influence patient motivation to maintain health, regain health, or control symptoms through adherence to treatment. Research has shown that practitioners who demonstrate more empathic understanding of patients concerns tend to have patients who are less anxious, more satisfied with the care provided and more likely to adhere to medical regimens (e.g. Bensing et al., 1996; Cameron, 1996; Reynolds, 2003).

Therefore it can be seen that empathy is an important disposition that is necessary for the successful practice of medicine. It is also important theoretically as it reflects an ability to recognise, understand, and feel the emotions of another (Austin, Evans, Magnus, & O'Hanlon,

2007). Thus it is an important disposition that reflects a level of social concern that is important for the maintenance of trust between a patient and a practitioner. Hojat et al., (2002) examined empathy in relation to the academic component of the medical undergraduate degree. They found that empathy was not related to overall year performance in either Year 1 or Year 2. Nonetheless, in relation to clinical performance in medical school, they found that the medical students who had higher levels of empathy performed better at history taking and the physical examination of patients than those who had low levels of empathy. These findings demonstrate that empathy is related to the clinical and practical skills in medicine rather than the academic component. Therefore it can be seen that empathy is an important disposition that is related to the clinical elements medical school performance and therefore needs further investigation.

3.3.6 NARCISSISM

Narcissism is a trait that has its foundations in psychoanalytic theory and as such has mainly been examined in clinical settings in relation to narcissistic personality disorder (Raskin & Terry, 1988). Narcissism is defined by Rhodewalt and Morf, (1995) as a tendency to exhibit:

> "Extreme self absorbtion and egocentrism, display self aggrandisement and self importance, and fantasize about unlimited ability, power, wealth, and beauty. Narcissists tend to be exhibitionistic, and they frequently express a need for attention and admiration. Narcissism is also characterised by disturbances in personal relationships and communicate a sense of entitlement and tend toward exploitativeness while failing to empathise with the feelings of others" (p2).

Narcissism is characterised by a pre-occupation with the self at the expense of others (Emmons, 1987). This involves a lack of empathy, a manipulative exploitative nature, an overly ambitious and competitive nature, authoritarianism, arrogance, aloofness, superiority,

and a display of cool indifference at criticism (Kernis & Sun, 1994). This cool indifference however, is a mask, as an individual who scores highly on narcissism is overly dependent on other people's evaluations of themselves (Watson, Grisham, Trotter, & Biderman, 1984). Criticism of their attributes and achievements results in an internal hostility, anger, and aggression, directed at the person who gave the criticism (Rhodewalt & Morf, 1995).

Narcissism as a trait in a non-clinical sample has not received as much empirical interest as other personality characteristics. This is particularly so in medical education research where it has been mostly overlooked. Narcissism has been neglected in relation to medical students academic performance, attitudes or their professional behaviour (Powis et al., 2005). It can be argued that narcissism is an important dispositional characteristic that may detrimentally influence performance in particular types of assessment in medical school. for example, it can be seen that individuals who score highly on narcissism display a number of interpersonal behaviours that can be considered detrimental and adversarial (Powis et al., 2005). These individuals may have difficulty building rapport and relationships with patients as they demonstrate aloofness, grandiosity, arrogance and lack empathic skills (Munro et al., 2005). It is likely that narcissism would be detrimental to team working if the exploitative, arrogant, authoritarian tendencies are displayed. Therefore elements of academic performance that require group working tasks may be adversely affected by this disposition. In addition, in the academic setting, they may react negatively to constructive criticism from academic staff and may make inappropriate interpretations of feedback viewing it as persecution or rejection, thus learning from feedback may be inhibited (Robinson, 2001).

Although narcissists tend to react internally to criticism with hostility and aggression, they enjoy being in evaluative situations and prefer tasks where they are being evaluated than when they are not evaluated. This supports the idea that narcissists use the evaluations of others to bolster their self esteem and maintain a high positive self concept, and that they are

keen to demonstrate their abilities (Morf & Rhodewalt, 2001). Where a high score may be considered detrimental to interpersonal relationships, a low score on narcissism may be beneficial for interpersonal relationships, team working, and patient skills and potentially be beneficial for assessment of clinical skills. Nonetheless, most of this is speculation as narcissism has previously not been examined in detail in relation to academic performance, and in particular in medical students. Therefore narcissism may be an important characteristic both to academic performance on group tasks, and further in a medical career where team work is imperative. As such this disposition is relevant to medical education and warrants further investigation in regard to medical students.

Whilst in the individual differences literature, there has been a vast proportion of research that has investigated relationships between particular combinations of the dispositions discussed in this section, only a few researchers have developed theoretical models that have specifically examined the dispositions in terms of determinants of academic performance. The following section will critically evaluate the models that have been proposed to explain the structure of the determinants of academic performance.

3.4 THEORETICAL MODELS OF DETERMINANTS OF ACADEMIC PERFORMANCE

There has been a growing interest within instructional psychology in the predictive validity of individual differences incorporating cognitive and non-cognitive psychological characteristics. In particular there is a growing recognition of the importance of the relationships between clusters of theoretically related psychological characteristics and the combined influence on academic performance (e.g. Ackerman & Kanfer, 2004; K. G. Brown, Le, & Schmidt, 2006; Conard, 2006; Corno et al., 2002). Rather than just examining the individual influences of isolated characteristics. Chamorro-Premuzic and Furnham, (2004)

suggests that would be beneficial to develop a coherent theoretical account of the determinants of academic performance. However, this has yet to be explored in medical education.

It can be argued that is necessary to integrate dispositional characteristics in a coherent integrative framework that attempts to describe the relationships and the mechanisms by which dispositions can influence performance (Chamorro-Premuzic & Furnham, 2005). There have been three main models to explain the nature of the determinants of general academic performance. The following section will review the models that have been proposed to explain the relationships between predictors of academic performance in general education. It will be argued that although these models were devised to explain general academic performance, they have the potential to be relevant to medical education.

3.4.1 APTITUDE COMPLEX MODEL (SNOW & LOHMAN, 1984)

Although many factors have been used and defined as aptitudes, a clear and accurate description of what defines an aptitude and aptitude complexes has been limited (Ackerman, 1996). In the past, the term aptitude has been used to represent mainly cognitive abilities (e.g. Conard, 2006; Donnon & Violato, 2006; Spelke, 2005) however, Cronbach and Snow (1977) argue that the term aptitude should not be used in this limited and static manner. They suggest that it is erroneous to limit the definition of aptitude merely to cognitive ability. They argue that cognitive ability is only one type of aptitude that functions differentially according to the educational context, affective characteristics, personality, and motivation. Snow, (1989) instead suggests that an aptitude refers to an initial characteristic of a learner that may partially account for the outcome of a learning situation. Thus an aptitude is an initial predisposition that may be a necessary prerequisite for achieving successful learning outcomes (Snow, 1989). Therefore the definition of aptitude should incorporate dispositional

personal characteristics including cognitive ability, motivation, affect, learning orientation, and personality, all of which may be a necessary prerequisite for achievement (Snow, 1996a). It is argued that the term aptitude should reflect at least three types of trait; cognitive, affective, and conative (motivational) (Snow & Swanson, 1992). An individual may possess a large collection of these interactive aptitudes which they apply in varying levels dependent upon the task demands and the characteristics of the environment (Snow, 1989).

Snow (1989) suggests that a cognitive aptitude complex should utilize traditional measures of cognitive ability that comprises complex cognitive skills such as arithmetic, verbal and spatial ability in order to reflect an "ability to learn" (p.22). Cognitive ability provides a measure of optimal level of mental functioning that endows the individual with the necessary resources for completing the task (Snow & Lohman, 1984). In addition, it can incorporate measures of knowledge and understanding.

The Affective Complex is hypothesised to involve a group of affective aptitudes that may operate by influencing how the resources are enhanced or inhibited by emotion. This Complex incorporates characteristics that are related to an individual's predisposition for emotional response and typical mood states, it reflects the emotional interpretation of, and perception of the environment (Linnenbrink & Pintrich, 2004).

The conative complex may exert its influence through driving the amount of effort expended on a task. The conative complex incorporates motivational characteristics, i.e. aptitudes that incorporate wants, needs, intentions, and actions (Dweck, 1986). Conative aptitudes may be responsible for how cognitive processes are used and transformed into behaviour. They are characteristics that reflect the tendency to actively engage in, want to engage in, and maintain the drive in a task, therefore is an approach-oriented cluster of aptitudes (Snow, 1996b).

Aptitude complexes can therefore be defined as a set of cognitive and non-cognitive personal characteristics that reflect an individual's readiness, capability, drive and action that enables them to be successful at a particular type of task, or in a particular type of situation (Snow, 1996b). These combinations of characteristics may influence the quality, level, and quantity of learning and performance on various assessments of learning (Snow, 1989). According to Snow (1994), aptitude complexes operate via two parallel pathways; performance, and commitment. Performance involves the use of cognitive resources in order to complete a task and commitment refers to the motivations underlying performance. When these two pathways operate at an optimal level then the result is successful academic performance. It is argued that the affective components can act as either a positive or negative influence on both motivation and performance (Snow, 1996a). Cronbach and Snow, (1977) suggest that combining aptitudes into a complex based upon theoretical and empirical similarity may provide a more meaningful explanation of the influence of aptitudes on academic performance. It could also provide more statistical explanatory power than examining individual aptitudes and their isolated relations with academic performance (Ackerman & Kanfer, 2004).

Snow, (1996a) suggests that the definition and description of various profiles of cognitive, affective and conative characteristics may be beneficial for advancing the understanding of the prerequisites for success in particular educational contexts. Combining constellations of aptitudes into complexes and creating a profile of the characteristics that predict academic performance may enable comparisons of types across situations and educational contexts (Ackerman & Kanfer, 2004). This may also provide a potentially useful tool for medical student selection procedures.

Although it is suggested that there is a distinction between cognitive affective and conative complexes, it should be noted that these complexes are not necessarily mutually exclusive. Instead it is suggested that the different aptitude complexes may interact with each other to exert their influence academic performance (Snow, 1989). For example, It has been shown that individuals with high levels of cognitive ability are more disrupted by high levels of negative affective characteristics such as neuroticism, and their performance on academic tasks is impaired (e.g. Chamorro-Premuzic & Furnham, 2003b). Individual differences such as personality and motivation may interact with cognitive ability particularly in higher education where these factors seem to increase in importance in predicting academic performance. This may be due to the volitional nature of participation in higher education (Chamorro-Premuzic, 2005). Snow, (1989) suggests that affective, conative, and cognitive complexes may interact and interrelate with each other. During learning, while cognitive ability may be necessary for efficiency of processing information, it can is likely that it is the conative characteristics of the individual that provide the drive underpinning actual performance, where the affective characteristics may serve to enhance or disrupt the drive and the process of learning (Corno et al., 2002).

For example, cognitive ability may be necessary for efficiency of processing information, problem solving, memory storage and retrieval and synthesising and integrating knowledge (Snow & Lohman, 1984). However, the conative aptitudes are as influential in determining performance outcomes. Conative aptitudes provide the initial drive necessary for the expenditure of effort, they are also responsible for maintaining and regulating the focus of the cognitive processes, and the sustained effort necessary for completing a task (Snow, 1996b). The affective characteristics of an individual can serve to enhance or disrupt the process by influencing the motivations that initiate and regulate sustained efforts, or by interference in the cognitive processing tasks (Snow, 1996).

Although Snow and Lohman (1984) mainly focused on the cognitive aspect of aptitude complexes in their research, they importantly recognised that any comprehensive aptitude theory needs to also incorporate conative and affective complexes as these can influence the learning process (Wagner, 2000). It is argued that the aptitude for learning reflects more than just cognitive ability as people with the same level of cognitive ability perform differently under similar conditions of learning which suggests an influence of other individual differences and environmental factors (Kyllonen & Lajoie, 2003).

Snow and Swanson (1992) argue that specialised knowledge domains may require specialised aptitudes requiring specialised styles of learning and thinking. This may be particularly appropriate to medical education as medicine requires skills in social interaction, and interpersonal skills in addition to specialised and detailed academic and scientific knowledge (Powis, 2003). Although it is acknowledged that some of the key determinants of medical school performance relate to personality, learning styles cognitive ability and prior performance, medicine is not just a scientific career, it is also a caring career. A career in medicine inevitably involves a large proportion of time interacting with patients, understanding the patient's perspective, and having good communication and interpersonal skills (Lumsden et al., 2005). Therefore it is necessary to consider interpersonal qualities that may be potentially important and specific to health professional careers. Examining the predictive power of aptitude complexes has both theoretical and practical importance. Theoretically it would improve the understanding of the role of individual differences in person-situation interactions.

Corno et al, (2002) argues that it is necessary to examine the interrelations between aptitudes at a theoretical level. They suggest that exploring the commonality between the aptitudes would allow synthesis within the field of individual differences. This in turn would help to reduce the jangle fallacy which refers to the measurement of the same construct but using

different scales and labelling with different names (Marsh, 1994). Therefore exploring the dimensionality of dispositional characteristics may provide a theoretically meaningful taxonomy of trait complexes. This taxonomy may then be examined in relation to different educational contexts and various indicators of academic performance. Practically the ability to predict performance in an educational setting from a set of scores on aptitude tests may be beneficial for use as one of the tools in selection procedures particularly where the training facilities are limited and expensive as is the case with medical education (Corno et al., 2002).

A potential strength of this model is that it acknowledges the multivariate nature of performance outcomes. It suggests that different aspects of performance require different aptitudes in order to achieve at a particular level, nonetheless it does not specify what the aspects of performance are, and which aptitude complexes would be predictive of the outcomes (Snow & Lohman, 1984). Whilst this aptitude complex theory clearly suggests a combination of cognitive, affective and conative dispositions, it can be seen that it lacks the fine grain specificity necessary for operationalising a model for research purposes. For example, it does not specify precisely the traits that should make up each component, only that the components should reflect the general aptitude of one of the dimensions; cognitive, affective or conative. In addition, it lacks empirical support for the hypothesised interrelations and interactions between the components. The main thrust of the research that has discussed aptitude complexes has focussed on cognitive ability and the cognitive component of aptitude complexes (Snow, 1996a).Therefore it can be seen that the aptitude complex provides a broad theoretical foundation on which models of individual differences can be built (Snow, 1996b) nonetheless, the complexes need specificity.

3.4.2 PPIK THEORY (ACKERMAN, 1996).

Ackerman, (1996) utilised the structure of aptitude complex theory as a basis for building a more specific framework for understanding individual differences in performance. This model specifies that the components comprise; Intelligence-as-Process, Personality, Interests and Intelligence-as-Knowledge (PPIK) theory. Ackerman, (1996) attempted to address the interrelations between individual differences and examine them in combination in an attempt to better understand the nature of adult intellectual development. PPIK theory draws upon and combines facets of Cattell's Investment Theory of Intelligence (Cattell, 1984), and the aptitude complexes of Snow and Lohman, (1984). PPIK incorporates the interactive influences of non-intellectual individual difference components such as personality and motivation with cognitive ability components. He incorporated these traits into a trait complex theory that can explain the development of adult intellectual knowledge and skills (Ackerman, 1996). Ackerman uses the term traits instead of aptitudes in order to avoid the confusion of terminology, as "aptitude" has been more associated with intelligence, in addition to attempting to reflect the dispositional nature of the characteristics.

Trait complexes are defined as particular sets of traits that in combination differentially influence outcomes, and attempts to explain how personality, motivation and intelligence interrelate. Ackerman (1996) combines individual differences in personality, ability and motivation into complexes but renamed them trait complexes in order to reflect the stable nature of these individual differences, and the inclusion of non-ability traits into his theory of intellectual development. Similar to Cattell's (1984) gf theory of intelligence, Ackerman, (1996) views intelligence as consisting of two factors; Intelligence-as-Process and Intelligence-as-Knowledge. However, Ackerman, views intelligence-as-process as incorporating more decontextualised processes than Cattell's conceptualisation of fluid intelligence (Ackerman and Beyer, 2003). Although Ackerman (1996) acknowledges that it is inherently difficult to separate process from knowledge, he suggests that some elements of

intelligence have been universally accepted as process. These include; reasoning skills, short term memory span, perceptual speed and spatial rotation, all of which appear to peak in young adulthood (Ackerman & Rolfhus, 1998). The content part of intelligence incorporates knowledge and skills, both the quality and quantity of information retained. This can be seen to represent procedural and declarative long term memory storage and retrieval (Ackerman, 1996).This lead to Kanfer and Ackerman, (1989) to define ability as "an individual's total attentional-cognitive capacity" that is, cognitive ability refers to the resource capacity of a person's information processing system. Individual differences in cognitive ability represent variation in total resource capacity, which is a combination of attentional resources, perceptual speed and processing resource capacity (Kanfer and Ackerman, 1989).

The PPIK model is said to contain four broad sets of traits, identified as Social, Clerical/Conventional, Science/Math, and Intellectual/Cultural (Ackerman & Beier, 2003). Social complex was said to contain the dispositions extraversion, social potency and well being. Clerical complex was said to contain openness, typical intellectual engagement, and crystallised intelligence. Science complex was said to contain elements of cognitive ability; reasoning and perceptual speed, and clerical was said to contain control, conscientiousness, and traditionalism.

These complexes were devised outside of education, and as a result it is argued that these complexes can predict in a variety of different life situations (Ackerman & Rolfhus, 1998). Inherent in PPIK theory is the assumption that it's the application of intelligence-as-process that ultimately determines intelligence-as-knowledge. However, Ackerman (1996) suggests that individual differences in motivation, interests, and personality determine how intelligence-as-process resources are utilised an applied in the acquisition of intelligence-as-knowledge. That is; how much effort is expended, and how cognitive resources are utilised and the level or amount of cognitive resources applied to learning (Ackerman, and Beier, 2003).

PPIK provides a theoretical framework that can be used to understand and investigate the direction of causal relations between ability, personality and motivation. It represents adult intellectual knowledge and skills combine into trait complexes. These complexes are specific to the person's experiences, education and expertise whilst recognising the typical and maximal distinction in performance (Ackerman & Kanfer, 2004). Unlike a vast majority of the research examining personality or intelligence, the PPIK theory integrates the fields of personality, motivation and intelligence and provides an explanation of the development of intelligence.

Previous research that has focused on PPIK theory has considered the developmental aspects of PPIK and has found broad support for the theory (Ackerman & Rolfhus, 1998). Results from a number of studies that have established that variations in cognitive investment and the differential influences of personality, ability, and interests lead to differences in depth and breadth of knowledge (Ackerman, 2003). Support for the predictions of the theory on the development of adult intellectual abilities have been shown by Ackerman, Kanfer and Goff, (1995) who demonstrated that trait complexes can be identified and related successfully to task learning particularly complex knowledge and skill acquisition. As a consequence, these complexes may be useful as a predictor of performance and may be useful in selection procedures for vocations where complex task learning is necessary (Ackerman & Kanfer, 1993).

For example, PPIK has been examined in relation to complex task knowledge acquisition in highly skilled vocations where high quality complex knowledge retention is necessary, such as training and selection for air traffic controllers (Ackerman & Kanfer, 1993). Nonetheless, it has not been specifically used within medical education and the prediction of outcomes in medical student training. It can be argued that medicine is also a highly skilled vocation where a vast amount of knowledge and skills are necessary for a successful career as a doctor.

Ferguson, James and Madeley, (2000) recommend that it would be worthwhile to explore the possibility of medicine specific trait complexes that could be applied to various medical school performance measures. These could in turn inform selection procedures and curriculum development. Therefore PPIK provides a potential explanation of the interrelations between individual differences in relation to medical school academic performance. Nonetheless, this has still to be explored.

3.4.3 INTELLECTUAL COMPETENCE MODEL OF PERFORMANCE (CHAMORO-PREMUZIC & FURNHAM, 2005)

Chamoro-Premuzic and Furnham, (2005) proposed model of Intellectual Competence to explain individual differences in academic achievement. They state that intellectual competence refers to "cognitive and non cognitive traits based on the identification of empirical observable individual differences leading to differences in future achievement" (p352). They recognised that cognitive ability rarely predicts performance in isolation, and should instead be integrated with extant dispositional characteristics. They argue that this would provide a more comprehensive framework for understanding the differences in academic performance.

The model proposes that cognitive ability should be combined with an optimal combination of the Big Five personality traits; Surgency, Agreeableness, Conscientiousness, Emotional Stability, and Intellect (Chamoro-Premuzic & Furnham, 2006). Therefore this model suggests combining the Big Five and cognitive ability into a single "Intellectual Competence" personality dimension. The model is described in terms of a spiral that represents evolutionary processes and growth from a biological cognitive characteristic; gf, to the experience level of gc. Hence, the model takes into consideration typical and maximal indicators of performance (Chamoro-Premuzic & Furnham, 2005). It is argued that the optimal combination of dispositional characteristics will add incremental predictive validity

to measures of cognitive ability when predicting performance (Chamoro-Premuzic & Furnham, 2006). Indeed, there is a growing body of literature that demonstrates a strong relationship between the "optimal" levels of personality, cognitive ability and academic performance therefore providing some support for the model (e.g. Ackerman, 2003; Chamorro-Premuzic & Furnham, 2004; Chamorro-Premuzic, Moutafi, & Furnham, 2005).

Nonetheless, this model is a fairly new model of an explanation of individual differences in academic performance. It is only proposed as a preliminary model of the determinants of academic performance, and is need of scientific rigor in testing the explanatory value and the structure of the model. In addition, it may be difficult to determine the optimal level of characteristics for successful academic performance when there is disagreement in the literature as to which characteristics are most important.

3.5 STRENGTHS AND LIMITATIONS OF THE RESEARCH TO DATE

Although the models proposed can form a basis for investigation of the predictors of academic performance, it still remains unclear as to how many components underlie dispositional characteristics that are related to academic performance in medical school. For example, the Aptitude Complex Model proposed by Snow and Lohman (1984) loosely suggests that three dimensions underlie determinants of performance; Cognitive, Affective and Conative. However, Ackerman proposes that trait complexes should comprise elements of motivation (in the form of interests) and personality with elements of intelligence and knowledge. Chamoro-Premuzic and Furnham, (2005) on the other hand suggest that intellectual competence comprises a single component; namely intellectual competence, that subsumes a number of broad individual difference characteristics. There does seem to be a consensus however, that cognitive ability is an important disposition alongside prior knowledge both of which should be considered in any model of predictors of academic performance (Furnham, Forde, & Cotter, 1998). In addition, the models are in agreement

when describing predictors in terms of potential broad dimensions that underlie dispositional characteristics. It can be seen that although there is agreement regarding the existence of underlying explanatory dimensions, there is a disagreement within the literature as to the number of underlying dimensions in predictive dispositional characteristics. Therefore it is necessary to explore the dimensional structure underlying dispositional characteristics that are important in predicting academic achievement.

3.6 SUMMARY, AIMS AND RESEARCH QUESTIONS

This chapter has critically discussed the research that has examined performance in medical school from a predictor-centric approach. The initial focus was upon the importance of predicting medical student academic performance. The review discussed both cognitive and non cognitive characteristics that have previously been shown to be related to performance. Previous academic performance, cognitive ability, personality traits, and learning styles were discussed and it was shown that A-levels and cognitive ability are consistent predictors of academic performance, however the findings relating to personality and learning styles is not as straight forward with discrepancies and disagreements within the literature.

Need for cognition, motivational traits, dispositional negative affectivity, narcissism and empathy were then presented as potentially useful and theoretically important dispositional characteristics for academic performance in medical school. The discussion then turned to evaluation of the current theories and models of the predictors of academic performance. Each of the models were critically discussed and evaluated for their explanatory value in relation to medical school academic performance. However, it was concluded that further exploration of the structure underlying determinants of academic performance was warranted as there was disagreement between the models as to the number of underlying dimensions.

Therefore the purpose of Chapter 5 is to answer the following research question;

What is the most explanatory number of underlying components that adequately summarises dispositional characteristics of students during the first two years of medical school.

And the purpose of Chapter 6 will be to answer the following research question;

Do dimensional combinations of characteristics predict different academic performance outcomes in medical school.

3.7 NEXT CHAPTER

The next chapter will outline the research methodology used in this thesis. It will include an outline of the design of the study, the students that participated in this study, and the scales that were used for measuring the psychological characteristics of participants. The procedure for data collection will be outlined, and an outline of the assessment variables will be presented. The chapter will finish by presenting the statistical methodology that was used in this thesis to answer the research questions and hypotheses.

4 METHODOLOGY

This chapter will outline the research methodology used in this thesis. It will provide an outline of the design of the study appropriate for the hypotheses that are presented. A description of the sample used including sampling methods, socio-demographics of participants, will be outlined and there will be justification as to the representativeness of the sample. A description of the scales used for data collection and the methods of data collection will then be provided and finally there will be a brief outline and justification of the statistical methodology used in this thesis to answer the research questions and hypotheses.

4.1 DESIGN

A prospective longitudinal cohort study design was used for the purposes of this study. Predictor variables were measured at entry to medical school in a single cohort of medical students. The predictor variables incorporate measures of cognitive ability, personality traits, approaches to study, need for cognition, motivational traits, and dispositional negative affectivity. The outcome variables consist of the scores that the students achieved on assessments taken throughout the duration of the first two years of medical school. These outcome variables included; scores obtained on two forms of multiple choice examinations; multiple-choice questions, and true false abstain answers, coursework, practical work, oral presentations, in-course assessments, and observed structured clinical examinations. In addition, and in accordance with measures of performance used in previous research (e.g. Kay-Lambkin, Pearson, & Rolfe, 2002), overall year one performance and overall year two performance were also used as outcome variables as these constitute the academic element of the medical school degree. Overall year performance is the average percentage achieved over all the modules taken during the academic year weighted according to the number of credits that each module is worth.

The research was undertaken over a period of two years between September 2003 and July 2005 at the University of Nottingham Medical School UK. This time period was chosen as it constitutes the duration of the first two years of the preclinical academic element of the undergraduate medical degree, when students are gaining the underpinning basic academic medical knowledge necessary for a career in medicine.

4.2 PARTICIPANTS

This section will outline the sampling methods used in the study, and the response rates involved in the research. Then the socio-demographic characteristics of participants will be discussed and the sample will be compared to national medical school entrants in 2003 in order to demonstrate the representativeness of the sample.

4.2.1 SAMPLING METHODS AND RESPONSE RATE

The sample used was an opportunistic sample consisting of first year medical students undertaking the undergraduate medical degree at Nottingham University. During the first week of the first semester (September 2003) all first year students were fully briefed about the purpose and nature of the research and were asked if they would be willing to participate.

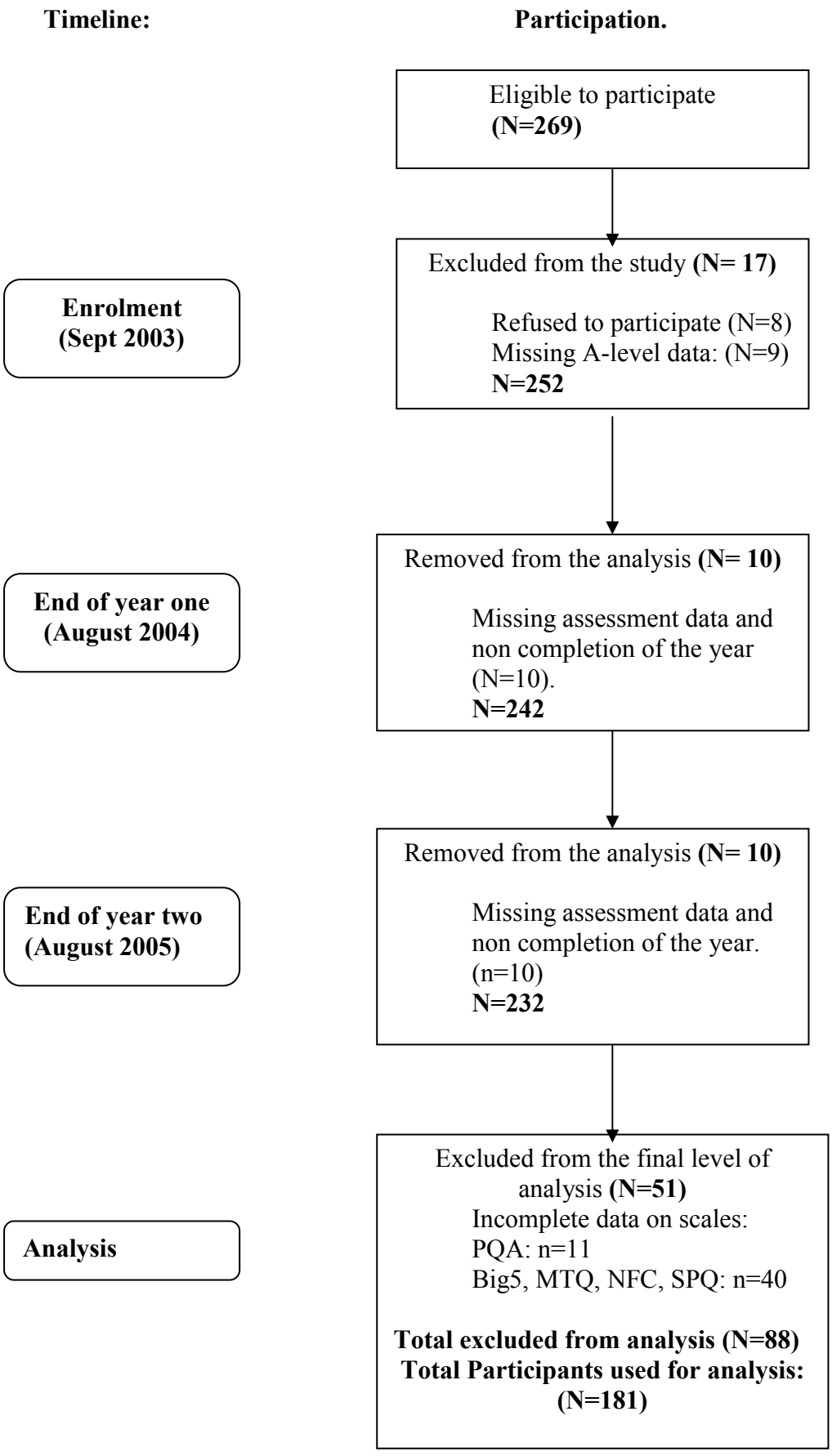
Figure 4-1 provides a flow diagram of the time scale for when measurement took place, number of participants in each stage of the study and when assessment data was obtained. It can be seen that there was an initial response rate of 97% which at the final phase of results collection had dropped to 89.6% this was due to student attrition, or students retaking the year. There was incomplete data on the scales for 51 participants (19.5% of the initial sample) therefore these were removed from the analysis.There was no A-level information for 9 participants (3.4%) in the sample, and they were removed from the analysis. In total 88 of the

original participants did not complete the study, this left a final total of 181 participants for the analysis. Therefore 67.3% of the original cohort was used as participants in this study.

4.2.2 INCLUSION CRITERIA

The inclusion criteria for this study required that the participants had to be first year undergraduate medical students, who have not studied a degree previously. In addition, only those participants with previously attained British qualifications (GCSE and A-Level qualifications) were to be included in the analysis. Students with international baccalaureate degrees or other international qualifications were excluded from the study. This criterion for inclusion was used in order to facilitate comparisons with national data sets from UCAS, and to avoid the potential influence of extraneous factors such as variations in types and standards of qualifications.

Figure 4-1 Flow Diagram showing participation rates in each phase of the study.



4.2.3. SOCIO-DEMOGRAPHIC AND EDUCATIONAL DISTRIBUTION OF PARTICIPANTS.

Socio-demographic data for all the participants was taken from the University and Colleges Admissions Service (UCAS) forms. All applicants to University in the UK complete these forms prior to acceptance into University and the data are used in the selection process by the medical school. These data included age, sex, ethnic group, and previous academic performance (GCSE and A-Level grades). Age represents the age of the participant on the 1st October 2003 which is the date on which the participants commenced their undergraduate studies. Ethnic group was categorised as Asian, Black, Oriental, White, and Mixed Race (unspecified) this is in accordance with the categorisation system used by UCAS on their admissions forms (UCAS, 2007). This system of ethnic categorisation was used as it allows comparison of the sample with national statistical data from England collected by UCAS and is available from the UCAS website (UCAS, 2007). These data were used for group comparisons to examine the representativeness of the sample.

The age range of the participants in this study was 17-22 years with a mean age of 18.28 years (*SD* = .59). As can be seen from Table 4-1, the largest proportion of participants were white in their ethnic origin. The ethnic group least represented in this sample were Oriental. Table 4-1 also shows that sample used in this study is similar to national entrants to medical schools in the UK in 2003 in terms of the ethnic dispersion of the sample. The largest percentage of the national entrants to medical school in 2003 were white, and the smallest percentage of national entrants in 2003 were of the oriental ethnicity. Therefore the sample are similar to British national entrants to medical school in terms of their ethnicity.

Table 4-1 Comparison of the ethnicity of the sample with national medical school entrants in 2003

Ethnicity	% of the sample	% of national entrants in 2003
White	54.1	69.52
Asian	11.0	22.16
Black	2.2	2.49
Oriental	1.7	1.41
Mixed Race (unspecified)	2.8	2.99
Unknown	28.2	1.83

As can be seen in table 4-2, 37.6% of the sample used in this study were male and 62.4% of the sample were female. Nationally in 2003, 38.8% of all entrants to medical school were male and 61.2% were female (UCAS, 2007). Therefore it can be seen that the sample used in this study are similar to national entrants to medical school in terms of their gender.

Table 4-2 Comparison of the sex of the sample with national medical school entrants in 2003

	% of the sample	% of national entrants in 2003
Male	37.6	38.8
Female	62.4	61.2

The socio-economic status of participants was assessed using the Townsend score for economic deprivation and the Index of Multiple Deprivation. The Townsend score is a composite score derived from the 1991 national census data that reflects material deprivation and reflects four levels of material deprivation. These levels of deprivation include;

unemployment, overcrowding, lack of owner occupied accommodation, and lack of car ownership. It is calculated as the sum of z-scores for the four levels with scores greater than zero indicate greater levels of material deprivation (ODPM, 2007). The Index of Multiple Deprivation (IMD) score is a weighted score that represents deprivation measured using seven domains. The seven domains of deprivation include; income, employment, health and disability, education, barriers to housing and services, living environment, and crime. A high IMD score indicates higher levels of deprivation (ODPM, 2007).

The mean IMD score for the sample used in this study was 11.13 (*SD* = 8.74) the mean Townsend score for levels of material deprivation in this sample was -2.38 (*SD* = 2.29) both the IMD and the Townsend scores indicate that the participants have low levels of material deprivation therefore the participants were mainly from a high socio-economic background. This is in accordance with admissions data to medical school nationally where students from higher socio-economic backgrounds tend to be both the applicants and successful entrants to undergraduate medical school (e.g. James, Ferguson, Symonds, & Yates, 2008; Powis et al., 2007).

Type of school previously attended by the participants was categorized as sixth-form college, voluntary-aided school, comprehensive school, further education, grammar school, private grant maintained school, state grant maintained school, and independent school. It can be seen from table 4-3 that the majority of the participants in this sample attended independent schools. This is in accordance with the profile of medical school applicants and entrants with the majority of students from private schools achieving the necessary academic entry level requirements in comparison to the relatively poor performance of those students who attended state schools and therefore did not gain a place at medical school where competition for places is high (cf. Powis et al., 2007).

Table 4-3 Type of school that participants attended prior to medical school

Type of school	Percent
6th form college	1.2
Voluntary aided school	1.2
Comprehensive school	5.8
Further education	16.2
Grammar school	4.0
Grant maintained (state)	2.9
Grant maintained (private)	23.7
Independent school	45.1

4.2.4. PREVIOUS ACADEMIC PERFORMANCE OF PARTICIPANTS.

Previous academic performance for undergraduate UK students consisted of GCSEs and A-Levels. GCSE's were scored as 12 for A-star grade, 10 for A grade, 8 for B grade, 6 for C grade, 4 for D grade, 2 for E grade and 0 for a fail. The average GCSE score was derived by summing the scores and dividing by the number of GCSEs obtained. A-levels were scored as 10 for A grade, 8 for B grade, 6 for C grade, 4 for D grade, 2 for E grade and 0 for a fail. The average A-level score was obtained by summing the scores and dividing by the number of A-levels obtained.

There are strict entry requirements at medical school and a high level of previous academic performance is expected. At the University of Nottingham, students are expected to achieve at least a minimum of six GCSEs at grade A (60 minimum GCSE score) and three A-Level passes; two at grade A and one at grade B (28 minimum A-Level score), and having a fourth A-level does not compensate for lower grades and does not increase the chance of being offered a place at medical school (University of Nottingham Medical University of

Nottingham Medical School., 2007). These requirements are an absolute minimum that students are expected to achieve. This admissions policy is not restricted to Nottingham Medical School this is a country wide policy with other medical schools having similar high standards expected at both GCSE and at A-Level. For example the entry requirements for studying medicine at Keele University require the AAB at A-Level and a minimum of B grades at GCSE (Keele School of Medicine University of Keele., 2007). Therefore these academic standards are not something that is unique to the entry requirements at Nottingham University.

If a student does not achieve these grades then they are not admitted to medical school. As there are strict entry requirements for medicine regarding the previous academic performance necessary for studying medicine, there is an inevitable restriction of range within the sample. This can be seen in table 4-4, which shows that the mean average score of both GCSE and A-Levels in this sample are towards the high end of the range of scores. Nonetheless, it can be see that the data are normally distributed as the data do not appear to suffer problems with either skewness or kurtosis, with both of these statistical values falling below 3.29 which is considered the acceptable limit for normal distribution (cf. Field, 2005; Tabachnick & Fidell, 2001).

Table 4-4 Previous academic performance of participants used in the study.

Previous Academic Performance	Mean	Standard deviation	Range	Skewness (*SE*=.181)	Kurtosis (*SE*=.359)
Average GCSE score	11.12	.58	9.11-12.00	-.54	-.20
Average A-Level score	9.79	.33	8.00-10.00	-1.11	-.11

It is argued that the representativeness of a sample is key to the generalisability of the findings of a study (Ward, 1992). As table 4-1 and 4-2 demonstrate, the sample used in this study is similar to entrants to medical school nationally in 2003 in their sex, and in their ethnic diversity. In addition, the socioeconomic status, and educational background, and type of school attended by this sample is similar to national levels of medical school entrants. Therefore, this sample may be considered on the whole to be representative of medical school entrants in the UK, and not be unique to Nottingham Medical School in their socio-demographic distribution, or their previous educational backgrounds. In comparison to medical students from other medical schools, the entry requirements for medicine are almost the same. Therefore the prior academic performance of Nottingham Medical School undergraduate entrants, and in particular this sample of students, is similar to undergraduate medical students across the UK.

4.3 MATERIALS

This section will provide a detailed description of the psychological measurement scales used in this study and the assessment scores used as outcome variables. The questionnaire measures will be described in terms of their psychometric properties, and then a description of the outcome measures will be provided.

4.3.1 QUESTIONNAIRE MEASURES

The battery of tests used in this study consisted of eight scales which included three scales taken from the Personal Qualities Assessment (Powis et al., 2005), the Goldberg's Big Five Bipolar Marker Scale (Goldberg, 1990, 1992), Short Form of the Marlow-Crowne Social Desirability Scale (Strahan & Gerbasi, 1972), the Shortened Form of the Need for Cognition Scale (Cacioppo, Petty, & Kao, 1984), the Shortened Study Process Questionnaire (Fox, McManus and Winder, 2001) and the Motivational Trait Questionnaire (Kanfer & Heggestad,

2000). These scales were used to measure mental agility, dispositional negative affectivity, stress empathy and narcissism, the Big Five personality traits, social desirability, need for cognition, approaches to study, and trait motivation respectively.

Of the scales used in this study, four are published, and four are copyrighted. Examples of the four published scales can be found in the appendices. As the Motivational Trait Questionnaire and the Personal Qualities Assessment are copyright protected, copies of these scales cannot be included in the appendices for legal reasons. Nonetheless, a full description of the scales with scoring methods and example questions are provided in this section. In addition, the full scales can be obtained from their respective authors on request.

PERSONAL QUALITIES ASSESSMENT (POWIS ET AL., 2005)

The Personal Qualities Assessment was chosen for this study as it is designed as a screening measure for medical student selection procedures. It is designed to detect those individuals with characteristics that are considered both desirable and undesirable for the successful pursuit of a career in medicine (Powis et al., 2005). It is an assessment battery that is compiled of new measures and published scales. The components of the personal qualities assessment chosen for this study comprised; the mental agility test devised by Powis et al, (2005), the depression-anxiety-stress scale (Lovibond & Lovibond, 1995), and the NACE scale to measure narcissism and empathy (Powis et al., 2005). As this is a new battery of scales, it is necessary to outline the scales in order to understand the relevance of why they were chosen as measures for inclusion in the study. Each of the scales will be described in detail in this section.

4.3.1.1 MENTAL AGILITY TEST (POWIS ET AL., 2005)

The mental agility test was devised to be more complex and difficult than typical cognitive ability measures, and was designed specifically for use with medical students and related health disciplines. The scale was developed and was chosen for this study to provide a method to discriminate those individuals of higher mental agility, as medical students have typically been shown to be high achievers at secondary education (Lumsden et al., 2005). The mental agility test is a time constrained measure that allows participants 60 minutes to complete the test. It consists of 45 multiple choice items with four possible answers, designed to measure higher levels of arithmetic, verbal and spatial abilities (Powis et al., 2005). It asks questions such as "Alan died in 1975, his son Bill died 80 years after Alan was born, together they lived for 100 years. When was Bill born?" The scale alternates between questions measuring arithmetic, verbal and spatial ability, and progressively becomes more difficult with the simplest questions are at the beginning of the scale, and the most difficult are at the end of the scale. A high score overall on this scale indicates greater adaptive numerical, verbal and spatial problem solving ability (Powis et al., 2005). The test has been shown to be adequately reliable, particularly in homogenous groups of individuals with Cronbachs α of .80 being reported (Powis et al., 2005). The mental agility test has also been found to be correlated with other extant cognitive ability tests demonstrating convergent validity and is in the process of being tested for predictive validity (Munro, 2005, personal communication).

4.3.1.2 THE DEPRESSION ANXIETY AND STRESS SCALE (LOVIBOND & LOVIBOND, 1995)

The Depression Anxiety and Stress Scale component of the Personal Qualities Assessment is a 42 item scale that was originally devised by Lovibond and Lovibond, (1995) to measure generalised emotional syndromes known as dispositional negative affectivity in a non-clinical population. It asks respondents to rate the extent to which they generally experience a particular emotionally negative symptom on a four point severity/frequency Likert scale

ranging from frequently or often true to never or hardly ever true. Items on the scale include statements such as “I felt that I had nothing to look forward to”, “I felt scared without good reason” and “I found myself getting agitated”. The scale has three subscales; Depression, Anxiety and Stress and each subscale total score is a composite measure determined by summing the scores for the 14 items that reflect each of the subscales. A high score on each of the subscales reflects high levels of depression, anxiety, or stress. The scale has been shown to have very good psychometric properties. It has been shown to have good long term stability between three and eight years (e.g. Lovibond, 1998), has been shown to have good internal reliability with Cronbach’s α ranging from .89 to .96 (Lovibond & Lovibond, 1995) and a good factor structure with a three factor solution explaining 55% of the variance (Brown et al., 1997). In addition to impressive reliability, it has shown to be a valid measure that correlates highly with existing measures such as the Beck’s Depression Inventory (e.g. Lovibond & Lovibond, 1995) that has been tested within a clinical sample and has been shown to discriminate between depression, anxiety and stress in a known clinical population (Brown et al., 1997). Therefore this scale is a reliable and valid measure of dispositional negative affectivity.

4.3.1.3 NARCISSISM AND EMPATHY SCALE (LUMSDEN ET AL., 2005)

The narcissism and empathy section of the personal qualities assessment battery is a 99 item scale that is designed to measure the traits of narcissism and empathy in a non clinical sample. It contains items such as “I usually try to maintain a cool and detached feeling toward people” and “I am so sensitive to the moods of my friends I can almost feel what they are feeling”. It asks respondents to rate the extent to which they agree with each statement by circling a number on a four point likert scale with 1 representing definitely agree, 2 representing agree on the whole, 3 representing disagree on the whole and 4 representing definitely disagree. A high score on each section of the scale reflects a high level of the trait in question. The scale has been shown to have good psychometric properties with Cronbach’s α of between .78 and

.84 being reported (Powis et al., 2005). Although no predictive validity studies have been reported as yet, the scales have been shown to have good construct validity with both convergent and discriminant validity being demonstrated for each subscale (Powis et al., 2005). Therefore it can be seen that this scale is a reliable and valid measure of narcissism and empathy.

4.3.1.4 SHORT FORM MARLOWE-CROWNE SOCIAL DESIRABILITY SCALE (STRAHAN & GERBASI, 1972)

The social desirability scale was developed as a means of assessing the degree to which participants respond in a socially desirable manner (see appendices for complete version of the scale). It contains 20 items which are statements concerning personal attitudes and traits, such as 'I have never intensely disliked anyone' 'I never resent being asked to return a favour'. It asks the participants to indicate whether each statement is true or false about them. Each item is scored 1 for a pre-determined socially desirable response and zero for a non-socially desirable response. A social desirability score, ranging from 0 to 20, is then calculated by summing the scores, the higher the score, the higher the level of socially desirable responses. The scale has been shown to have good reliability with reliability coefficients of .73 to .83 across various samples being reported (e.g. Fraboni & Cooper, 1989; Strahan & Gerbasi, 1972). It is also one of the most widely used measures of social desirability (Helmes & Holden, 2003). Using mixed effects modelling, Beretvas, Meyers, and Leite, (2002) found internal consistency reliability coefficients of between .67 and .73, and test-retest correlations of .86 with a time interval over a month. Therefore this scale was included as it is a reliable measure of social desirability.

4.3.1.5 BIG FIVE MARKER SCALE (GOLDBERG, 1992)

The Big Five marker scale (Goldberg, 1990, 1992) was used to measure individual differences in personality (See Appendices for complete version of the scale). The marker scale is a 35 item bipolar rating scale that provides the participant with a list of bipolar trait descriptors such as 'introverted-extraverted', 'unkind-kind', 'negligent-conscientious', 'nervous-at ease' and 'un-reflective-reflective'. These bipolar trait descriptors are placed on a continuum numbered 1-9, with 6-9 representing the trait and 1-4 representing the opposite trait. Participants are required to circle the number that best describes them generally. The marker scale is designed to measure the Big Five personality domains of; surgency, agreeableness, conscientiousness, emotional stability and intellect. Each scale has seven items the scores of which combine to provide a composite score for each of the Big Five traits. A high score represents a high level of the trait being measured. This scale has been used extensively (e.g. Goldberg, 1992; Johnson, McGue, & Krueger, 2005; Zeldow et al., 1987) and has been shown to have impressive reliability demonstrating Cronbachs α reliability scores of .87 for surgency and agreeableness, .84 for conscientiousness, .88 for emotional stability, and .76 for intellect (Goldberg, 1992). The scale has also been shown to be a valid measure of personality and is considered a standardised measure of the Big Five facets of personality.

4.3.1.6 SHORTENED FORM NEED FOR COGNITION SCALE (CACIOPPO ET AL., 1996).

The Shortened Need for Cognition Scale (see appendices for full version of the scale) is an 18 item five point Likert scale designed to measure the degree to which an individual enjoys effortful cognitive activity (Cacioppo et al., 1996). It contains statements such as 'I find satisfaction in deliberating hard and for long hours' and 'thinking is not my idea of fun'. Half of the items on the scale are worded negatively therefore are reverse scored. Participants are asked for each statement to circle the number that best describes them on a five point Likert

scale ranging from 1 (extremely uncharacteristic of me) to 5 (extremely characteristic of me). After reversal of the necessary items, the scores are summed to form a single total need for cognition score. A higher score indicates a higher level of Need for Cognition. The scale has been shown to be a valid and reliable tool and has been utilised extensively in the literature in a variety of cultures and languages (e.g. Cacioppo et al., 1996; Espejo et al., 2005; Sadowski, 1993; Sadowski & Gulgoz, 1992, 1996; Verplanken, 1991) therefore is considered a standard measurement tool for measuring need for cognition.

4.3.1.7 THE SHORTENED FORM STUDY PROCESS QUESTIONNAIRE (FOX, MCMANUS AND WINDER, 2001)

The Shortened Form of the Study Process Questionnaire (Fox, McManus and Winder, 2001) is designed to measure the approaches to study that students adopt. It comprises three subscales of deep, surface and strategic, each of these subscales contains a motivational element and a strategy element. The 18 item scale contains items such as 'I chose my present course largely with a view to the job situation when I graduate rather than their intrinsic interest to me', 'I find that at times studying gives me a feeling of deep personal satisfaction', and 'I want top grades in most or all of my courses so that I will be able to select from among the best positions available when I graduate'. The Likert response scale ranges from 1 (rarely true of me) to 5 (usually true of me) participants are asked to circle the number that applies to the way they generally approach their studying. The scores are summed according to each of the three subscales of surface, deep, and strategic approach to study, none of the items on this scale are reverse scored. A higher score on each subscale reflects a higher level of the approach to study typically adopted by the participant. A vast amount of research has utilised this scale and shown it to be a reliable and valid measure of approaches to study (Delva, Kirby, Knapper, & Birtwhistle, 2002; e.g. N. Entwistle, McCune, & Hounsell, 2002; Fox et al., 2001; Zhang, 2000).

4.3.1.8 THE MOTIVATIONAL TRAIT QUESTIONNAIRE (KANFER & HEGGESTAD, 2000).

The Motivational Trait Questionnaire was used to measure individual differences in trait motivation. The scale has 48 items and respondents are asked to respond on a 6 point Likert scale. The scale contains items such as 'when I am learning something new, I try to understand it completely' 'I perform better when I compete with others', 'my heart beats fast before I begin difficult tasks', and the scale ranges from 1 (very untrue of me) to 6 (very true of me). Participants are asked to circle the number that best represents how they see themselves. Nine of the items are negatively worded and are reverse scored such as 'if I already do something well, I don't see the need to challenge myself to do better' 'I am not a competitive person' and 'I do not get nervous in achievement settings'. A higher score on each of the three scales reflects a higher level of that trait. The three main factors measured by the motivational traits questionnaire are personal mastery, competitive excellence, and motivational anxiety. Each of these main factors consists of two sub-factors; one that represents motivational elements, and one that represents goal setting. Personal mastery consists of desire to learn and mastery goals, competitive excellence consists of competition seeking and other referent goals and motivational anxiety consists of worry and emotionality. Previous research has shown the motivational trait questionnaire to have good reliability and validity (Ackerman & Kanfer, 2004; Kanfer & Ackerman, 2000; Kanfer & Heggestad, 2000).

Table 4-5 Means, standard deviations, range and Cronbach's Alpha for all scales used in this study.

Scale	Mean	Standard deviation	Cronbach's alpha
Mental Agility	28.42	4.74	.80
Depression	14.29	4.48	.87
Anxiety	17.74	4.17	.78
Stress	21.09	4.39	.81
Empathy	73.44	6.32	.75
Narcissism	53.25	7.92	.75
Surgency	46.71	6.54	.81
Agreeableness	52.94	4.93	.81
Conscientiousness	51.51	5.69	.79
Emotional stability	46.35	6.84	.81
Intellect	49.81	5.60	.75
Need for cognition	61.94	7.55	.82
Surface study approach	17.36	3.41	.60
Deep study approach	21.69	3.16	.60
Strategic study approach	21.14	3.65	.66
Personal mastery	70.26	8.46	.88
Competitive excellence	45.40	11.41	.91
Motivational anxiety	67.19	12.05	.87

When using any psychometric scales it is necessary to ensure that the measures used are reliable. Using Cronbach's α as a measure of reliability, it can be seen from table 4-5 that all of the scales used in the study had Cronbachs α of .6 and above in this sample which demonstrates that the scales have adequate reliability according to the standards described by Field (2005).

4.4 OUTCOME MEASURES.

In order to fully understand the assessment methods used in medical education and how they measure student performance, it is necessary to outline how the course is structured and taught. Describing the course structure and content will provide a clearer understanding of what the outcome measures are actually supposed to be measuring and what a performance outcome incorporates. This section will outline the structure of the medical degree in years one and two in terms of the content of the course, the necessary requirements to pass the course, and the assessment methods used to assess student performance.

The Bachelor of Medical Sciences (BMedSci) degree is a taught modular course that is mainly taught using a series of lectures, tutorials, seminars, and workshops. The first two years of the BMedSci is when the students are mainly taught about basic medical science. The basic medical sciences are taught in modules that are structured into four concurrent themes; Theme A reflects "the cell" incorporating molecular and cellular aspects of medicine, Theme B reflects "the person" incorporating human structure and function, Theme C reflects "the community" incorporating health care in the community, and Theme D reflects "the doctor" incorporating early clinical and professional development (See Table 4-6 and 4-7 for the modules relating to each theme).

Ten modules are undertaken by the students in the first year of the undergraduate degree. The ten modules have a total of sixteen assessments of various techniques for assessing student progress and achievement on the course. These assessments include short notes exams, short written answer exams, oral presentations, written coursework, practical coursework, observed structured clinical exams, multiple choice question exams, true/false/abstain choice exams and practical exams. Table 4-6 shows the modules, assessment methods, and percentage each assessment counts towards the overall module grade.

Table 4-6 Compulsory modules, assessment methods, themes, and number of credits undertaken in Year 1.

Module title	Assessment type	Number of Credits	Theme	% the assessment contributes to the overall module grade
Clinical and laboratory sciences	2 hour multiple choice exam	10	A	100
Molecular basis of medicine	2 hour multiple choice exam	15	A	100
Musculoskeletal system	1 hour true/false/abstain exam	20	B	33
	30 minute practical exam			33
	Practical coursework			33
Human development and tissue differentiation	1 hour short essay exam	10	B	33
	1 hour practical exam			33
	45 minute multiple choice exam			33
Cardiovascular, haematology, and the respiratory system	3 hour true/false/abstain exam	20	B	100
Structure, function, and pharmacology of excitable tissues	1.5 hour true/false/abstain exam	10	B	100
Behavioural sciences	1.5 hour short notes exam	10	C	70
	Oral presentation			30
Public health medicine	45 minute short written answer exam	5	C	100
Communication skills	Coursework	5	D	100
Early clinical and professional development	45 minute observed structured clinical exam	15	D	50
	Written coursework			50

In year two, students are required to undertake nine modules which have a total of thirteen assessments used to assess performance on the course (see Table 4-7). These compulsory modules must be passed in order to obtain 100 credits. Students then have to take a further 20 credits from a choice of optional modules, they can either take one 20 credit module (molecular medicine) or take two 10 credit modules from a choice of five modules on offer. As these modules are optional, results for all students on all assessments on each module are not available therefore this study will focus on performance in the assessments on the ten core modules in year one and the nine core modules in year two, as assessments on these modules is compulsory and therefore data is available for all students.

Table 4-7 Compulsory modules, assessment methods, number of credits undertaken by students in Year 2.

Module title	*Assessment type*	*Number of credits*	*Theme*	*% the assessment contributes to the overall module grade*
Clinical and laboratory sciences 2	3 hour multiple choice exam combined with short notes exam	20	A	100
Functional and behavioural neuroscience	2 hour exam comprising true/false/abstain, structured answers, and a seen case history analysis	15	B	100
Alimentary system and nutrition	1.5 hour true/false/abstain exam	10	B	100
Human development and tissue differentiation 2	45 minute multiple choice exam 1 hour short essay exam	20	B	30 70
General and biochemical pharmacology	1 hour true/false/abstain exam	5	B	100
Metabolism and nutrition: Endocrine and kidney	3 hour true/false/abstain exam combined with short answer exam	10	B	100
Public health medicine	Coursework Coursework	5	C	50 50
Communication skills 2	Written coursework	5	D	100
Early clinical and professional development 2	Coursework 45 minute observed structured clinical exam	10	D	50 50

Passing or failing a module in both year one and year two is determined by the overall module grade percentage. 40% or higher is the pass rate, lower than 40% is considered a failure of the module. Students are required to pass every module at 40% or more in order to progress to the next academic year.

In both years one and two, theme D which comprises early clinical and professional development 1 and 2, and the communication skills 1 and 2 modules require that students must achieve at least 40% in all assessments in order to pass the module and to pass the year. The remainder of the modules allow for compensation of marks; students are allowed to

progress even if they incur a fail, however compensation is only allowed following fulfilment of certain requirements. Students are required to pass all theme D modules, and they must achieve an overall grade of at least 50%, have obtained a grade of at least 35% in the failed modules, have no more than ten credits of failure in a single theme, and have pass marks totalling at least 100 credits. Failure to achieve these criteria results in non-progression on the course.

4.4.1 ASSESSMENT METHODS

Multiple choice exams are a time constrained assessment that is designed to assess the broad knowledge of the student on a particular topic. Typically multiple choice exams consist of a question that asks which of the statements that are given are correct or not correct. Each question has five alternative answers for the respondent to choose from and typically only one of the answers provided is correct. True/false/abstain exams are generally time constrained assessment methods designed to assess the broad knowledge of the module. A true/false/abstain/exam typically take the format of providing a statement that the respondent is expected to recognise as either true or false, and the respondent is expected to state whether the statement is true or false, or they can abstain from responding by not ticking any box. Short essay exams are time constrained assessments where the student is provided with a set of at least six questions and the student has to construct a short written essay response to two questions demonstrating their understanding and knowledge of the area. Short notes exams are similar in structure to short essays however, the student must answer more questions with short concise responses. Practical exams are time constrained assessments that are designed to test practical skills, and take the form of spotter exams, and in course assessments. These assessments require the student to demonstrate their practical skills such as the ability to identify physical structures and substrates and identify and diagnose problems. Seen case history analysis exams are designed to test a students' ability to detect and diagnose problems

from a patients' case history and provide a comprehensive overview and diagnosis of the patients' condition.

An observed structured clinical exam is a time constrained assessment designed to assess student knowledge, competence, and skills in a variety of simulated settings. The assessment has a variety of time constrained stations where students are expected to demonstrate their competence (Harden & Gleeson, 1979). There are monitoring stations where a trained observer is required to give the student a score on their communication skills with simulated patients, their practical skills such as performing a physical examination, and their diagnostic ability (Wallace, Rao, & Haslam, 2002). The other form of station is the marker station where students are assessed on their written skills in the form of writing reports, and their interpretive ability, e.g. their ability to interpret X-rays, lab results (Rushforth, 2007). Students then receive an overall mark for their performance.

Coursework can take two different forms; practical and written, both types have a longer duration of time constraint. In practical coursework, students are given a task to complete within a set amount of time in order to demonstrate their practical abilities. With written coursework, this generally takes the form of report writing or essay writing to answer questions set by the assessor where students have to demonstrate their written skills and their knowledge of the subject area.

4.5 PROCEDURE

This section will outline the procedures involved in the process of data collection used in this study. This will include a description of the methods of data collection, ethical procedures that were adhered to, and the statistical methodology used.

4.5.1 DATA COLLECTION.

Participants were verbally informed of the nature and purpose of the study and they then completed the battery of questionnaires and an ethical consent form on the first day of the first semester in year one, September 2003. This was the first day of formal teaching on the BMedSci programme. Participants were required to adhere to the time limit of 60 minutes to complete the mental agility test. There was no other time limit for completing the remaining scales. Participants were required to provide their student identification number and their syndicate code in order that the responses could be matched up with UCAS data and assessment scores at a later date. Socio-demographic details, age, gender, and ethnicity were then obtained from the student records and UCAS forms. Assessment grades were obtained at the end of each of the first four semesters from the medical school faculty records office.

4.5.2 ETHICS.

Ethical approval was sought and obtained from the internal ethics committee at the University of Nottingham Medical School by Professors David James and Eamonn Ferguson. All ethical considerations were upheld in accordance with the British Psychological Society's ethical code of conduct. No deception was necessary for this study therefore participants were fully informed of the purpose and nature of the research through a verbal introduction to the nature and purpose of the study, and written information regarding what the study would entail. Participants were advised that they could contact the researcher through a number of different means if they had any questions or concerns regarding the study. Each battery of scales also contained a consent form which participants were required to sign if they agreed to participate

(see appendices). The consent form also contained information about the necessity to access to their personal academic records in order to obtain assessment grades. In addition participants were advised that all responses would be kept confidential; all data would be kept on a password protected computer, and no tutors would be informed of their results. Participants were advised that they were free to withdraw from participation at any point without any adverse consequences.

4.5.3 STATISTICAL METHODOLOGY

This section will outline and provide a brief summary of the two statistical methodologies used in this thesis; Principal Components Analysis and Regression Analysis. This will incorporate a description of the statistical techniques, why the statistical methods are used, and why their use is appropriate for this particular set of analyses. It is argued that in order to answer complex research questions, it is necessary that the research design and the statistical methodology used need to match in complexity (Schuwirth & Cantillon, 2005). The complex nature of academic performance research means that complex multivariate statistical methodology should be used. This is in order to take into account the necessary variance within this type of data therefore this research is going to utilise robust multivariate techniques in order to determine the interrelationships between predictors and assessment outcomes. Principal Components Analysis will first be outlined and discussed, finally multiple regression analysis will be outlined and its use in this thesis justified. The description of each technique will incorporate justification of statistical and methodological considerations and criteria used for the analysis.

4.5.3.1 PRINCIPAL COMPONENTS ANALYSIS

Factor analysis is a set of techniques used for determining the underlying structure of relationships in a data set and is used to explain the data in terms of a smaller number of underlying latent dimensions. One of the oldest and most widely used data reduction techniques is Principal Components Analysis (e.g. Hotelling, 1933a, 1933b) which closely relates to Factor Analysis. The main aim of this thesis is to reduce a range of students' dispositional characteristics, into a smaller more meaningful set of broad basic factors. In addition, the aim is to reduce the assessment in medical school into a smaller more meaningful set of basic components. Therefore Principal Components Analysis is the most appropriate and robust multivariate technique to utilise for the current purpose (Goldberg & Velicer, 2006).

There are two major types of Factor Analysis techniques; Exploratory Factor Analysis (incorporating Principal Components Analysis), and Confirmatory Factor Analysis. Exploratory Factor Analysis refers to a set of statistical techniques that can be used for determining the latent structure underlying a set of observed data (Field, 2005). These techniques are mainly utilised when a researcher has no apriori hypotheses as to the structure that underlies the data (Tabachnick & Fidell, 2001) whereas Confirmatory Factor Analysis is used to confirm a hypothesised structure underlying latent constructs and their indicators.

The aims of this thesis incorporate examining the unknown structure of personal characteristics identified as important in medical students and the unknown structure underlying medical school assessment. There is a lack of an identified structure underlying the students' personal characteristics that have been proposed as important in the context of medical education. In addition, there is a lack of agreement as to the number of components that should underlie medical school assessments. Therefore it can be argued that it is most appropriate to explore the underlying structures using Principal Components Analysis. This

analysis will identify the Principal components underlying student characteristics and identify the Principal components underlying medical school assessment; this will identify the most explanatory structure of both student characteristics and the structure of medical school assessment.

When intending to conduct a Principal Components Analysis there are a number considerations that the researcher must take into account in order to successfully apply the technique (Ferguson & Cox, 1993). The first step is that the sample size must be appropriately large enough for the technique to be used. Ferguson and Cox, (1993) recommend that in order to ensure stability of the factor structure, it is necessary to sample a minimum of 100 participants, this study has sampled 181 participants therefore the sample size is adequate for the analysis.

The next consideration involves determining the number of components to retain. Deciding upon the method for selecting the optimal number of components to retain in a principal components analysis is arguably one is the most important decisions that needs to be made and remains a contentious issue in the literature (Goldberg & Velicer, 2006). It is essential that the appropriate method is chosen as an incorrect decision at this stage may result in erroneous conclusions being drawn about the optimal number of components underlying the data (Ledesma & Valero-Mora, 2007).

The most common methods of determining the optimal number of factors includes the *K*1 rule (Kaiser, 1960), the Scree test (Cattell, 1966), and the Minimal Average Partial test (Velicer, 1976). The *K*1 rule is arguably the most simplistic method of determining the appropriate number of components to retain (Ledesma & Valero-Mora, 2007). According to this rule, all components that have eigenvalues that are greater than one should be retained. Although this

method seems simple, it can be inefficient and problematic as it can substantially overestimate the number of factors to retain (Ledesma & Valero-Mora, 2007). This is due to the arbitrary decision of using 1 as a cut off point for selection of components. This means that factors that have an eigenvalue of 1.01 could be retained as a key component but a component with an eigenvalue of .99 being rejected as unimportant when essentially they are similar (Goldberg & Velicer, 2006).

Cattell's (1966) Scree test involves examination of a line graph of eigenvalues. In the graph, eigenvalues are represented in descending order as points, and the line joins together the points. The researcher then subjectively determines the point of inflection by visually scanning the graph and deciding the point at which the line levels off in the graph that is; after the last significant drop in the line (Ledesma & Valero-Mora, 2007). This method has been criticised as being too subjective and can result in different interpretations of the same Scree plot therefore may not be a reliable estimate of the number of components to retain (Zwick & Velicer, 1986).

Velicer, (1976) suggested a method for determining the number of components to retain known as Minimum Average Partial. This method suggests that components that have at least two variables with high loadings should be retained. It is a rule that is proposed to find the most appropriate factor solution rather than the minimum number of components and is based upon analysis of the partial correlation matrix (Ledesma & Valero-Mora, 2007). The only weakness of this method is that it can tend to underestimate the number of components when the loadings are low, and when there are a small number of variables in a component (Costello & Osborne, 2005). Nonetheless, it has been shown to be a more reliable method of determining the number of retainable components (Gorusch, 2003).

As has been noted, the first two methods for determining the optimal number of components have a number of weaknesses if used in isolation for determining the number of factors to retain (e.g. Costello & Osborne, 2005; Ferguson & Cox, 1993; Ledesma & Valero-Mora, 2007). It has been recommended by Costello and Osborne, (2005) that a more efficient approach would be to use a combination of methods, and for the researcher to use their theoretical understanding of the items to be incorporated into the analysis in order that the appropriate number of meaningful components will be retained. Therefore it is important to use a combination of Velicer's (1976) criteria, taking consideration of Cattell's (1966) Scree method, and using a theoretical understanding of assessments for determining the most explanatory number of components to retain (Goldberg & Velicer, 2006).

The final consideration in conducting a Principal Components Analysis involves rotation to simple structure. Rotation is the process of rotating the factor axes to achieve a simpler data structure and to clarify the structure (Goldberg & Velicer, 2006). Simple structure refers to variables having a high loading on one factor and low loading on other factors (Ferguson & Cox, 1993). There are two common methods for rotation; Orthogonal Varimax and Oblique Oblimin. Oblique Oblimin rotation is used when the researcher wants higher order components that are correlated, whereas Orthogonal Varimax rotation is used when the components required are relatively independent of each other (Costello & Osborne, 2005). Therefore as this research is attempting to identify independent broad higher level factors, it is recommended that Orthogonal Varimax rotation is the optimum method of rotation to choose (Goldberg & Velicer, 2006).

4.5.3.2 REGRESSION ANALYSIS

In order to analyse whether medical student characteristics can predict academic performance in medical school, it is necessary to utilise Regression Analysis. Regression Analysis is part of the family of statistics that utilise the General Linear Model. It is a statistical analysis tool that uses the Method of Least Squares to calculate the line of best fit through a set of data points (Schroeder, Sjoquist, & Stephan, 1986). The line of best fit is used to determine the extent to which changes in the level of an outcome variable are as a result of the changes in a predictor or number of predictors (Field, 2005). Multiple Regression Analysis is used when there is more than one predictor to be included into the model. It determines the linear combination of predictors that are significantly correlated with the outcome (Miles & Shevlin, 2001). The score on the outcome variable is predicted from a combination of all the predictor variables. In this case the outcome variable is academic performance in medical school, and the predictors are the personal characteristics of medical students as measured during the first week of term.

When using Multiple Regression Analysis it is important that the researcher considers the method of regression to be used; forced entry, hierarchical or stepwise (Tabachnick & Fidell, 2001). The stepwise method uses a mathematical criterion based upon the correlations and semi-partial correlations between the predictors, to decide the order that the predictors should be entered into the model. This can take the form of forward, stepwise and backwards. The forward method uses the predictor with the highest simple correlation with the outcome. The stepwise method removes the least useful predictor based upon the lowest correlation with the outcome. The backwards method enters all predictors simultaneously then combines forward and stepwise methods to determine the most useful predictors. Unfortunately, this method is not recommended as it removes important theoretical decisions from the researcher and bases decisions solely on mathematical criterion (Field, 2005).

In forced entry, predictors should be chosen based upon strong theoretical grounds as this method forces all the predictors into the model simultaneously. Forced entry is used when there is no theoretical reason for assuming that one predictor is more important to the model than another (Schroeder et al., 1986). It is recommended that the forced entry method be used when there is no apriori theory or empirical evidence to suggest the predictors order of importance. As previous research has shown that there are empirical and theoretical grounds for knowing the order of importance of the predictor variables, neither the stepwise nor the forced entry methods are appropriate for the analysis that this thesis requires.

Hierarchical Multiple Regression on the other hand allows the researcher to decide the order in which the predictors are incorporated into the model. This decision should be made based upon prior theoretical knowledge and empirical evidence (Miles & Shevlin, 2001). As previous empirical evidence has shown that particular characteristics are predictive of academic performance in medical school, and have demonstrated the relative importance of particular characteristics, the Hierarchical Multiple Regression method is the most appropriate method for analysis of the data in this thesis. Therefore this thesis will use the Hierarchical Regression Method to predict academic performance in medical school from personal characteristics of medical students measured at entry to medical school.

4.6 SUMMARY AND NEXT CHAPTER

This chapter has provided an outline the research methodology used in this thesis. It has shown that the design of the study is a longitudinal cohort design, with a sample of 181 medical students. A description of the scales used for data collection and the methods of data collection were provided. This included a description of the Personal Qualities Assessment (PQA) incorporating; a mental agility test, a narcissism scale, an empathy scale, and a dispositional negative affectivity scale, a description of a Big-Five personality scale, a scale

for measuring approaches to study, a need for cognition scale, and a motivational traits scale. The medical school assessment structure was outlined. The data were collected from the participants during the first week of semester 1 and their performance data was taken from the academic faculty office. Finally Principal Components Analysis and Hierarchical Linear Regression statistical methodology were outlined and justified as the most appropriate methods to be used for exploring the underlying structure of academic performance and dispositional characteristics and predicting types of performance in medical school.

The following chapter is the first of the results chapters and will examine the factor structure underlying medical student performance. Principal Components Analysis will be used to address research question one. The chapter will briefly introduce the reason for utilising a Principal Components Analysis, the chapter will then go on to present the results from the analysis, and briefly discuss the findings. The chapter will conclude by justifying the necessity for using a multivariate approach to academic performance outcome.

5 PRINCIPAL COMPONENTS ANALYSIS OF ACADEMIC PERFORMANCE.

5.1 INTRODUCTION

Chapter two provided a review of the academic performance literature. In particular the literature that has focussed upon assessment. It was identified that there is a discrepancy in the way that academic performance is viewed as a construct for research purposes. The educational literature tends to view performance as a unidimensional construct. This viewpoint has led to a tendency for researchers to aggregate scores on assessments into a composite score to reflect overall performance (e.g. Alfayez, Strand, & Carline, 1990). Alternatively, single examination scores have also been used as an outcome measure of performance (e.g. Norman et al., 1987) however, this approach has been criticised for being too specific.

The assessment literature on the other hand has suggested that performance on assessment is multidimensional by nature (McKinley et al., 2008). Researchers have suggested that performance on assessment may be determined by; subject, mode, time, type or competence (Amin et al., 2006). That is by the subject content, whether the assessment is written or practical, the length of time allowed for completing the assessment, the type of assessment, or the underlying competence that it was designed to measure.

Two models were developed to explain academic performance as a variable relating to competence; Bloom's (1956) Taxonomic model, and Miller's (1990) Pyramid Model. Both of these models were proposed to explain the desired outcomes of the educational process. To date, they have not been examined as a potential explanation for actual academic performance. As such, there is a lack of clarity as to what exactly is the structure of assessment methods. It can therefore be seen that the analysis of the structure of assessment that this thesis presents is long overdue.

The purpose of this chapter is to analyse the structure of actual academic performance of medical students on assessments undertaken during the first two years of medical school. The focus of this chapter will be presenting a Principal Components Analysis of assessment. Principal Components Analysis was chosen as it is an exploratory data reduction technique that is appropriate for reducing assessments into a smaller number of meaningful dimensions. Therefore, as the aim of this chapter is to explore the underlying structure of assessment, Principal Components Analysis is the most appropriate method of analysis. This is in order to examine the first research question that was presented in chapter two;

What is the most explanatory number of components that adequately summarises academic performance in medical school.

5.2 DESCRIPTIVE STATISTICS FOR ASSESSMENTS.

Four modules scores were initially removed prior to analysis. These overall modules scores were removed as they contained more than one assessment type that could not be delineated from the overall module grade and therefore their inclusion could have adversely influenced the results of the Principal Components Analysis. These modules included; Behavioural Sciences Year 1, Human Development Year 2, Public Health Medicine Year 2, and Communication Skills Year 2. The assessments that are associated with these modules can be seen in Table 4-7 and 4-8. The optional modules taken in Year 2 by the students were also excluded from the analysis because all students did not take part in all the optional module assessments. Out of a total of 28 assessments taken during the first two years of medical school, 22 assessment scores were included in the analysis. The assessments that were included can be seen in Table 5-1 which also gives the mean scores, standard deviations, range and distribution for each assessment included. It can be seen from Table 5-1 that on average students seemed to excel in the Practical Exam in Human Development, but performed the less well in the Musculoskeletal System MCQ examination.

Table 5-1 Mean Scores, Standard Deviations, Range and Distribution for all Assessments (*N*=181)

Module	Assessment	Year	Mean	SD	Range	Skew (*SE*=.18)	Kurtosis (*SE*=.36)
Excitable tissues	TFA	1	65.78	14.53	83	-.42	.35
Musculoskeletal System	TFA	1	59.08	14.28	79	-.13	-.14
Musculoskeletal System	SPOT	1	66.22	13.66	63	-.37	-.50
Musculoskeletal System	PRAC CW	1	68.97	1.10	8	-.57	3.57
Molecular Basis of Medicine	MCQ	1	69.01	14.01	64	-.38	-.56
Clinical and Laboratory Sciences	MCQ	1	61.41	14.14	70	-.08	-.46
Cardio, Respiratory and Haematology	TFA	1	60.23	10.99	51	-.08	-.44
Communication Skills	CW	1	69.72	10.47	61	-.40	.08
Human Development	MCQ	1	62.24	12.86	66	-.32	.16
Human Development	SA	1	61.94	7.16	38	-.50	.22
Human Development	PRAC X	1	71.47	12.73	64	-.43	.08
Clinical, Professional Development	CW	1	67.34	11.01	43	-.07	-.86
Clinical, Professional Development	OSCE	1	69.65	8.97	57	-.37	.62
Public Health Medicine	SA	1	61.35	9.90	53	-.31	.23
Alimentary System	TFA	2	65.98	13.57	63	-.14	-.40
Clinical Laboratory Sciences	MCQ	2	62.02	11.59	61	.03	-.30
Functional Behavioural Neuroscience	TFA	2	61.16	9.21	52	-.53	.74
Clinical, Professional Development	OSCE	2	69.77	8.81	53	-.65	1.08
Clinical, Professional Development	CW	2	66.29	10.29	54	-.13	-.54
General Biochemical Pharmacology	TFA	2	63.34	11.31	64	-.45	.234
Musculoskeletal System	MCQ	2	62.40	8.37	53	-.38	.52
Renal and Endocrine System	TFA	2	63.97	11.77	69	-.14	.24

Note. MCQ- Multiple Choice Question Exam, TFA- True/False/Abstain Exam, CW- Coursework, SA- Short Answer Exam, ICA- In Course Assessment, OSCE- Observed Structured Clinical Examination, SPOT- Spotter Exam, PRAC X- Practical Exam, PRAC CW- Practical Coursework, SN- Short Notes Exam

5.3 PRINCIPAL COMPONENTS ANALYSIS OF ACADEMIC PERFORMANCE IN MEDICAL SCHOOL

A Principal Components Analysis with Orthogonal Varimax rotation to simple structure was used to explore the linear combinations of variables underlying performance on 22 assessments taken during Year 1 and Year 2 of medical school. This study used data from 181 participants which as noted in section 4.5.3.1 is considered an appropriate sample size for this analysis (Ferguson & Cox, 1993).

Data were examined for normality of distribution by examining the skewness and kurtosis of the data. Table 6-2 demonstrates that the data were normally distributed as all skew and kurtosis scores were in the acceptable rage for normality except for the Musculoskeletal practical coursework, however this score was not deviant enough to cause concern (Tabachnick & Fidell, 2001). Therefore all cases remained in the analysis as the number of variables exceeding the levels of skewness and kurtosis was <25% as advised by Ferguson and Cox, (1993).

Determinant was greater than 0.00001 (Determinant=1.07) demonstrating that multicollinearity and singularity are not a problem in this data set. Examination of the correlation matrix indicated that although the variables were inevitably fairly inter-correlated, the coefficients were not large enough to prove cause for concern about singularity in the data. Therefore Principal Components Analysis was the appropriate tool for analysis of these data and no variable needed to be eliminated (Field, 2000).

The correlation matrix was suitable for a Principal Components Analysis as the items were strongly interrelated (KMO=.93), and the correlation matrix was not an identity matrix (Bartlett's Test of Sphericity (231) =2362.27, $p<.001$). This demonstrates that the

relationships between the variables are meaningful (Tabachnick & Fidell, 2001). To assess the fit of the model to the data, the reproduced correlation matrix was examined for differences between the observed correlations and the correlations based upon the model. The reproduced correlation matrix revealed that there are 84 residuals (36%) with absolute values of greater than .05, suggesting that the model may accurately reflect the observed data.

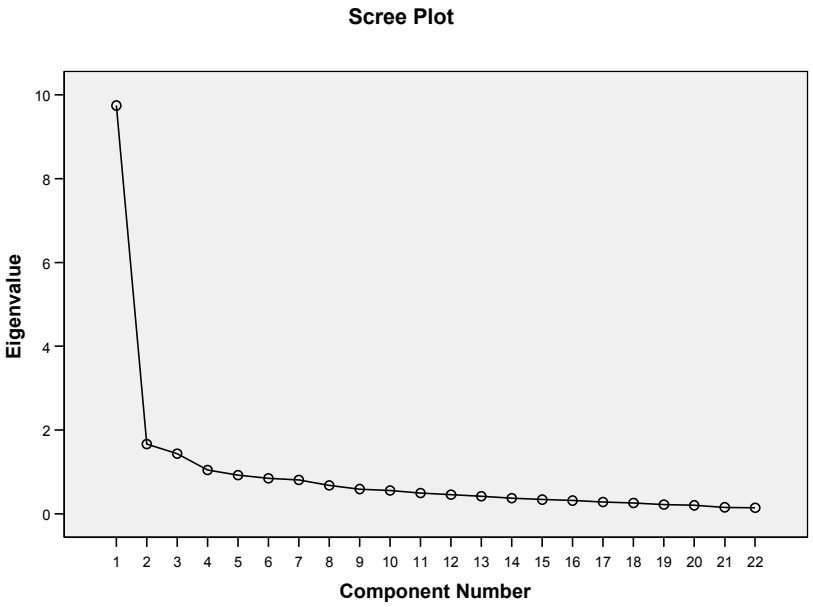
After five iterations, there was potential for four factors to be extracted in the analysis if the analysis was based upon the *K*1 rule of selecting all factors with eigenvalues >1 (Kaiser, 1960). As stated earlier, this method is flawed as having a tendency to overestimate the number of components to retain therefore this rule will be disregarded as the four components did not make theoretical sense. Examination of the Scree plot (see Figure 5-1) using Cattell's (1966) Scree test revealed that the one factor solution is potentially the most appropriate as one could be construed as the main point of inflexion. In addition a substantial proportion of the variance loads onto component one (see Table 5-2).

However, it has been suggested that using the Scree method for determining the number of components to retain is arbitrary, and could lead to an underestimation of the most appropriate number of dimensions underlying the data (Goldberg & Velicer, 2006). Instead, this study used the more robust method of Velicer's (1976) Minimum Average Partial method. Using this method, a three factor solution appears the most appropriate number of components to retain as there are a minimum of two variables loaded onto each of three components, (see Table 5-3). Therefore based upon Velicer's (1976) Minimum Average Partial rule, Three components were extracted and retained from the data. The total variance explained by three components is 58.41%. The first component explained the largest proportion of the variance (see Table 5-2).

Table 5-2 Eigenvalues for each Component and % of variance of each component

Component	Eigenvalue	% of the Variance
Scientific Knowledge assessment (Component 1)	9.74	44.28
(Interpersonal Skills Assessment Component 2)	1.67	7.58
Practical Skills Assessment (Component 3)	1.44	6.54

Figure 5-1 Scree plot of the eigenvalues of the Principal Components underlying assess



There were 16 items loaded onto component one, three items loaded onto component two, and three items loaded onto component three. Examination of the communalities showed that 72% of the variance associated Cardiovascular, Respiratory and Haemotology and 72% of the variance in Renal and Endocrine System is common variance demonstrating that these two variables are the most important to the model. None of the assessment variables have low enough common variance to merit removal from the analysis; however the least important variable to the model is Communication Skills with 37% of its associated variance being common variance.

Table 5-3 Component Loadings, and Communalities for Each of the Three Components of Academic Performance.

Module	Theme	Assessment	Year	Component 1 Scientific Knowledge Assessment	Component 2 Interpersonal Skills Assessment	Component 3 Practical Skills Assessment	Communalities
Cardio,Respiratory, and Haemotology	B	TFA	1	**.83**	.17	.00	.72
Msculoskeletal System	B	SPOT	1	**.83**	.07	.06	.69
Renal and Endocrine System	B	TFA	2	**.83**	.19	-.06	.72
Molecular Basis of Medicine	A	MCQ	1	**.82**	.02	-.05	.68
Clinical Laboratory Sciences	A	MCQ	1	**.82**	.10	.05	.69
Alimentary System	B	TFA	2	**.81**	.14	-.16	.70
Clinical Laboratory Sciences	A	MCQ	2	**.81**	.22	.01	.70
Musculoskeletal System	B	MCQ	1	**.80**	.14	-.09	.67
Human Development	B	MCQ	1	**.80**	-.08	.10	.66
Excitable Tissues	B	TFA	1	**.78**	-.04	-.08	.61
Musculoskeletal System	B	MCQ	2	**.77**	.08	-.00	.61
Human Development	B	PRAC X	1	**.75**	-.01	.06	.57
Functional Behavioural Neuroscience	B	TFA	2	**.70**	.24	.12	.58
General Biochemical Pharmacology	B	TFA	2	**.68**	.16	-.06	.49
Human Development	B	SA	1	**.62**	.20	.40	.58
Public Health Medicine	C	SA	1	**.43**	.32	.26	.36
Clinical, Professional Development	D	OSCE	2	.14	**.74**	.00	.56
Communication Skills	D	CW	1	-.04	**.61**	-.02	.37
Clinical Professional Development	D	CW	2	.11	**.60**	-.16	.52
Clinical, Professional Development	D	CW	1	-.06	-.07	**.71**	.40
Musculoskeletal System	B	PRAC CW	1	.11	.14	**.61**	.61
Clinical, Professional Development	D	OSCE	1	.27	.49	**.53**	.59

MCQ- Multiple Choice Question Exam, TFA- True/False/Abstain Exam, CW- Coursework, SA- Short Answer Exam, PRAC CW- Practical Coursework OSCE- Observed Structured Clinical Examination, SPOT- Spotter Exam, PRAC X- Practical Exam, SN- Short Notes Exam, ESS-essay

Theme A: The Cell, Theme B: The Person, Theme C: The Community, Theme D: The Doctor

It can be seen from Table 5-3 that component one contains a mixture of Year 1 and Year 2 assessments that are all related to either Theme A or Theme B or Theme C. Therefore the content corresponds with the cell, the person and the community. Fifteen of the assessments were written assessments, and one was practical. All 16 assessments in this component had short time constraints. The types of assessment that make up component one incorporate True/False/Abstain exams, multiple choice question exams, short answer exams, a spotter exam, and a practical exam. It can be seen that component one contains elements reflecting the need for the student to demonstrate knowledge and understanding of various biomedical concepts and facts, all under strict short time constraints in examination conditions. Therefore component one should be labelled "Scientific Knowledge Assessment" dimension.

Component two contains two Year 2 assessments and a single Year 1 assessment. All the assessments in this component correspond to Theme D which is focussed upon the doctor and their skills. The mode of assessment in this component incorporated practical coursework assessing communication skills, and an Observed Structured Clinical Exam involving assessment of the student's interpersonal skills with patients. The time constraints on two of the assessments on this component are long in duration, whereas one assessment (Observed Structure Clinical Examination) has a shorter time constraint. The types of assessment incorporated into this component incorporate two coursework scores, and a single Observed Structured Clinical Examination score. It can be seen that component two contains elements reflecting more interpersonal skills assessments. Therefore component two should be labelled "Interpersonal Skills Assessment" dimension.

Component three contains only Year 1 assessments with a module belonging to Theme D (Clinical and Professional Development), and a module belonging to Theme B (Musculoskeletal System) reflecting the doctor, and the person. The mode of assessment on this component was practical for all assessments. The types of assessment that are reflected in component 3 are two practical pieces of coursework, and an Observed Structured Clinical

Examination. It can be seen that this component contains assessments of mainly practical clinical skills such as that are expected of a doctor in training. Therefore component 3 should be labelled “Practical Skills Assessment” dimension.

5.4 CHAPTER DISCUSSION

This chapter has shown that academic performance in medical school is a multidimensional construct that comprises three dimensions that summarise and explain the structure of academic performance. These dimensions have been identified as Assessments of Scientific Knowledge Assessment, Interpersonal Skills Assessment, and Practical Skills Assessment. The results in this chapter suggest that academic performance is multidimensional, thus using a multidimensional approach to academic performance in medical school is necessary if a comprehensive account of academic performance is to be obtained.

The Scientific Knowledge Assessment dimension contains assessments that have a time constraint of short duration, typically around a couple of hours. It reflects assessments of performance on modules from Theme A and Theme B. The modules in Theme A represent “the cell”, incorporating molecular and cellular aspects of medicine, Theme B represents “the person”, incorporating human structure and function, therefore the content of these modules aim to educate the students in the basic medical sciences. The assessment types that are incorporated into this component include multiple choice examinations, True/False/Abstain exams, short answer exams, a spotter exam, and a practical exam therefore the assessments all require the students to demonstrate their knowledge of the basic medical science under a short duration time constraint using different modes of assessment.

The Interpersonal Skills Assessment component contains modules from Theme D. The assessments are a mixture of Year 1 and Year 2 and typically use less time constrained methods. The modules in Theme D represent “the doctor”, incorporating Clinical and

Professional Development and Communication Skills, therefore the content of these modules aim to educate the students in communicating effectively with patients, the doctor-patient relationship, and basic clinical skills. The assessment types that are incorporated into this component include two pieces of coursework aimed at assessing the student's communication and interpersonal skills, and an Observed Structured Clinical Examination that aims to assess the interaction between student and patients in a simulated diagnosis situation. Therefore the assessments in this component all require the students to demonstrate their interpersonal practical clinical skills and communication skills reflecting an underlying dimension of Interpersonal Skills Assessment.

The Practical Skills Assessment dimension contains only Year 1 modules. This component comprises two types of assessments (practical coursework and an Observed Structured Clinical Examination) from the Clinical and Professional Development module, and practical coursework from the Musculoskeletal System module. Clinical and Professional Development is a component of Theme D, designed to educate the students about "the doctor", whereas Musculoskeletal System is a component of Theme B designed to educate the students about "the person". This Observed Structured Clinical Examination is designed to assess the basic clinical skills of the students, whereas the coursework element of the Clinical and Professional Development module involves the students demonstrating their reflective evaluation of the practical skills necessary in both a practical and clinical setting. The practical coursework for the Musculoskeletal module requires students to demonstrate their practical skills such as the ability to identify physical substrates, and identify and diagnose problems. It can be seen that these assessments have time constraints of short duration and are designed to measure the practical skills of the students. Therefore this dimension reflects a Practical Skills Assessment.

A number of potential structures for the underlying dimensions in assessment were described in Chapter 2 including module content, mode, time constraints, and type. From the description

of each of the three underlying dimensions; the Scientific Knowledge Assessment, Interpersonal Skills Assessment, and Practical Skills Assessment, it can be seen that the structure does not seem to correspond with either the module content, mode of assessment, year group, the time constraint explanations or the type of assessment. Each of these three components contains a mixture of year, subject, time constraint, and type of assessment being used. In addition, a content explanation of assessment does not correspond to the three components. Theme A, Theme B, and Theme C are mainly incorporated into the Assessments of Scientific Knowledge component, the Interpersonal Clinical Skills Assessment, and Practical Skills Assessment both contain Theme D elements, and the Practical Skills Assessment contains a Theme B element of assessment. Therefore utilising a subject, mode of assessment, year of assessment, or time constraint explanation of the underlying structure of performance in medical school would be erroneous. When considering types of assessments, the Scientific Knowledge Assessment component contains a mixture of assessment types including written examinations, and practical examinations, and has a combination of assessments from Year 1 and Year 2, and the Practical Skills component contains assessments of both short and long duration. Therefore it appears that the explanation of academic performance in medical school requires more than just a simple explanation based on subject, mode, time or type of the modules or the assessment.

It is therefore necessary to turn to the competency models for an explanation of the underlying dimensions of academic performance. Two potential models that were hypothesised to explain the desired outcomes of education from a competence approach were presented in Chapter 2; Bloom's (1956) Taxonomic model, and Miller's (1990) Pyramid Model. Both of these models were proposed to explain the *desired* outcomes of the educational process, but to date these models have not been evaluated as a potential explanation for *actual* academic performance.

The alternative competence model that is designed to explain the underlying dimensions of the desired outcomes in medical education is the Pyramid Model (Miller, 1990). The Pyramid Model suggests that the underlying structure of academic performance consists of four hierarchical levels; knowledge, competence, performance, and action. At the base of the pyramid is the construct knowledge, reflects scientific knowledge on which all other levels of the pyramid are based. Second is competence which reflects an ability to demonstrate and apply knowledge to decision making, and medical problem solving. The third level of the pyramid is performance, which is where students demonstrate their skills and practical or procedural knowledge. Lastly at the top of the pyramid is the action level which Miller hypothesised is the occurrence within medical practice after qualification.

Miller (1990) suggested that there are particular assessment methods that assess the levels of this framework. This has been specified by more recent researchers (e.g. Harden, Crosby, Davis et al., 1999). It has been suggested that written tests such as multiple choice examinations are measures of the 'knowledge' level, as they require students to have the necessary underpinning knowledge in order to perform successfully on the assessments. On the other hand, modified essay questions and short case histories, and patient management programs are tests of the competence level as they assess the students' ability to utilise knowledge for diagnostic purposes, and therapeutic procedures. Harden, et al., (1999) suggested that the performance level is assessed using observed structured clinical examinations (OSCE), patient simulators, and model devices designed for testing technical skills, because these tests measure a students ability to demonstrate competence in technical and clinical skills.

Whilst Miller's Pyramid model seems intuitive, and has been used for a basis for the development of assessment procedures in medical education, the findings from this research show that the levels of the Pyramid do not closely correspond to the three dimensions

underlying academic performance identified in this study. The findings from this research suggest that a key component is omitted from Millers Model, that is; assessment of the interpersonal skills of the students. In Millers model it is assumed that interpersonal skills should be combined with practical skills. However, the model of academic performance presented here suggests that they should be considered as different components of academic performance in medical school. The results suggest that academic performance comprises underpinning scientific knowledge, the practical skills of the students and the interpersonal skills of the students. This makes sense as the aim of medical education is to develop individuals with the most desirable attitudes and practical skills in addition to the scientific knowledge base (The General Medical Council, 2003). In addition, Miller suggests that competence is one of the facets of academic performance whereas this research suggests that overall academic performance is measuring different competence levels.

The results of this study suggest that the three dimensions of assessment identified in this thesis; Scientific Knowledge Assessment, Interpersonal Skills Assessment, and Practical Skills Assessment correspond with Bloom's (1956) Taxonomic model of educational objectives.

Bloom et al, (1956) argue that educational goals can be divided into three distinct categories reflecting knowledge, attitudes, and skills. 'Knowledge' in this context reflects cognitive processes indicating development of knowledge recall and recognition, and intellectual abilities. 'Attitudes' refers to particular interpersonal skills, moral development, and values. The 'Skills' category refers to more practical skills and applications of knowledge such as reasoning ability and synthesis of information. Knowledge is said to incorporate the scientific, technical, and intellectual capabilities required of the graduating students (Anderson and Krathwohl, 2001). Attitudes on the other hand are said to involve the underlying ethics, morals, empathy, and communication ability. Skills are said to involve investigative skills,

and clinical skills, and use of technology. It is argued that it is essential that these qualities are instilled by medical education, and therefore should underpin assessment. Harden, Crosby, and Davis (1999) suggests that any outcome based model of medical educational outcome should identify, define, and communicate the knowledge attitudes and skills that doctors need to possess. Wass, Van Der Vleuten, Shatzer, and Jones, (2001) concur and suggest that that the educational objectives of medical education typically follow the assessment of knowledge, attitudes, and skills which require multiple assessment methods in order to measure competence.

The Scientific Knowledge Assessment can be seen to be in accordance with the knowledge component of Bloom's Taxonomy. Bloom (1956) argues that knowledge can be categorised into different types. The types of knowledge correspond to cognitive processes indicating development of knowledge recall and recognition, and intellectual abilities (Anderson and Krathwohl, 2001). The Scientific Knowledge Assessment dimension incorporates measurement of the scientific, technical, and intellectual capabilities of medical students which can be seen to correspond to the categories in the Taxonomic Model.

Interpersonal Skills Assessment corresponds to the Attitudes component of Bloom's Taxonomy, in that is incorporates measurement of the underlying ethics, morals, empathy, and communication ability in medical students. The Practical Skills Assessment corresponds to the skills component of Bloom's Taxonomy as it incorporates investigative skills, practical skills, clinical skills, and use of technology. Therefore it can be seen that Bloom's Taxonomy of Educational Objectives corresponds to both desired outcomes of education, and actual academic performance in medical school. This is one of the first studies to demonstrate support for this structure in relation to actual outcomes in an education context rather than the desired outcome. In addition, this is the first time it has been examined in relation to the actual academic performance of medical students.

Previous research that has examined academic performance in medical school as an outcome variable has typically taken one of three approaches when operationalising performance as an outcome measure. These include a macro approach, a micro approach, and an approach inferring competence from scores on final exams. A macro approach uses composite measures that aggregate assessments into one score which reflects total overall academic performance. A micro-approach involves using a single assessment score as an outcome measure of academic performance. Lastly, performance on a final end of degree examinations has been used as an indicator of overall academic performance. Salvatori, (2001) identified that end of year one scores, and overall degree classification were the outcome measures used most often in the literature that examines the prediction of academic performance.

The findings from this study suggest that combining the diverse range of assessment measures into one single aggregate score reflecting overall performance in this manner may potentially obscure theoretically important differences in academic performance. This may result in a significant loss of potentially rich and useful information regarding individual differences in academic performance (Snow, 1994). In addition, these findings suggest that using a single assessment result score as an outcome measure may be too specific in that medical competence can be seen to be a more multifaceted and complex phenomenon (Amin et al., 2006). Therefore it can be seen that combining all scores achieved across an undergraduate degree may lose some explanatory power, and the use of a single measure of performance can be weak and unreliable.

Indeeed, as Schuwirth and Van Der Vleuten, (2004b) argue, it is necessary for academic performance research to examine whether there are other more meaningful ways that scores can be combined. Schuwirth and Cantillon, (2005) argue that using oversimplified composite academic outcome measures cannot give an accurate representation of competence and may lack the sensitivity necessary for detecting differences. They suggest that there is a need for a

multidimensional approach to predicting outcome measures. Combining academic performance measures into a set of scores that considers the individual facets of academic performance which also provides more global information, may provide a rich but manageable quantity of information (Wass, McGibbon et al., 2001). Thus achieving a balance between both single assessment scores, and multi-microlevel scores seems to be a more useful approach to defining academic performance as an outcome variable for research purposes. Therefore this analysis of the structure of academic performance variables was necessary and has gone some way to develop an explanation of academic outcome variables which may be more representative of the specific competencies that underlie medical student performance.

From a theoretical and a practical perspective, it is of interest to develop an integrative framework of assessment types in relation to the predictors of academic performance. This would enable a clearer understand how personal characteristics are differentially related to and predictive of, performance on various different assessment types (Chamorro-Premuzic, Furnham et al., 2005). From an applied perspective, developing theoretical models of cognitive, affective and motivational processes in an ecologically valid setting such as the medical education setting may identify the combinations of traits that are most important for different aspects of medical student assessment (Powis et al., 2005). This may then benefit selection procedures by helping to provide a taxonomy of core personal characteristics to be measured at selection, and help to select those candidates most likely to be successful and perform well in the medical school setting (Busato et al., 1999). In addition, this may be of benefit to pastoral care and support mechanisms. It could possibly provide the potential to identify which components of the medical course students could struggle with, based on their dispositions. The purpose of the next results chapter is to examine the underlying structure of dispositional characteristics measured at entry to medical school. This is in order to assess whether there are patterns of characteristics that may be predictive of the different assessment

types identified in this chapter. Therefore the next chapter will examine the interrelationships between personal characteristics.

5.5 CHAPTER SUMMARY AND NEXT CHAPTER

The preceding section has shown that there are three Principal Components that best explain academic performance in medical school. The three component solution best corresponds to Scientific Knowledge Assessment, Interpersonal Skills Assessment, and Practical Skills Assessment. It has been shown that this model of academic performance in medical school corresponds to Bloom's (1956) Taxonomy, in that it reflects measurement of knowledge, Skills and Attitudes. In particular, this is a model of academic performance that is specific to medical education, and may provide additional explanatory variance when predicting performance using dispositional characteristics. It has been suggested that this multidimensional model of academic performance may provide more explanatory value than using either a single examination score, or an overall aggregated score to measure performance. Nonetheless, this has yet to be examined and will be the focus of Chapter 7. The next chapter will present the second of the results chapters. It will examine the structure of the dispositions of medical students.

6 PRINCIPAL COMPONENTS ANALYSIS OF STUDENT CHARACTERISTICS

6.1 INTRODUCTION

The purpose of this chapter is to determine the number of underlying dimensions in the dispositional characteristics of medical students using a Principal Components Analysis. Previous research has identified numerous factors both cognitive and non-cognitive that are predictive of academic performance (Ferguson et al., 2002). Usually, these characteristics have been examined as independent entities, or in arbitrary combinations. Typically, the impact of such characteristics on academic performance have been reported in isolation within the literature (Ofori & Charlton, 2002). It has been argued that predicting performance needs to be approached using an integrative framework in order to maximise the understanding of factors that influence academic performance (Chamoro-Premuzic & Furnham, 2005). It has been suggested that this might be an informative approach to explaining individual differences in academic performance (Ofori & Charlton, 2002). Therefore the purpose of this analysis is to examine a combination of dispositional characteristics and attempt to determine if there is an underlying explanatory structure. These characteristics include; previous academic performance, cognitive ability, personality, and learning styles. In addition, it has been recognised that non-traditional dispositional characteristics are also worth investigating in relation to academic performance in medical school (Powis et al., 2005). This is in response to the requirement that the selection process needs to distinguish dispositional characteristics that are desirable for a career in medicine (Powis, 2003).

Therefore this chapter will explore whether there is an underlying structure to previous academic performance, cognitive ability, narcissism, empathy, stress, anxiety, depression, social desirability, surgency, agreeableness, conscientiousness, emotional stability, intellect, need for cognition, surface study approach, deep study approach, strategic study approach, personal mastery motivation, competitive excellence motivation, and motivational anxiety.

This Chapter therefore aims to answer the following research question;

What is the number of components that adequately explains and summarises student's personal characteristics measured at entry to medical school

6.2 DESCRIPTIVE STATISTICS FOR CHARACTERISTICS

A total of 19 dispositional characteristics and two previous academic performance variables (GCSE score and A-Level score), were measured. Measurement of medical student's characteristics took place during the first week of the first semester in Year 1 at Nottingham University Medical School. The characteristics that were examined comprised; cognitive ability, narcissism, empathy, stress, anxiety, depression, social desirability, surgency, agreeableness, conscientiousness, emotional stability, intellect, need for cognition, surface study approach, deep study approach, strategic study approach, personal mastery motivation, competitive excellence motivation, and motivational anxiety.

The mean scores, standard deviations, range and distribution for each dispositional characteristic included in the analysis are shown in Table 6-1. It can be seen from Table 6-1 that out of the Big Five personality traits, participants scored the highest on agreeableness, and lowest on emotional stability. Of the approaches to study, the participants scored highest on a deep approach to study, and lowest on a surface approach. Of the motivational traits, participants scored highest on personal mastery motivation and lowest on competitive excellence. Therefore on average, the participants are agreeable, low emotionally stable students who adopt a deep approach to study, with a desire to master the subject material.

Table 6-1 Means, Standard Deviation, Range and Distribution for all Characteristics

Characteristic	Mean	*SD*	Range	Skew (*SE*=.18)	Kurtosis (*SE*=.36)
Average GCSE Score	11.12	.58	2.89	.58	.34
Average A-level Score	9.79	.33	1.33	.33	.11
Cognitive Ability	28.42	4.74	24	-.07	-.03
Narcissism	53.25	7.93	43	.05	.24
Empathy	49.24	4.58	22	-.35	-.48
Social Desirability	13.56	3.14	17	-.43	.277
Stress	21.10	4.39	22	.05	-.22
Anxiety	17.74	4.17	21	.31	-.38
Depression	14.29	4.48	24	1.47	2.59
Surgency	46.71	6.54	35	-.63	.38
Agreeableness	52.94	4.93	26	-.28	.31
Conscientiousness	51.51	5.69	28	-.48	.09
Emotional Stability	46.35	6.84	37	-.73	.45
Intellect	49.81	5.60	29	-.41	.02
Need for Cognition	61.94	7.55	44	-.75	.99
Surface Approach to Learning	17.36	3.41	18	.11	-.13
Deep Approach to Learning	21.70	3.16	18	-.04	.18
Strategic Approach to Learning	21.14	3.65	17	-.35	-.42
Personal Mastery Motivation	70.26	8.46	49	-.36	.12
Competitive Excellence Motivation	46.15	10.29	56	-.17	.16
Anxiety Motivation	67.19	12.05	63	-.02	.13

6.3 RESULTS OF PRINCIPAL COMPONENTS ANALYSIS

A Principal Components Analysis with Orthogonal Varimax rotation to simple structure was used to explore the linear combinations of variables underlying 21 characteristics of medical students measured during the first week of term at Nottingham University Medical School. This study used data from 181 participants which is considered an appropriate sample size for this analysis (Ferguson & Cox, 1993).

Data were examined for normality of distribution by examining the skewness and kurtosis of the data. Table 6-1 demonstrates that the data were normally distributed. The only variable of concern was depression as the skew and kurtosis statistics were larger than 1. Nonetheless, all cases remained in the analysis as the number of variables exceeding the levels of skewness

and kurtosis was <25% as advised by Ferguson and Cox, (1993) and it did not pose a threat to the analysis.

Determinant was greater than 0.00001 (determinant=.001) demonstrating that multicollinearity and singularity are not a problem in this data set. Examination of the correlation matrix indicated that although the variables were inevitably fairly inter-correlated, the coefficients were not large enough to prove cause for concern about singularity in the data. Therefore Principal Components Analysis was the appropriate tool for analysis of these data and no variable needed to be eliminated (Field, 2000).

After an initial Principal Components Analysis was conducted, cognitive ability, A-level score, and GCSE score were removed from the analysis as the loadings for these items were less than .32 on any component (see Table 6-2). This poor loading and communality demonstrates they are not contributing sufficiently to the shared variance in the components and are therefore not contributing to this principle components analysis as each explain less than 10% of the variance in the model (Tabachnick & Fidell, 2001).

Table 6-2 Communality and loading for each of the removed variables

	Communality	**Highest loading and component number**
Cognitive Ability	.03	-.164 (2)
Average GCSE score	.10	-.234 (3)
Average A-level score	.02	-.119 (1)

After removal of cognitive ability, A-level score, and GCSE score, the correlation matrix was suitable for a Principal Components Analysis as the remaining 17 items were strongly interrelated (KMO=.78), and the correlation matrix was not an identity matrix (Bartlett's Test of Sphericity (153) =1184.40, p<.001). This demonstrates that the relationships between the variables are meaningful (Tabachnick & Fidell, 2001). To assess the fit of the model to the

data, the reproduced correlation matrix was examined for differences between the observed correlations and the correlations based upon the model. The reproduced correlation matrix revealed that there are 93 residuals (60%) with absolute values of greater than .05, suggesting that the model may accurately reflect the observed data.

After six iterations, there was potential for five components to be extracted in the analysis if the analysis was based upon the *K*1 rule of selecting all factors with eigenvalues >1 (Kaiser, 1960). As stated earlier, this method is flawed as having a tendency to overestimate the number of components to retain therefore this rule will be disregarded as the five components did not make theoretical sense, and was a potential overestimation. Examination of the Scree plot (figure 6-1) using Cattell's (1966) Scree test revealed that a three component solution is potentially the most appropriate as three could be construed as the main point of inflexion. In addition a substantial proportion of the variance loads onto the three components (see Table 6-2). In addition, Velicer's (1976) Minimum Average Partial method suggested that a three factor solution would be most appropriate (see Table 6-3). Therefore based upon Velicer's (1976) Minimum Average Partial rule, and Cattells Scree test, three components were extracted and retained from the data. The total variance explained by three components is 50.92% (see Table 6-3).

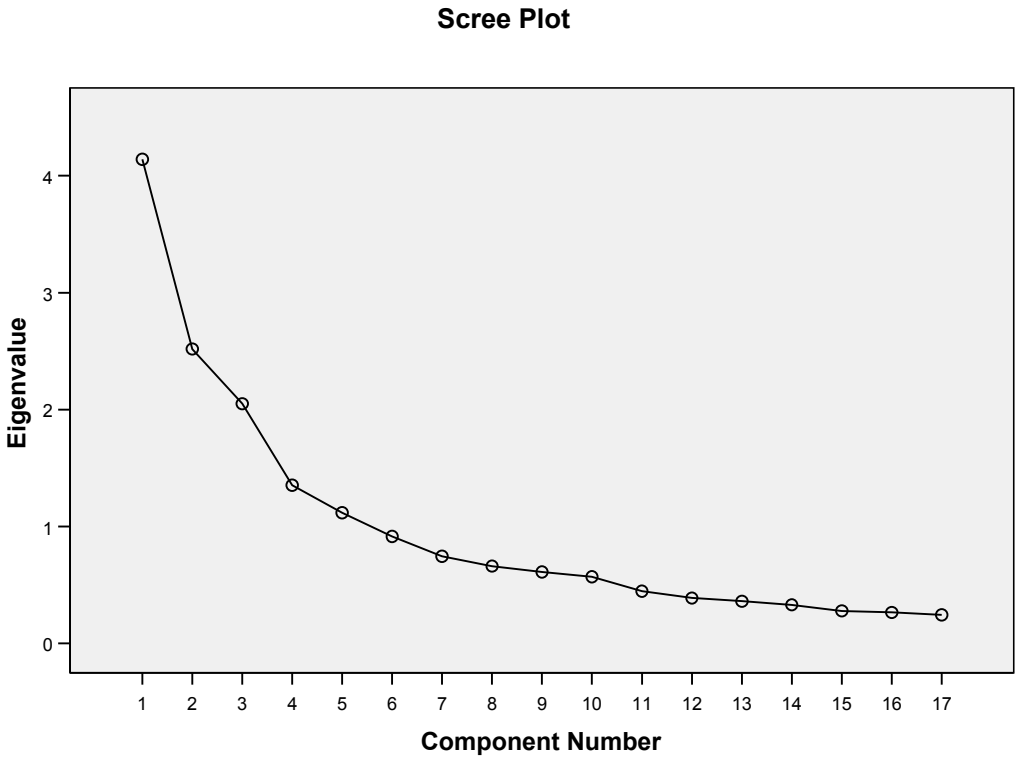
Table 6-3 Eigenvalues for Each Component and % of the Variance of each Component

Component	Eigenvalue	% of the Variance
Component 1	4.66	25.89
Component 2	2.39	13.29
Component 3	2.11	11.75

Table 6-4 Component Loadings, and Communalities for each of the 3 Components of the Dispositional Characteristics.

Characteristic	Component 1 Emotionality	Component 2 Intrinsic Motivation	Component 3 Interpersonal	Communalities
Anxiety	**.80**	.00	.04	.65
Stress	**.79**	.06	.26	.7
Depression	**.74**	-.19	.05	.59
Emotional Stability	**-.71**	.22	-.11	.59
Motivational Anxiety	**.59**	.03	.07	.36
Surgency	**-.46**	.35	.06	.34
Personal Mastery	.02	**.82**	-.09	.69
Deep Study Approach	-.05	**.72**	-.07	.52
Strategic Study Approach	-.10	**.60**	.48	.60
Conscientiousness	-.16	**.60**	-.04	.38
Need for Cognition	-.06	**.59**	-.25	.41
Intellect	-.39	**.46**	.07	.37
Agreeableness	-.18	.40	**-.43**	.38
Narcissism	-.18	-.02	**.81**	.70
Competitive Excellence	-.07	.15	**.72**	.56
Empathy	-.18	.22	**-.62**	.47
Social Desirability	-.40	.25	**-.57**	.55
Surface Study Approach	-.09	-.40	**.44**	.36

Figure 6-1 Scree Plot of the Eigenvalues of Dispositional Characteristics



Component one will be labelled as an Emotionality dimension as it consists of characteristics that reflect a type of generalised emotional disposition. These characteristics include; anxiety, stress, depression, emotional stability, motivational anxiety and surgency. The emotionality dimension is a group of affective dispositions that may operate by influencing how the resources are enhanced or inhibited by emotion. The Emotionality dimension incorporates characteristics that are related to an individual's predisposition for emotional response and typical mood states, it reflects the emotional interpretation of, and perception of the environment (Linnenbrink & Pintrich, 2004).

Component two will be labelled as an Intrinsic Motivation dimension as it consists of dispositions that reflect an inherent interest that is motivated by a desire to know. This component comprises the dispositional traits of; personal mastery motivation, a deep study approach, a strategic study approach, conscientiousness, need for cognition, and intellect. The Intrinsic Motivation disposition may exert its influence through driving the amount of effort expended on a task. This dimension incorporates motivational characteristics, that is; traits that incorporate wants, needs, intentions, and actions (Dweck, 1986). This dimension may be responsible for how cognitive processes are used and transformed into behaviour. The characteristics incorporated indicate the tendency to actively engage in, want to engage in, and maintain the drive, in a task. This complex includes personal mastery, deep study approach, strategic study approach, conscientiousness, need for cognition, and intellect.

Component three can be labelled as an Interpersonal dimension as it comprises agreeableness, narcissism, competitive excellence, empathy, social desirability, and a surface approach to study. The Interpersonal Traits dimension refers to characteristics that are responsible for how well an individual relates to, and interacts with other people. That is, traits that endows the basic skills for social functioning, and social concern (Hoorens, 1995). This complex may be responsible for how an individual perceives, relates to, and interacts with, an individual and

demonstrates the level of capability of successful social functioning. These characteristics can therefore be seen to indicate interpersonal dispositions.

6.4 CHAPTER DISCUSSION

The results of this study have shown that neither previous academic performance variables, nor cognitive ability share enough common variance with the dispositional characteristics measured in this study. Therefore both GCSE and A-level scores, along with cognitive ability had to be removed from the analysis. Once cognitive ability and previous academic performance were removed, the results showed that dispositional characteristics in medical students can be best explained in terms of three underlying dimensions. Emotionality incorporates traits that reflect an emotional predisposition for responding to events in a particular manner. Intrinsic Motivation incorporates approach oriented drives that reflect a predisposed need to learn, achieve, and understand, and experience the world. Interpersonal Traits dimension incorporates dispositions that can influence the level of social functioning and social concern.

This model of the determinants of academic performance in medical school does not fit well with the Intellectual Competence model proposed by Chamorro-Premuzic, (2005). He argues that personality and cognitive ability are interrelated constructs that can be combined to form one overarching construct of the "intelligent personality". Chamorro-Premuzic, (2005) argues that there are optimal levels of particular personality traits that will combine with cognitive ability and in turn, will influence academic performance. This study however, does not support this view point, as neither cognitive ability, nor previous academic performance loaded significantly onto any of the three dimensions identified. This suggests that personality and cognitive ability are distinct constructs that measure different concepts. Indeed previous research has demonstrated the distinctions between cognitive ability and personality when examined from a psychometric approach and suggested that personality and cognitive ability

are orthogonal (Eysenck, 1994). Therefore the results of this study do not suggest a single overarching "intellectual personality". Instead it suggests that there are distinct clusters of traits that are independent of cognitive ability. And that these dispositions cluster together in terms of Emotionality, Intrinsic Motivation, and Interpersonal Traits dimensions.

The findings of this study only partially support the trait complex model of PPIK. Ackerman, (1996) The results of this study demonstrate some support for the cognitive trait complex identified by Ackerman and Beier, (2003) as it showed that intelligence may be discernable in terms of two distinct factors- process and knowledge. As the previous academic performance variable and the cognitive ability variable were distinct from each other, and distinct from the other dimensions identified in this model. Indeed, other researchers have suggested that previous academic performance is a measure of prior knowledge (McManus, Powis et al., 2005). In addition, the findings support the assertion that dispositions can be combined together to form trait complexes.

The PPIK model contains four broad sets of traits, identified as Social, Clerical/Conventional, Science/Math, and Intellectual/Cultural (Ackerman & Beier, 2003). Each complex contains a set of traits that covary and combine in a meaningful way manifesting the overarching complex. The Social complex was said to contain the dispositions extraversion, social potency and well being. Clerical was said to contain openness, typical intellectual engagement, and crystallised intelligence. Science was said to contain elements of cognitive ability, and clerical was said to contain control, conscientiousness, and traditionalism.

The results of this study suggest that the dimensions found in this study do not correspond with the dimensions proposed by Ackerman (1996). The dimensions identified in this study incorporated Emotionality, Intrinsic Motivation, and Interpersonal Traits dimensions. For example, this study found that conscientiousness was incorporated into the same dimension as intellect. Whereas Ackerman, (1996) argues that these two traits are in different complexes. It

is possible that these differences between the model presented in this thesis and PPIK may be due to differences in the number and variety of traits that were measured. PPIK measured Typical Intellectual Engagement, alongside interests, traditionalism, and wellbeing. This study examined the Big Five personality traits, approaches to study, alongside motivational traits, empathy, narcissism. The traits that were measured in this study may differ in both characteristic and associated behaviours than those relating to PPIK. This may have resulted in the disparate findings as the model presented here contains different traits, and different combinations of traits than those proposed by Ackerman and colleagues (e.g. Ackerman & Kanfer, 2004).

Therefore it can be seen that the dimensions identified in this study more closely correspond to the Aptitude Complex Theory proposed by Snow and Lohman, (1984). Aptitude complexes can be defined as a set of cognitive and non-cognitive personal characteristics which reflect an individual's readiness, capability, drive and action. These characteristics may enable an individual to be successful at a particular type of task, or in a particular type of situation (Snow, 1996b). These combinations of characteristics may then influence the quality, level, and quantity of learning and performance on various assessments of learning (Snow, 1989). An individual may possess a large collection of these interactive aptitudes which they apply in varying levels dependent upon the task demands, and the characteristics of the environment (Snow, 1989). In Snow's conceptualisation, aptitudes are classified according to three descriptions; Cognitive, Affective, and Conative dimensions. Each of the trait complexes identified in this study will now be compared with Snow and Lohman's (1984) conceptualisation.

Snow (1989) suggests that a cognitive aptitude complex should utilize traditional measures of cognitive ability that comprises complex cognitive skills such as arithmetic, verbal and spatial ability in order to reflect an "ability to learn" (p.22). However, from the findings of this study

it is unclear whether this complex is dispositional. Neither cognitive ability, nor previous academic performance, were sufficiently related to the other dispositional characteristics measured in this study. Cognitive ability did not share a significant proportion of the variance with any of the three dimensions that were found underlying the dispositional characteristics.

Although previous research has shown that personality and intelligence may be related (e.g. Ackerman & Beier, 2003; 2005), it is possible that incorporating cognitive ability measures into a Principal Components Analysis along with dispositional characteristics may have been spurious. Some researchers argue that personality and cognitive ability are not related as they are measuring theoretically separate constructs (Eysenck, 1971; Leeson et al., 2008). This would provide a plausible explanation as to why cognitive ability does not contribute to the common variance in the analysis (e.g. Leeson et al., 2008).

Another plausible explanation is that it is possible that the measure of cognitive ability used in this study is already a composite measure of a cognitive complex, as the components of the scale were not differentiated. It is therefore possible that the composite cognitive ability score represents a cognitive ability dimension in its own right. This is plausible as cognitive ability did not share common variance with the dispositional characteristics and is therefore orthogonal. The cognitive ability test used in this study was designed to assess a combination of verbal, numerical, and special abilities. Indeed, this explanation would correspond with Snow's conceptualisation of Cognitive Aptitude, in that it combines the measurement of numerical, verbal and spatial abilities into a single score reflecting cognitive ability (Snow & Lohman, 1984).

The Emotionality Complex identified in this study corresponds with Snow and Lohman's (1984) description of their Affective Aptitude Complex as it contains components related to a

generalised emotional disposition (Snow & Lohman, 1984). These dispositions include; stress, anxiety, depression, emotional stability and motivational anxiety. In addition, Surgency negatively loads onto this component suggesting that introversion is related to the component of Emotionality. The Emotionality complex is a group of affective dispositions that may operate by influencing how the cognitive resources are enhanced or inhibited by emotion.

The two levels of this complex are temperamental traits, and characteristic mood. Temperamental traits refer to dispositions such as emotional stability, introversion, and motivational anxiety. All of which affect how a person reacts to situations with emotion, is motivated by emotion, and controls their own emotional world. Characteristic mood incorporates measures of general mood including stress, anxiety, and depression which all reflect a generalised predisposition for a negative affective syndrome (Lovibond, andLovibond, 1998). Emotionality can be seen to incorporate characteristics that are related to an individual's predisposition for emotional response such as motivational anxiety, emotional stability and introversion. It also contains typical mood states, such as stress, anxiety and depression. It reflects the emotional interpretation of, and perception of the environment (Linnenbrink & Pintrich, 2004). The interpretation and perception may then influence the emotional response which in turn can influence academic performance. Each of the characteristics in this dimension will now be discussed with regards to how they may reflect this dimension. When considered from a dispositional perspective, stress, anxiety and depression refer to a pre-dispositional vulnerability to generalised negative affectivity. That is; a typical way of responding to situations through the use of emotions. Therefore the generalised negative affectivity is a key component of the Emotionality complex.

Motivational anxiety is said to involve an inherent fear of failure that results in the individual being apprehensive in performance evaluation contexts (Kanfer & Ackerman, 2000). Through anxiety these individuals will avoid situations where negative evaluation may occur such as achievement oriented situations. The inherent fear of failure leads the individual to focus on

the emotions associated with performance and adopt goals that may reduce the associated emotional responses to the achievement situation. Emotional stability on the other hand, is reflective of an emotionally secure, relaxed, calm emotionally stable, individual. Individuals who score highly on emotional stability are not easily upset, and generally less reactive emotionally (Digman, 1990). As emotional stability loads negatively onto this dimension, it is important to consider the opposite end of the continuum- neuroticism. A large proportion of the research interest in emotional stability has examined the opposite end of the emotional stability continuum, namely neuroticism. Neuroticism is defined as an inability to cope with stress, a high propensity to worry, experiencing high levels of negative affect, and demonstrating high levels of emotionality and insecurity (Eysenck, 1992). Neuroticism may be considered a relevant trait for medical education, as it may influence the ability to cope with stressful situations in academic settings and medical settings further in their career as doctors (Matthews et al., 1988). Therefore it can be seen that emotional stability is a temperamental aptitude that can influence reaction to emotion and how an individual controls their emotional world and is thus an important trait for an emotionality complex.

Surgency belongs to the Big-Five model of personality (Goldberg, 1990). In the literature it is also known as extraversion. Surgency is characterised by boisterousness, extraversion, sociability, assertiveness, adventurousness, gregariousness, impulsivity and sensation seeking (Matthews, Davies, & Lees, 1990). Extraverts are characterized as being sociable individuals who thrive on the interaction with other people. However, in the case of the Emotionality dimension, it is the opposite end of the continuum that is important to this dimension as it loaded negatively onto this factor. Introversion is characterised by a lack of social confidence, a reserved nature, a preference for being alone. A person who scores highly on introversion can even appear aloof and distant as they tend to avoid social gatherings and prefer their own company (Larsen & Buss, 2005). The lack of social confidence may reflect why this trait is incorporated into the Emotionality dimension. It is possible that a high score on introversion

through its relationship with social anxiety invokes an emotional reaction (Fontaine, 1991). In addition, introversion has been shown to be related to depression due to the socially isolating effect of the trait in its extreme (e.g. Parker and Crawford, 2007). Therefore, introversion is an important and influential component of an Emotionality trait complex.

Previous research has shown that the affective characteristics within the emotionality trait complex are theoretically interlinked. It is widely recognised within the research that stress, anxiety, and depression are closely related (Szasbo & Lovibond, 2006). Indeed many studies have shown that stress anxiety and depression are all positively interrelated (e.g. Lovibond, 1998; Lovibond & Lovibond, 1995; Stewart et al., 1995). In addition, Neuroticism has been shown previously to be related to depression (Hutchinson & Williams, 2007; Roberts & Kendler, 1999), the mediation of pervasive negative reactivity to stressful situations (Pillow, Zautra, & Sandler, 1996), and high levels of symptoms of anxiety (Watson, Gamez, & Simms, 2005). It can be argued that those individuals who have a more nervous, anxious, and emotionally unstable disposition are more likely to be motivated by a fear of failure and potentially adopt avoidance goals, and be introverted, than those who are assertive, bold and confident (Halamandaris, and Power, 1999). These characteristics of the emotionality complex have clear implications for performance in an academic setting in that it would be expected that individuals who score highly on emotionality will have poorer academic performance. However examining their combined influence on performance has yet to be examined, which will form part of the analysis of chapter 5.

The Intrinsic Motivation complex can be seen to correspond with the Conative complex proposed by Snow and Lohman, (1984). Conative refers to aptitudes that incorporate wants, needs, intentions, and actions, that is; intrinsic motivational characteristics (Corno et al., 2002). It is argued that it may exert its influence through driving the amount of effort expended on a task. The Intrinsic Motivation complex may be responsible for how cognitive

processes are used and transformed into behaviour. They refer to characteristics that reflect the tendency to actively engage and want to engage in and maintain the drive in a task (Snow, 1996b). This complex includes personal mastery, deep approach to study, a strategic approach to study, conscientiousness, need for cognition, and intellect.

It is argued that conative aptitudes can underlie and influence how an individual utilises their abilities and how they obtain knowledge and skills (Dweck, 1986). Conative aptitudes may also influence how a person approaches a task, in that it can determine their persistence, and the amount of effort used to complete a task (Dweck, 1986). Intrinsic Motivational Traits can underlie and influence how an individual utilises their abilities and how they obtain knowledge and skills (Dweck, 1986). Motivational trait complexes may also influence how a person approaches a task, in that it can determine their persistence, and the amount of effort used to complete a task (Dweck, 1986) Each of the traits will now be discussed in terms of how they fit theoretically into the Intrinsic Motivation complex.

Personal mastery belongs to the motivational trait framework outlined by Kanfer and Heggestad, (2000). Personal mastery is said to involve an intrinsic motivational desire to learn and reflects an inherent need to achieve. Personal mastery is composed of two motivational components; a desire to learn and mastery goals. Kanfer and Ackerman (2000) hypothesise that mastery goals are related to, and influenced by, the desire to learn, and therefore individuals who possess high levels of the intrinsic desire to learn will adopt goals based upon self-referent standards that represent persistent effort aimed at mastery of the task and improvement in performance, therefore both components of personal mastery reflect approach-oriented intrinsic motivations (Kanfer & Heggestad, 2000).

As personal mastery reflects an intrinsic interest in material through a desire to learn, it can be seen that it may be pertinent to the context of medical education. An intrinsic interest in

increasing self-knowledge could influence self-directed learning practices such as problem solving and the ability to learn from previous mistakes. For example, Elliott and Dweck, (1988) found that children motivated by personal mastery reacted to failure in an adaptive manner. Mastery oriented children reacted to their failure at a task as a form of constructive criticism that is; a learning process where the children viewed their failure as a way to learn from the experience. Therefore personal mastery can be seen to fit coherently into an Intrinsic Motivation complex as it reflects intentions and drives, and how those drives translate into action through goal setting (Kanfer & Ackerman, 2000).

A deep approach to study is one of the approaches to study in the theory of learning styles outlined by Entwistle, (1986). Individuals who utilize a deep approach intend to fully understand the meaning of information presented to them because they are intrinsically motivated to study for personal understanding (Davidson, 2002). They do this by actively engaging with the information and attempting to comprehend the argument that is being communicated. They then integrate the information into a wider context in order to understand the broad implications of the material presented (Entwistle, 2001).

A deep approach to study is primarily motivated by an interest in, and a desire to understand the material to be learnt and the field of study (McCune & Entwistle, 2000). This intrinsic motivational element of a deep approach invokes strategies to promote understanding such as relating information to and synthesizing new material with current knowledge (Davidson, 2002). Strategies such as interconnecting ideas, questioning principles and going beyond the bare minimum in order to fully comprehend the material to be learnt are adopted (Zeegers, 2001). Students who adopt a deep approach to study tend to become more self directed learners and have an intrinsic interest in the subject they are studying. Both of these may be considered desirable qualities for an individual wanting to pursue a career in medicine as medicine is constantly changing and being updated. Thus self-directed learning becomes

essential in order to stay abreast of new advances (Newble & Gordon, 1985). Therefore a deep approach to study may be an influential disposition that is incorporated into an intrinsic motivation complex, as it is a reflection of intentions and translates the intentions into academic actions (Entwistle, 1988).

A strategic approach to study is another component of the learning styles theory developed by Entwistle, (1988), and Biggs, (1993). This approach involves students adopting a well organised structured way of approaching their studies; however the focus for these individuals is on motivating factors such as achieving the most optimum grade possible and competition with academic peers (Zhang, and Sternberg, 2001). This strategy is unlike the deep or surface approach in that it is not related to one specific strategy; individuals who adopt a strategic approach can adopt either a surface or a deep strategy dependent upon the task demands it is the underlying motivation that distinguishes the strategic approach from the deep or surface approaches (Diseth and Martinsen, 2003). However, it is still an organised and motivated way of approaching studies. Therefore a strategic approach to study can be seen to be reflective of an intrinsic motivational dimension as it contains the drive to be organised.

Conscientiousness belongs to the Big Five taxonomy of personality (Goldberg, 1990). Conscientiousness subsumes traits such as organized, careful, hardworking, reliable, thorough, and self disciplined. Individuals who score highly on measures of conscientiousness tend to be dedicated, hardworking individuals who are thorough in their work. These individuals are less susceptible to distractions, and can remain self disciplined and focused on the task at hand (Costa & McCrae, 1992). Conscientiousness can be seen to be important component of an intrinsic motivation trait complex as it reflects a person's intentions, and persistence and how these intentions translate into actions through hard work and discipline. Therefore conscientiousness is an important characteristic for a motivational dimension,

particularly as it has been shown to be predictive of academic performance (Wagerman & Funder, 2007).

Need for cognition is hypothesised to be a stable personality attribute that reflects an individuals tendency to engage in and enjoy effortful cognitive activity, such as thinking, reasoning, learning, and problem solving. It reflects a persons inherent need to make sense of and understand the world and their surroundings (Cacioppo et al., 1996). In order to make sense of the world, individuals high in need for cognition actively seek out and enjoy effortful cognitive endeavours (Tidwell et al., 2000). Whereas individuals low in need for cognition tend to avoid effortful cognitive activity where they can, and actively dislike such practices (Cacioppo et al., 1996). Need for cognition may be relevant to medical education as the subject of medicine is complex and requires a lot of cognitive effort in order to understand the volume of scientific knowledge necessary (Harden, Crosby, Davis et al., 1999). Therefore a desire to engage in cognitive effort may be an influential motivational characteristic for a medical student to possess. As such, need for cognition may be useful to incorporate into an Intrinsic Motivation complex as it reflects an innate need to understand the world, and will influence the amount of persistent effort that will be expended on a task (Watt & Blanchard, 1994).

Intellect is the another of the super-ordinate traits that comprise the Big-Five model of personality (Goldberg, 1990). Intellect is characterised by a curiosity about the world, a willingness to try new things, and the enjoyment of new ideas. Intellect subsumes traits such as curiosity, imagination, creativity, and unconventionality. Individuals who score high on intellect want to experience new things, and have an innate need to understand and experience the world. This might be useful in an academic setting as it may motivate students to seek out new and challenging information and new materials for their studies. Therefore it can be seen

that intellect reflects an Intrinsic Motivational trait as it reflects the wants and needs aspect of moitvation.

Previous research has shown that the components of the Intrinsic Motivation Complex are both theoretically and empirically linked. Intellect has been shown to be significantly related to conscientiousness (Laidra, Pullmann, & Allik, 2007). Intellect and conscientiousness may overlap with need for cognition. Intellect is characterized by a curiosity about the world, a willingness to try new things, and enjoyment of new ideas whereas conscientiousness is typically characterized by being task oriented organized and persistent. Need for cognition seems to overlap with these two traits as it is said to reflect an enjoyment for engagement in cognitively effortful tasks and persisting at tasks that are difficult (Cacioppo et al., 1996). Therefore need for cognition seems to be related to both intellect and conscientiousness (Sadowski and Cogburn, 1997). This makes intuitive sense as these relationships reflect the dual nature of the definition of need for cognition incorporating enjoyment of (relating to intellect) and the tendency to engage in (relating to conscientiousness) effortful cognitive processing.

Vermetten, Lodewijks, and Vermunt, (2001) examined the five factor model of personality in relation to approaches to study, they found that intellect directly influences a deep approach to study, with individuals who are more reflective, curious and analytical being more likely to adopt a deep approach. As Kanfer and Ackerman's (2000) motivational trait framework is a relatively new theoretical model, relatively little work has been conducted examining it in relation to constructs such as need for cognition and approaches to study. Nonetheless, it can be argued that the motivations underlying need for cognition and a deep approach to study seem to conceptually overlap with the motivational trait of personal mastery (Semper, Ferguson, James, & 2004). Each of the motivational elements within these constructs involves an innate desire to learn about, understand, and make sense of the world. That is, need for

cognition reflects an innate desire to make sense of the world, personal mastery involves a desire to learn, a deep approach to study strategy comes from the motivation of intrinsic interest and a desire to understand the subject matter.

It can be seen from this conceptualization and previous research that the traits of conscientiousness, intellect, personal mastery, a deep approach to study, and need for cognition, all reflect approach-oriented motivational predispositions relating to wants, needs, motivations, and actions. All of these aptitudes can be seen to be distinct but theoretically overlapping constructs that statistically combined into a theoretically meaningful Intrinsic Motivation trait complex.

In addition to the three key aptitude complexes of cognitive, affective and conative, Corno et al., (2002) suggests that researchers should identify and describe specific trait complexes that may be required for different contexts. This suggests that different situations may require situation specific aptitude complexes that are not necessarily relevant in another context. In medicine, it can be seen that in addition to the level of academic knowledge required, it is essential that medical students have particular levels of social aptitudes that incorporate interactional, and relational skills in order to practice medicine effectively (Bensing & Dronkers, 1992). Therefore it could be argued that an Interpersonal Traits complex would be important when examining the context of medical education.

Snow and Swanson (1992) suggests that there is a need for specialized instructional theory based upon the different needs of different populations. This should incorporate the characteristics, and the educational context based upon the domain of knowledge being transferred. They argue that a trait complex theory can be specialised for a particular knowledge domain and specific learner populations. Specialised knowledge domains and particular learner populations may require specialised combinations of traits in order to be successful (Snow & Swanson, 1992). These

specialised traits should be based upon the general aims of the instructional process, i.e. what is expected threshold of skills that are expected at the end of the academic process (Glaser & Bassok, 1989). Corno et al.,(2002) suggests that researchers should identify and describe aptitude complexes that may be required for different contexts. This suggests that different situations may require specific aptitude complexes that are not necessarily relevant in another context.

This study identified an Interpersonal Trait complex that may be specific for medical education. The Interpersonal complex refers to characteristics that are responsible for how well an individual relates to, and interacts with other people, that is, traits that reflect basic skills for social functioning, and social concern. This complex may be responsible for how they perceive, relate to, and interact with an individual and demonstrates the level of capability of successful social functioning (Paulhaus & Reid, 1991). The social functioning aspect refers to traits such as agreeableness, low competitive excellence, low levels of narcissism, and social desirability. The social concern aspect of the Interpersonal Traits complex pertains to traits that reflect an individual's level of social concern, and incorporates the traits of empathy and narcissism. The Interpersonal Traits complex may influence how an individual relates to others and may influence interpersonal interactions. This may be particularly pertinent in medicine as it may influence interaction with patients, or other team members when involved in team working and inter-professional practice (Maudsley, Williams, & Taylor, 2007). It is likely that the Interpersonal Trait complex contains two potential distinctions; sociable and non-sociable components. It can be seen that agreeableness, empathy, and social desirability reflect a dimension of sociability in that these traits may aid the maintenance of positive interrelations with others, whereas the non-sociable type traits of competitive excellence, a strategic approach to study and narcissism, may hinder interpersonal relationships. Each of the components within this complex will be explored in the context of their incorporation into the Interpersonal Trait complex.

Agreeableness is another trait descriptor from the Big-Five super-ordinate personality traits (Goldberg, 1990). Agreeableness is characterised by a pleasant, cooperative, kind, empathetic, considerate, generous, and helpful nature (Digman, 1990). Individuals who score highly on measures of agreeableness are generally pro-social and interested in social harmony and cooperation (Costa & McCrae, 1992). The selection procedures for medicine incorporate assessment of these types of pro-social characteristics through the interview process and from the personal statements and references. These characteristics are already recognised as beneficial traits for a potential medical practitioner to display (Lievens et al, 2002). Agreeableness can therefore be considered as a a key component in an Interpersonal Traits complex relevant to medical training as it reflects an ability to build rapport and work co-operatively with others and generally keep harmony and may be a necessary trait for efficient and effective interaction in a medical context (Furnham & Mitchell, 1991).

Narcissism on the other hand is characterised by a pre-occupation with the self at the expense of others (Emmons, 1987). This involves a lack of empathy, a manipulative exploitative nature, and an overly ambitious and competitive nature. It is characterised by traits such as authoritarianism, arrogance, aloofness, superiority, and a display of cool indifference at criticism (Kernis & Sun, 1994). This cool indifference however, is a mask, as an individual who scores highly on narcissism is overly dependent on other people's evaluations of themselves (Watson et al., 1984). Criticism of their attributes and achievements results in an internal hostility, anger, and aggression, directed at the person who gave the criticism (Rhodewalt & Morf, 1995).

Narcissists display a number of interpersonal behaviours that can be considered detrimental and adversarial (Powis et al., 2005). For example, individuals who score high on narcissism may have difficulty building rapport and relationships with patients as they demonstrate aloofness, grandiosity, arrogance and a lack of empathy. It is likely that narcissism would be

detrimental to team working if the exploitative, arrogant, authoritarian tendencies are displayed (Munro et al., 2005). In addition, in the academic setting, they may react negatively to constructive criticism from academic staff and may make inappropriate interpretations of feedback viewing it as persecution or rejection, thus learning from feedback may be inhibited (Robinson, 2001). Therefore narcissism can be seen to be an interpersonal trait relevant to medical education. Where a high score may be considered detrimental to interpersonal relationships, a low score on narcissism may be beneficial for interpersonal relationships, team working, and patient skills and potentially be beneficial for assessment of clinical skills. Therefore it is trait that can be considered a key element of (a lack of) the social concern aspect of the Interpersonal Trait complex.

Competitive excellence is one of the three super-ordinate motivational traits within the framework defined by Kanfer and Ackerman, (2000). Competitive excellence involves an extrinsic competition seeking motivational drive, labelled competitiveness where the individual is driven by a need to perform better than other social referents (Kanfer & Ackerman, 2000). Thus it is not mastery of the task that is the drive, it is outperforming their social referents that is the key motivational drive underlying completion of a task. Therefore an individual who scores high on competitiveness adopts goals that are based on comparisons with the socially normative standards of performance labelled other referenced goals (Kanfer & Heggestad, 2000).

It could be argued that competitive excellence may not be adaptive for medical education. When a person decides to pursue a career in medicine, it is hoped that it is for reasons other than appearing better than/more competent than/cleverer than their peers (Maudsley et al., 2007). It is hoped that the drive underlying the decision to undertake and complete medical training is either for the intrinsic interest in the subject area, and on a more social level; helping patients to maintain their health and recover from illness (The General Medical

Council, 2003). This can be seen to reflect the social concern aspect of the Interpersonal Traits complex as a high score may have a detrimental effect on the concern for another persons well being. It can be seen that competitive excellence is incorporated into an Interpersonal complex as it reflects a tendency to compete with others, and make comparisons with others which may be to the detriment of others. These aspects of competitive excellence forms part of a social rivalry and may influence social functioning.

Empathy as a trait is conceptualised as an innate ability to understand and feel the emotions of others, and an ability to communicate an understanding of a persons feelings back to them (Kunyk & Olson, 2001). Squier, (1990) argues that effective practitioner's empathic skills can help to build a trusting relationship where the patient feels able to express their emotional concerns about their illness without reproach. He suggests that empathy can also be used to influence patient motivation to maintain health, regain health or control symptoms through adherence to treatment. Research has shown that practitioners who demonstrate more empathic understanding of patients concerns tend to have patients who are less anxious, more satisfied with the care provided and more likely to adhere to medical regimens (e.g. Bensing et al., 1996; Cameron, 1996; Reynolds, 2003). Therefore it can be seen that empathy is an important skill of an Interpersonal Traits complex necessary for the successful practice of medicine. It is also important theoretically to include in a Interpersonal Trait complex as it reflects an ability to recognise, understand, and feel the emotions of another (Looi, 2008). Thus it is an important trait that reflects a level of social concern that is important for the maintenance of trust in an interpersonal relationship (Bensing & Dronkers, 1992).

It has been suggested that socially desirable responding actually reflects an operational knowledge of social norms, which may be considered to be useful in certain employment settings, dependent on the type of social desirability and the context where interpersonal interaction is common (Mueller-Hanson et al., 2003). Paulhaus, and John, (1998) suggested

that social desirability reflects two types of characteristics, impression management and self deception. They argue that impression management is a conscious self presentation bias where individuals deliberately tailor their responses to display themselves in the most positive and competent way in order to impress others. Self deception is argued to be an unconscious bias that acts as a defence mechanism in order to protect self esteem by exaggerating to the self the image of being a good person, thus is an exaggeration of self worth (Furnham, 1986).

In particular, it has been suggested that impression management can vary according to situational demands, and may be especially influential where social acceptability may be viewed as being necessary (McFarland et al., 2005). However, extremely high scores on impression management may actually reflect maladjustment, poor self esteem and low levels of psychological wellbeing as these individuals tend to have difficulty relating to others in a meaningful way as they attempt to hide their true selves (Hoorens, 1995). In practical terms, social desirability may be an important individual difference variable as the ability to manage other peoples' impressions may actually be a beneficial trait, particularly in situations where social conformity and social influence is important such as gaining the trust of a patient (Lautenschlager & Flaherty, 1990). Therefore social desirability can be seen as an important component of an Interpersonal Trait Complex as it reflects the ability to recognise and utilise social norms which may be an indicator of social functioning.

A surface approach to study is a dispositional approach that forms part of the learning styles theory of how students typically approach their study (Entwistle and Ramsden, 1983). People who adopt a surface approach to their studies tend to memorise specific facts through rote learning without attempting to integrate or understand the meaning of the material being presented, because they are extrinsically motivated by factors such as pleasing other by doing enough to pass (Biggs, 1993). These individuals tend to 'question spot' for exam revision, and rote learn facts in order get through examinations with minimal effort (Entwistle, 2001). They

tend to rely on others for information, and can have a competitive element that motivates the use of this approach. Therefore a surface approach to study can be seen as a potential interpersonal complex as it is a temperamental trait that is motivated by affect, and affect determines the way a student approaches a learning task therefore determines the reaction to emotion (Entwistle, 2001).

Previous research has demonstrated that the characteristics within the Interpersonal Trait complex are interrelated. For example, narcissism has been shown to be related to low levels of agreeableness as narcissism relates to arrogance and an exploitative nature with a blatant disregard for others feelings, which is counter to agreeableness facets of co-operation, considerateness, and social orientation. Rhodewalt and Morf, (1995) examined narcissism in relation to the two facets of social desirability; impression management and self deception. They found that narcissism and both elements of social desirability are related. They suggest that narcissists use self enhancement to maintain high levels of the esteem and evaluation of others, this corresponds to impression management as it reflects a need for social approval. They argue that the self deception aspect of social desirability is related to grandiose self enhancement in that it maintains and increases self esteem and reflects a high level of positive regard (Morf & Rhodewalt, 2001).

It can be argued that impression management may be related to competitive excellence as managing their competence in the face of competition may be necessary in order to bolster self esteem and appear more competent (Paulhaus & Reid, 1991). A potential problem with student's who score highly on impression management, is that these individuals may utilise impression management tactics in order to appear methodical in their study habits in order to maintain social approval from their tutors, and potentially their peers (Schmeck & Geisler-Brenstein, 1989). It may be that appearing competent may be important in medical education. Whilst it is imperative that physicians are actually competent, appearing competent to the

patient-even in the face of uncertainty may aid the patients perception of the practitioner and strengthen the trust and relationship (Sitzia & Wood, 1997).

Morf, Weir, and Davidov (2000) argues that the self esteem of narcissists is contingent on performance outcomes as they are driven by this need for positive evaluation of others therefore it is likely that in an academic setting, competitive excellence is the most likely motivation for completing a course. They examined narcissism in relation to motivation and found that narcissists tend to approach a task with a performance goal rather than a mastery goal; that is they want to demonstrate their superior ability at a task rather than completing the task for intrinsic interest. It is also well recognised that people who score highly on narcissism tend to lack empathic skills, demonstrating a negative relationship between narcissism and empathy (Watson et al., 1984). Narcissistic individuals have difficulty with interpersonal relationships, which may stem from the lack of the ability to empathise with others. In addition, the self obsessional tendencies of narcissism means that relating to others may be difficult as they are too pre-occupied with how they feel themselves (Emmons, 1987).

Empathy has been shown previously to be positively correlated with agreeableness, in particular the friendliness aspect of agreeableness (e.g. Del Barrio, 2004) this relationship may be because agreeableness reflects pro-social characteristics such as consideration of, and cooperation with others that underpins the ability to empathise and interact successfully with others. It can be argued that the ability to maintain the positive impressions of others is essential for the maintenance of social relationships. It may be however, that the successful management of the impressions of others may underlie the motive to build and maintain positive relationships with other people which are facets of agreeableness and empathy (Graziano & Tobin, 2002). Therefore agreeableness and empathy may be meaningfully related to social desirability. Rather than social desirability being a response bias, therefore it can be seen that it can reflect prosocial tendencies.

Snow, (1996a) suggests that the definition and description of various profiles of cognitive, affective and conative characteristics may be beneficial for advancing the understanding of the prerequisites for success in particular educational contexts. Combining constellations of aptitudes into trait complexes and creating a profile of the characteristics that predict academic performance may enable comparisons across situations and educational contexts (Ackerman & Kanfer, 2004). This could be potentially useful as a tool for medical student selection procedures as it might provide an alternative method for discriminating between those students who would be particularly suited to studying for a medical degree (Neame et al., 1992). Therefore this study has gone some way towards classifying particular dispositional characteristics. This study has shown that the dimensions underlying dispositional characteristics reflect Emotionality, Intrinsic Motivation, and Interpersonal Traits which correspond to Snow and Lohman's (1984) conceptualisation of Aptitude Complexes. Nonetheless, it can be seen that there is a need to examine trait complexes in relation to academic performance in order to see if they have explanatory value in predicting academic performance outcomes. As such, this will be the focus of chapter 7.

6.5 SUMMARY AND NEXT CHAPTER

The preceding section has shown that there are three broad dimensions that best explain the dispositional determinants of academic performance in medical school. The three component solution best corresponds to Emotionality, Intrinsic Motivation, and Interpersonal Traits dimensions. It has been shown that this model of the determinants of academic performance in medical school correspond closest with Snow and Lohman's conceptualisation of Aptitude Complexes as the Emotionality component reflects the Affective aptitude complex, the Intrinsic Motivation dimension reflects a Conative Complex, and the Interpersonal Traits dimension reflects a specialised complex for medicine. It has been suggested that this type of multidimensional model of the determinants of academic performance may provide more

explanatory value than using single dispositional predictors. Nonetheless, this has yet to be examined.

As the three dimensions of assessment reflect different knowledge, skills, and attitudes, it is possible that the trait complexes may differentially predict academic performance types. It has been argued that there are some characteristics that are necessary for successful performance on different types of assessment (Chamoro-Premuzic, Furnham, & Ackerman, 2006). Therefore the purpose of Chapter 7 will be to focus upon the predictive value of trait complexes in relation to medical student performance. It will examine the predictive validity of the trait complexes; Emotionality, Intrinsic Motivation, and Interpersonal Traits, in addition to Cognitive Ability and previous academic performance.

The next chapter will present the final results chapter and will focus upon predicting academic performance in medical school. It will present a Hierarchical Multiple Linear Regression Analysis of the determinants of academic performance in medical school. It will first examine predicting overall year one score, and then will use the three Trait Complexes of Emotionality, Interest, and Interpersonal Traits to predict the three types of assessment; Scientific Knowledge Assessment, Practical Skills Assessment, Interpersonal Traits Skills Assessment.

7 PREDICTING ACADEMIC PERFORMANCE IN MEDICAL STUDENTS FROM THEIR PERSONAL CHARACTERISTICS MEASURED AT ENTRY TO MEDICAL SCHOOL.

7.1 INTRODUCTION

Previous research has identified numerous factors both cognitive and non-cognitive that are predictive of academic performance (Ferguson et al., 2002). Usually, these characteristics have been examined as independent entities, or in arbitrary combinations. The preceding chapter has used the statistical approach for combining characteristics into Emotionality, Intrinsic Motivation, and Interpersonal Traits trait complexes. This model was shown to correspond with Snow and Lohman's (1984) conceptualisation of Aptitude complexes. It was shown that the Emotionality component reflects the Affective complex, the Intrinsic Motivation dimension reflects a Conative complex, and the Interpersonal Traits dimension reflects a specialised trait complex for medicine. It has been suggested that this type of multidimensional model of the determinants of academic performance may provide more explanatory value than using single dispositional predictors. Nonetheless, this has yet to be examined.

With regards to assessment, Chapter 5 used the statistical approach for combining scores on academic assessments into three components that best corresponds to Scientific Knowledge Assessment, Interpersonal Skills Assessment, and Practical Skills Assessment. It has been shown that this model of academic performance in medical school corresponds to Bloom's (1956) Taxonomy, in that it reflects measurement of Knowledge, Attitudes and Skills. However, this model of academic performance has yet to be assessed for its explanatory value in terms of being differentially related to dispositional characteristics. As such, the explanatory value of these outcome measures of academic performance in medical school has yet to be determined.

Therefore the first aim of this chapter is to examine the predictive validity of previous academic performance, Cognitive Ability, and the Emotionality, Intrinsic Motivation, Interpersonal Traits trait complexes in relation to the traditional measures of academic performance; Overall composite measure of academic performance in Year 1 and Year 2. Previous academic performance in the form of A-Level score and GCSE score have been included as they have been shown to be predictive of medical school academic grades (Lumb & Vail, 1997; McManus et al., 2003). Therefore previous academic performance merits consideration when examining medical school academic performance and is an important determinant to incorporate into predictive model of academic performance (Ackerman & Kanfer, 2004).

The second aim of this chapter is to examine whether the previous academic performance, Cognitive ability, and the trait complexes; Emotionality, Intrinsic Motivation, and Interpersonal Traits differentially predict academic performance types in the first two years of medical school. The first section will examine whether previous academic performance, Cognitive ability, Emotionality, Intrinsic Motivation, and Interpersonal Traits predict academic performance in Year 1 and Year 2. The second section will examine whether GCSE score, A-Level Score, cognitive ability and the three trait complexes differentially predict the three dimensions of assessment. Each regression will be presented in a separate section; Scientific Knowledge Assessment, Interpersonal Skills Assessment, and Practical Skills Assessment. This analysis is important in order to determine whether clustering academic performance into principal components provides a more detailed explanation of the different qualities necessary to be successful on medical school assessments.

This chapter therefore aims to test the following hypotheses;

H1: Some combination of GCSE score, A-Level score Cognitive ability, Emotionality, Intrinsic Motivation, and Interpersonal Traits will significantly predict academic performance in Year 1

H2: Some combination of GCSE score, A-Level score Cognitive ability, Emotionality, Intrinsic Motivation, and Interpersonal Traits will significantly predict academic performance in Year 2

H3: Some combination of GCSE score, A-Level score Cognitive ability, Emotionality, Intrinsic Motivation, and Interpersonal Traits will significantly predict Scientific Knowledge Assessment

H4: Some combination of GCSE score, A-Level score Cognitive ability, Emotionality, Intrinsic Motivation, and Interpersonal Traits will significantly predict Interpersonal Skills Assessment

H5: Some combination of GCSE score, A-Level score Cognitive ability, Emotionality, Intrinsic Motivation, and Interpersonal Traits will significantly predict Practical Skills Assessment

7.2 PREDICTING OVERALL YEAR ONE PERFORMANCE

It can be seen from table 7-1 that the average academic performance in the first year is equivalent to a 2:1 degree classification therefore the students on average seemed to perform well in the first year of medical school. This table also gives the means and standard deviations for each of the trait complexes. A hierarchical Multiple Regression using forced entry was used to examine the relationship between GCSE score, A-level score, Cognitive Ability, Emotionality, Intrinsic Motivation, and Interpersonal Traits and overall academic performance in Year 1, and overall academic performance in Year 2.

In order that the individual characteristics were all measuring their respective dimension in the same direction, five characteristics were reverse-scored. Items that were reverse scored were emotional stability, surgency, agreeableness, empathy, social desirability. This was conducted in order to simplify interpretation of the dimensions. An average score for each dimension was computed by summing all the elements, and then dividing by N. This score is then taken as an average dimension score which was performed in order to ensure the data remain normally distributed. A high score on the Emotionality dimension refers to a higher level of emotionality, a high score on the interest dimension refers to a higher level of inherent interest, and a high score on the interpersonal dimension means a high level of poor interpersonal traits. Assessment scores were combined in the same manner; all scores for each component identified were summed and divided by N in order to obtain average composite scores for each dimension.

Colinearity statistics indicated that there was no multicolinearity in the data (all VIF=>1) and the Durbin-Watson statistic indicated that adjacent residuals were uncorrelated (DW=1.72) and the scatter-plots of standardised residuals indicated that the data fulfilled the assumption

of linearity and homoscedasticity. Therefore the regression model may be generalized to other samples.

Table 7-1 Mean Scores and Standard Deviations for All Trait Complexes and Overall Year 1 and Year 2 Scores. (*N*=181)

Predictor name	Mean	*SD*
GCSE score	11.12	.58
A-Level score	9.79	.33
Cognitive Ability	28.42	4.74
Emotionality	20.01	27.18
Intrinsic Motivation	46.06	26.55
Interpersonal Traits	32.09	17.21
Year 1 Performance	64.74	7.99
Year 2 Performance	64.20	8.13
Scientific Knowledge Assessment	63.60	9.19
Practical Skills Assessment	68.65	5.14
Interpersonal Skills Assessment	68.59	6.84

Model 1 represents the first stage of the hierarchy with GCSE score, A-level score, and Cognitive Ability as predictors as these have previously been shown to be highly predictive of performance in Year 1 of medical school. Model 2 represents the final model with Emotionality, Interest, and Interpersonal included in the model.

For the first model, the regression equation produced a good fit with the data (R^2=.17), Adjusted R^2=.16) with the first three predictors included in the model. The first model indicated that a combined influence of GCSE score, A-level Score, and Cognitive Ability accounted for 16% of the variance in overall Year 1 score. Using the enter method, a second

model emerged, and this added the predictor Emotionality but not Interest or Interpersonal. In this model, Emotionality account for an additional 4% of the variance in Year 1 performance. However in the second model, GCSE score became non-significant. Intrinsic Motivation and Interpersonal Traits did not significantly contribute to the model and therefore did not predict Year 1 performance.

There was a significant positive relationship between A-Level Score and Year 1 performance ($t(177)=4.82$, $p<.05$) and a significant positive relationship between Cognitive Ability and Year 1 performance ($t(177)= 2.9$, $p<.05$) and a significant positive relationship between Emotionality and Year 1 performance ($t(177)=2.35$, $p<.05$). Therefore A-level score, Cognitive Ability and Emotionality are significant predictor of academic performance in year one of medical school ($F(3,174)=7.58$, $p<.05$).

Table 7-2 Summary of Hierarchical Regression Analysis for Variables Predicting Academic Performance in Year 1 (N=181)

Predictor	*B*	β	*SE* β
Step 1			
GCSE	1.93	.14*	.95
A-Level	7.93	.32**	1.69
Cognitive Ability	.31	.19*	.12
Step 2			
GCSE	1.63	.12	.94
A-level	8.09	.33**	1.68
Cognitive Ability	.33	.20**	.12
Emotionality	.36	.17*	.15
Interpersonal Traits	-.16	-.08	.14
Intrinsic Motivation	.29	.14	.15

Note. $R^2=.17$, $\bar{R}^2=.16$ for Step 2; $\Delta R^2=.04$ ($p>.05$) (*$p<.05$; **$p<.01$)

However there was no significant relationship between GCSE score and Year 1 performance (p=.08), Interpersonal Traits and Year 1 performance, (p=.274), or Intrinsic Motivation and Year 1 performance (p=.06), As Table 7-2 shows, as A-level score increases by one unit, Year

1 performance increases by 8.09 ($p<.05$), as cognitive ability increases by one unit academic performance will increase by .33 ($p<.05$), as Year 1 performance increases Emotionality increase by .36 ($p<.05$).

These results demonstrate that in the first model, GCSE score, A-Level score, and cognitive ability are significant predictors of Overall Year 1 performance. However, when the trait complexes are included in the model, GCSE score becomes non-significant, with no significant change in the explanation of the variance. In addition, it is important to note that Intrinsic Motivation and GCSE score were approaching significance in the second model.

Based on the second model then it can be seen that as cognitive ability increases, Year 1 performance increases. As A-level score increases, Year 1 performance increases, and as Emotionality increases, Year 1 performance increases. However none of the other trait complexes are significantly predictive of Year 1 performance in medical school.

7.3 PREDICTING YEAR 2 PERFORMANCE.

It can be seen from table 7-1 that the average academic performance in Year 2 is equivalent to a 2:1 degree classification therefore the students on average seemed to perform well in the second year of medical school. This table also gives the means and standard deviations for each of the dispositional dimensions of Emotionality, Intrinsic Motivation, and Interpersonal Traits.

Colinearity statistics indicated that there was no multicolinearity in the data (all VIF=>1) and the Durbin-Watson statistic indicated that adjacent residuals were uncorrelated (DW=1.66) and the scatter-plots of standardised residuals indicated that the data fulfilled the assumption of linearity and homoscedasticity. Therefore the regression model may be generalized to other samples.

Model 1 represents the first stage of the hierarchy with GCSE score, A-level score, and Cognitive Ability as predictors as these have previously been shown to be highly predictive of performance in Year 2 of medical school. Model 2 represents the final model with Emotionality, Intrinsic Motivation, and Interpersonal Traits included in the model.

For the first model, the regression equation produced a good fit with the data (R^2=.16), Adjusted R^2=.15) with the first three predictors included in the model. The first model indicated that a combined influence of GCSE score, A-level Score, and Cognitive Ability accounted for 15% of the variance in overall Year 2 performance. In the second model, with all predictors included, GCSE score became non-significant. None of the trait complexes were significant predictors of Overall Year 2 performance.

There was a significant positive relationship between A-Level Score and Year 2 performance (t(177)=4.15, p<.05) and a significant positive relationship between Cognitive Ability and Year 2 performance (t(177)= 3.12, p<.05) Therefore A-level score, and Cognitive Ability are significant predictor of academic performance in year two of medical school (F(3,174)=11.21, p<.05).

However there was no significant relationship between GCSE score and Year 2 performance (p=.06), Emotionality and Year 2 performance (p=.06) Interpersonal Traits and Year 2 performance, (p=..25), or Intrinsic Motivation and Year 2 performance (p=.24), As Table 7-3 shows, as A-level score increases by one unit, Year 2 performance increases by 6.25 (p<.05), as cognitive ability increases by one unit academic performance will increase by .32 (p<.05).

Table 7-3 Summary of Hierarchical Regression Analysis for Variables Predicting Academic Performance in Year 2 (N=181)

Predictor	B	β	SE β
Step 1			
GCSE	1.82	.15*	.84
A-Level	6.18	.29**	1.50
Cognitive Ability	.31	.21**	.10
Step 2			
GCSE	1.62	.13	.85
A-level	6.25	.29**	1.51
Cognitive Ability	.32	.22**	.10
Interpersonal Traits	-.15	-.08	.13
Emotionality	.18	.10	.14
Intrinsic Motivation	.16	.09	.14

Note. R^2=.16, $\bar{R}^2$ =.15 for Step 2; ΔR^2 =.02 (p>.05) (*p<.05; **p<.01)

These results demonstrate that in the first model, GCSE score, A-Level score, and cognitive ability are significant predictors of Overall Year 2 performance. However, when the trait complexes are included in the model, GCSE score becomes non-significant, with no significant change in the explanation of the variance. In addition, it is important to note that Emotionality and GCSE score were approaching significance in the second model.

Based on the second model then it can be seen that as cognitive ability increases, A-level score increases, and as Emotionality increases, academic performance in Year 2 increases. However none of the trait complexes are significantly predictive of Year 2 performance in medical school.

7.4 PREDICTING SCIENTIFIC KNOWLEDGE ASSESSMENT

It can be seen from table 7-1 that the average academic performance in on Scientific Knowledge Assessment is equivalent to a 2:1 degree classification therefore the students on average seemed to perform well on this component of medical school assessment. This table also gives the means and standard deviations for each of the dispositional dimensions of Emotionality, Intrinsic Motivation, and Interpersonal.

Colinearity statistics indicated that there was no multicolinearity in the data (all VIF=>1) and the Durbin-Watson statistic indicated that adjacent residuals were uncorrelated (DW=1.67) and the scatter-plots of standardised residuals indicated that the data fulfilled the assumption of linearity and homoscedasticity. Therefore the regression model may be generalized to other samples.

Model 1 represents the first stage of the hierarchy with GCSE score, A-level score, and Cognitive Ability as predictors as these have previously been shown to be highly predictive of academic performance in medical school. Model 2 represents the final model with Emotionality, Intrinsic Motivation, and Interpersonal Traits included in the model.

For the first model, the regression equation produced a good fit with the data (R^2=.14), Adjusted R^2=.12) with the first three predictors included in the model. The first model indicated that a combined influence of A-level Score, and Cognitive Ability accounted for 12% of the variance in overall Scientific Knowledge Assessment score. Neither GCSE score nor any of the trait complexes significantly contributed to the model, and therefore were not significant predictors of Scientific Knowledge Assessment scores.

There was a significant positive relationship between A-Level Score and Scientific Knowledge Assessment ($t(177)=4.29$, $p<.05$) and a significant positive relationship between Cognitive Ability and Scientific Knowledge Assessment ($t(177)= 2.56$, $p<.05$) Therefore A-level score, and Cognitive Ability are significant predictor of Scientific Knowledge Assessment ($F(3,174)=9.41$, $p<.05$).

However there was no significant relationship between GCSE score and Year 2 performance (p=.19) Emotionality and Scientific Knowledge Assessment (p=.06) Interpersonal Traits and Scientific Knowledge Assessment, (p=.39), or Intrinsic Motivation and Scientific Knowledge Assessment (p=.10). As Table 7-4 shows, as A-level score increases by one unit, Scientific Knowledge Assessment score increases by 8.49 (p<.05), as cognitive ability increases by one unit Scientific Knowledge Assessment score will increase by .35 (p<.05).

Table 7-4 Summary of Hierarchical Regression Analysis for Variables Predicting Scientific Knowledge Assessment (N=181).

Predictor	B	β	SE β
Step 1			
GCSE	1.74	.11	1.11
A-Level	8.37	.30**	1.98
Cognitive Ability	.33	.17*	.14
Step 2			
GCSE	1.46	.09	1.11
A-level	8.49	.30**	1.98
Cognitive Ability	.35	.18**	.14
Interpersonal Traits	-.15	-.06	.17
Emotionality	.34	.14	.18
Intrinsic Motivation	.30	.13	.18

Note. $R^2=.14$, $\bar{R}^2=.12$ for Step 2; $\Delta R^2=.03$ ($p>.05$) (*$p<.05$; **$p<.01$)

A-Level score and cognitive ability were significant predictors of Scientific Knowledge Assessment. None of the trait complexes were significant predictors, however, it is important to note that Emotionality was approaching significance. Therefore it can be seen that as A-

level score increases, Scientific Knowledge Assessment scores increase. In addition, as cognitive ability increases, Scientific Knowledge Assessment scores increase. However none of the other trait complexes are significantly predictive of Scientific Knowledge Assessment.

7.5 PREDICTING INTERPERSONAL SKILLS ASSESSMENT

It can be seen from table 7-1 that the average academic performance in on Interpersonal Skills Assessment is equivalent to a high 2:1 degree classification therefore the students on average seemed to perform well on this the interpersonal skills component of medical school assessment. This table also gives the means and standard deviations for each of the dispositional dimensions of Emotionality, Intrinsic Motivation, and Interpersonal Traits.

Colinearity statistics indicated that there was no multicolinearity in the data (all VIF=>1) and the Durbin-Watson statistic indicated that adjacent residuals were uncorrelated (DW=2.23) and the scatter-plots of standardised residuals indicated that the data fulfilled the assumption of linearity and homoscedasticity. Therefore the regression model may be generalized to other samples.

Model 1 represents the first stage of the hierarchy with GCSE score, A-level score, and Cognitive Ability as predictors as these have previously been shown to be highly predictive of academic performance in medical school. Model 2 represents the final model with Emotionality, Intrinsic Motivation, and Interpersonal Traits included in the model.

For the first model, the regression equation produced a good fit with the data (R^2=.08), Adjusted R^2=.07) with the first three predictors included in the model. The first model indicated that a combined influence of A-level Score, and Cognitive Ability accounted for 8% of the variance in Interpersonal Skills Assessment. Neither GCSE nor any of the trait

complexes significantly contributed to the model, and therefore were not significant predictors of Interpersonal Skills Assessment scores.

There was a significant positive relationship between A-Level Score and Interpersonal Skills Assessment ($t(177)=2.72$, $p<.05$) and a significant positive relationship between Cognitive Ability and Interpersonal Skills Assessment ($t(177)= 2.10$, $p<.05$) Therefore A-level score, and Cognitive Ability are significant predictor of Interpersonal Skills Assessment scores ($F(3,174)=2.69$, $p<.05$).

However there was no significant relationship between GCSE score and Interpersonal Skills Assessment (p=.14) Emotionality and Interpersonal Skills Assessment (p=.64) Interpersonal Traits and Interpersonal Skills Assessment (p=.69), or Intrinsic Motivation and Interpersonal Skills Assessment (p=.67). As Table 7-5 shows, as A-level score increases by one unit, Interpersonal Skills Assessment score increases by 4.19 ($p<.05$), as cognitive ability increases by one unit Interpersonal Skills Assessment score will increase by .22 ($p<.05$).

Table 7-5 Summary of Hierarchical Regression Analysis for Variables Predicting Academic Performance in Interpersonal Skills Assessment (N=181)

Aptitude complex	B	Standardised β for year one	Standard Error for year one
Step 1			
GCSE	1.28	.11	.85
A-Level	4.20	.20**	1.52
Cognitive Ability	.22	.15*	.10
Step 2			
GCSE	1.27	.11	.87
A-level	4.19	.20*	1.54
Cognitive Ability	.22	.15*	.11
Interpersonal Traits	-.05	-.03	.13
Emotionality	-.07	-.04	.14
Intrinsic Motivation	-.06	-.03	.14

Note. R^2=.08, $\bar{R}^2$ =.07 for Step 2; ΔR^2 =.00 (p>.05) (*p<.05; **p<.01)

In this model, A-Level score and Cognitive Ability were the only significant predictors of Interpersonal Skills Assessment. None of the trait complexes predicted Interpersonal Skills Assessment. Therefore it can be seen that as A-level score increases, Interpersonal Skills Assessment score will increase. As cognitive ability increases, Interpersonal Skills Assessment will increase. However none of the other trait complexes are significantly predictive of Interpersonal Skills Assessment.

7.6 PREDICTING PRACTICAL SKILLS ASSESSMENT

It can be seen from table 7-1 that the average academic performance in on Practical Skills Assessment is equivalent to a high 2:1 degree classification therefore the students on average seemed to perform well on this the practical skills component of medical school assessment. This table also gives the means and standard deviations for each of the dispositional dimensions of Emotionality, Intrinsic Motivation, and Interpersonal Traits.

Colinearity statistics indicated that there was no multicolinearity in the data (all VIF=>1) and the Durbin-Watson statistic indicated that adjacent residuals were uncorrelated (DW=2.05) and the scatter-plots of standardised residuals indicated that the data fulfilled the assumption of linearity and homoscedasticity. Therefore the regression model may be generalized to other samples.

Model 1 represents the first stage of the hierarchy with GCSE score, A-level score, and Cognitive Ability as predictors as these have previously been shown to be highly predictive of academic performance in medical school. Model 2 represents the final model with Emotionality, Intrinsic Motivation, and Interpersonal Traits included in the model.

For the first model, the regression equation produced a good fit with the data (R^2=.10), Adjusted R^2=.09) with the first three predictors included in the model. The first model indicated that GCSE score accounted for 9% of the variance in Practical Skills Assessment. Using the Enter method, a second model emerged that added the predictor Emotionality to the model. In this model, Emotionality account for an additional 2% of the variance in Practical Skills Assessment. A-Level score, Intrinsic Motivation, or Interpersonal Traits did not significantly contribute to the model and therefore did not predict Practical Skills Assessment.

There was a significant positive relationship between GCSE Score and Practical Skills Assessment ($t(177)=4.15$, $p<.05$) and a significant positive relationship between Emotionality and Practical Skills Assessment ($t(177)= 2.12$, $p<.05$) Therefore GCSE score and Emotionality are significant predictor of Practical Skills Assessment scores ($F(3,174)=4.16$, $p<.05$).

However there was no significant relationship between A-level score and Practical Skills Assessment (p=.98) Cognitive Ability and Practical Skills Assessment (p=.35) Interpersonal Traits and Practical Skills Assessment (p=.98), or Intrinsic Motivation and Practical Skills Assessment (p=.49). As Table 7-6 shows, as GCSE score increases by one unit Practical Skills Assessment score increases by 2.63 (p<.05), as Emotionality increases by one unit Practical Skills Assessment score will increase by .22 (p<.05).

Table 7-6 Summary of Hierarchical Regression Analysis for Variables Predicting Practical Skills Assessment (N=181)

Aptitude complex	B	Standardised β for year one	Standard Error for year one
Step 1			
GCSE	2.73	.31**	.63
A-Level	-.22	-.01	1.13
Cognitive Ability	.07	.07	.08
Step 2			
GCSE	2.63	30**	.64
A-level	-.03	-.00	1.13
Cognitive Ability	.07	.07	.08
Interpersonal Traits	-.00	-.00	.10
Emotionality	.22	.16*	.10
Intrinsic Motivation	.07	.05	.10

Note. $R^2=.10$, $\bar{R}^2=.09$ for Step 2; $\Delta R^2=.02$ ($p>.05$) (*$p<.05$; **$p<.01$)

In this model, GCSE score and Emotionality were the only significant predictors of Practical Skills Assessment. Cognitive Ability, A-Level score, Intrinsic Motivation, and Interpersonal traits did not predict practical Skills Assessment. Therefore it can be seen that as GCSE score increases, Practical Skills Assessment score will increase. As Emotionality increases, Practical Skills Assessment score will increase.

7.7 CHAPTER DISCUSSION

The results of this study showed that 16% of the variance in Year 1 and 15% of the variance in Year 2 of medical school is predicted by A-Level scores and cognitive ability. This is in accordance with previous research. In addition, when assessment was categorised according to the underlying dimensions, A-Levels and cognitive ability were significantly predictive of Scientific Knowledge Assessment, and Interpersonal Skills Assessment.

It is suggested that A-levels are highly predictive of medical school performance because it has been shown on numerous occasions that prior performance predicts future performance (Wilkinson & Frampton, 2004). In addition it is argued that in order to score highly in A-levels, a good level of cognitive ability, and other personal characteristics such as attitude, motivation, and dedication are necessary, and these qualities are just as relevant for higher education (McManus et al., 2005). Therefore in accordance with the findings of McManus et al., (2003), previous academic performance as measured by A-Level scores have been shown to be in predictive of, and related to the academic and scientific component of the medical degree.

Previous research has shown that cognitive ability is a pervasive positive influence on performance across many life domains including academic performance (Allik & Realo, 1997; Furnham et al., 2003; Laidra et al., 2007). It is hardly surprising that the results from this study demonstrate that cognitive ability predicts overall Year 1 and Year 2 performance.

A surprising finding was that Emotionality significantly predicted Overall Year 1 performance by adding 4% to the variance in Year 1 score, and 2% of the variance in Practical Skills Assessment. The Emotionality complex contains the dispositions; anxiety, stress, depression, neuroticism, motivational anxiety, and introversion. The positive relationship between Emotionality and Year 1 performance suggests that those who are more emotional and have a predisposition for high levels of negative emotional response and typically low mood states perform better overall in the first year of medical school than those who are more stable and less predisposed to emotional reaction. Previous research has indicated that some of the characteristics in this trait complex are negatively related to academic performance (e.g. Furnham & Mitchell, 1991). For example, neuroticism has been shown to be negatively related to academic performance. It is suggested that high scorers on neuroticism are likely to be highly anxious and stressed which could lead to emotional states that interfere with academic productivity and cognition (Grover & Smith, 1981). Therefore the findings of this study are contrary to expectations. There are two possible interpretations of this finding; the Yerkes Dodson law of arousal (Yerkes & Dodson, 1908) and the influence of introversion on performance.

The Yerkes-Dodson Law suggests that performance and arousal are interlinked (Yerkes & Dodson, 1908). It is argued that there is an optimal level of stress and anxiety for performance, however if arousal becomes too high, then performance is detrimentally impacted (Gould & Tuffey, 1996). It may be that the students in this study were reaching an optimal level of arousal and not exceeding this level, therefore higher emotionality may equal higher levels of performance. However, it is more likely to be a combination of the Yerkes-Dodson law explanation and the influence of Introversion. Previous research has shown that introversion is strongly related to academic performance (Cassidy & Eachus, 2000; Furnham, 1992). research has shown that individuals who score highly on introversion are less

susceptible to the influence of distractions and highly motivated on academic tasks (e.g. Furnham, 1992). are less likely to procrastinate when studying and have better attention spans than individuals who are extraverted (e.g. Coombs et al., 1993; Matthews et al., 1990). Therefore it is possible that introversion could have influenced the direction of the relationship between emotionality and performance. As such, it is possible that the beneficial effect of introversion on performance, combined with moderate levels of anxiety and stress, may have influenced the direction of the relationship between Emotionality and performance in Year 1 and Practical Skills Assessment.

When examining Practical Skills Assessment; GCSE score and Emotionality were the only significant predictors. Cognitive ability, A-Level score, Intrinsic Motivation, and Interpersonal traits did not predict practical Skills Assessment. This finding demonstrates that there is differentiation between GCSE and A-Levels when predicting performance. It is Possible that A-Levels provide the basic knowledge and understanding of concepts prior to undertaking a medical degree (McManus et al., 2003). GCSEs on the other hand, seem to equip students with the basic practical skills, or require the students to have a particular level of practical skills in order to be successful. Previous research has shown that GCSE sciences are practically oriented with no less that 20% of the total GCSE scores being related to practical assessment (Jenkins, 1995). As the GCSE requirement for entry into medical school involves sciences, this could explain the relationship with practical examinations. The findings thus support the use of GCSEs in selecting medical students as GCSEs were predictive of Practical Skills Assessment whereas A-Levels did not.

One curious finding was that Intrinsic Motivation was only approaching significance in predicting Overall Year 1 performance. The Intrinsic Motivation dimension contains characteristics such as personal mastery, deep approach to study, strategic approach to study, conscientiousness, need for cognition and intellect. This was particularly surprising as a deep

approach and a strategic approach have been shown previously to predict academic performance in medical school (e.g. McManus, Richards, & Winder, 1999). In addition, is a large body of literature that suggests that conscientiousness is one of the most pervasive predictors of academic performance (Chamorro-Premuzic & Furnham, 2003a). One possible explanation for this finding may be that intrinsic motivation exerts its influence through the direction of resources used. For example, conscientiousness may exert its influence by directing individuals into good study habits, and influencing persistence of effort (Furnham & Mitchell, 1991). In addition need for cognition has been shown to affect the cognitive resources allocated to a task (Cacioppo et al., 1996). As such it may influence academic performance indirectly through cognitive ability.

It should be noted that Interpersonal Traits did not predict performance on Interpersonal Skills Assessment, or any other medical school outcome. The Interpersonal Skills Traits incorporate Agreeableness, Narcissism, competitive excellence, empathy, social desirability and surface approach to study. It would be unlikely that the sociability traits included into the Interpersonal complex would predict academic performance on scientific knowledge or practical skills. However, it could be expected that Interpersonal Traits would predict Interpersonal Skills, as the Interpersonal Skills Assessment involves ascertaining the interpersonal social and communication skills of the students. However, it may be that the effects of the traits in this complex would not be demonstrated until later in the physician's career and may be important for other outcome measures such as patient satisfaction, and effectiveness in interpersonal team working. Although the findings were non-significant, does not imply that the characteristics in this dimension are not important to the practice of medicine. It is possible that the behavioural outcomes of these traits are not measured in medical school, but still remain important to selection procedures as the traits can be seen as both desirable and undesirable in medical doctors.

The findings presented suggest that cognitive skills are a key component that is predictive of educational outcomes. It also provides further support for the continued use of A-Levels as part of the selection procedures in medicine as they consistently predicted first and second year academic performance in medical school. This is consistent with previous research conducted by McManus Smithers, Partridge, Keeling, and Fleming (2003) who suggest that A-Levels are an important component of success in medical school. These findings support previous research that has shown that A-levels are predictive of the preclinical years of a medical degree (Arulampalam et al., 2004; e.g. Markert, 1985; McManus et al., 2003). Therefore, as A-levels are consistently predictive, it is justified that A-level grades are used in selection procedures in medical school as once again the predictive validity of these measures of prior academic achievement has been demonstrated.

It can be seen that the most pervasive predictors of performance in this study are cognitive ability and A-level grades. A-level grades have been shown previously to be a consistent predictor of performance in a wide variety of academic and occupational settings (cf.Borman, Hanson, & Hedge, 1997). They has been shown to be predictive of preclinical, and clinical performance in medicine (e.g. McManus et al.,2005), and the predictive validity of A-levels remains robust even after adjustment for the inevitable restriction of range in a medical student population (Roth, BeVier, Switzer, & Schipmann, 1996).

Overall the findings of this study suggest that it is beneficial to delineate academic performance variables in terms of the broad underlying dimensions, as it can help to determine how particular characteristics operate when predicting performance, that is; which characteristics influence which type of performance.

7.8 NEXT CHAPTER

The Final chapter will draw together the findings of this study and the research will be critically evaluated in relation to the main thesis presented; that categorising academic performance and categorising characteristics into more parsimonious components provides a more comprehensive explanation of the different qualities necessary to be successful in medical school. Firstly the research findings regarding the dimensionality of assessment will be presented and critically evaluated. Secondly, the findings regarding the dimensionality of the dispositional characteristics measured in this thesis will be discussed and evaluated. Thirdly the findings regarding the predictive value of combining dispositional characteristics into a trait complex and examining in relation to a model of academic performance in comparison to traditional measures of academic performance will be discussed. The limitations of the study will be analysed and the contributions that this thesis makes to knowledge in the field of medical education will be outlined and suggestions for pertinent further research will be presented.

8 OVERALL DISCUSSION

8.1.1 INTRODUCTION

The aims of this chapter are to review the overall findings of the three results chapters; The examination of the structure of assessment in Chapter 5, the examination of the structure of dispositional characteristics in Chapter 6, and using trait complexes to predict academic performance types in Chapter 7. Each of these sections will be discussed and critically evaluated in the context of the main research thesis; clustering academic performance and clustering characteristics into more parsimonious components provides a more comprehensive explanation of the different qualities necessary to be successful in medical school.

8.1.2 FINDINGS IN RELATION TO THE DIMENSIONALITY OF ASSESSMENT.

This study demonstrated that there are three broad dimensions that best explain academic performance in medical school. The three component solution best corresponds to; Scientific Knowledge Assessment, Interpersonal Skills Assessment, and Practical Skills Assessment. It has been shown that this model of academic performance in medical school corresponds to Bloom's (Bloom et al., 1956) Taxonomy of Educational Objectives, in that it reflects measurement of Knowledge, Attitudes and Skills.

This thesis has suggested that academic performance in medical school is a multidimensional construct that comprises three dimensions that summarise and explain the structure of academic performance. These dimensions have been identified as Assessments of Scientific Knowledge Assessment, Interpersonal Skills Assessment, and Practical Skills Assessment. The results from this research suggest that using a multidimensional approach to academic performance in medical school is necessary if a comprehensive account of academic performance is to be obtained.

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A number of potential structures for the underlying dimensions in assessment were proposed in Chapter 2 including module content, mode, time constraints, and type. From the description of each of the three underlying dimensions; the Scientific Knowledge Assessment, Interpersonal Skills Assessment, and Practical Skills Assessment, it was shown that the structure does not seem to correspond with either the module content, mode of assessment, year group, the time constraint explanations or the type of assessment. In addition, a content explanation of assessment does not correspond to the three components. Therefore utilising a subject, mode of assessment, year of assessment, or time constraint explanation of the underlying structure of performance in medical school would be erroneous. It appears that the explanation of academic performance in medical school requires more than just a simple explanation based on subject, mode, time or type of the modules or the assessment.

It is assumed in the literature that all assessment instruments are designed to measure latent competencies. Performance on an assessment is assumed to reflect the latent construct it was designed to measure, that is; a competence in a particular area (Gijbels, Van de Watering, Dochy, & Van den Bossche, 2005). This study has demonstrated that assessment methods are the realisation of competence through performance. The model described by this study was reflective of competence in knowledge attitudes and skills as suggested by models of competence (Bloom et al., 1956). Therefore it has supported the assertion that it is performance that is reflective of the level of competence (Beckman et al., 2006)

The competence model that best corresponds to the model presented in this thesis is the Taxonomic model. Bloom et al, (1956) argue that educational goals can be divided into three distinct categories reflecting Knowledge, Attitudes, and Skills. 'Knowledge' in this context reflects cognitive processes indicating development of knowledge recall and recognition, and intellectual abilities. 'Attitudes' refers to particular interpersonal skills, moral development, and values. The 'Skills' category refers to more practical skills and applications of knowledge such as reasoning ability and synthesis of information. Knowledge is said to incorporate the

scientific, technical, and intellectual capabilities required of the graduating students (Bloom et al., 1956). Attitudes on the other hand are said to involve the underlying ethics, morals, empathy, and communication ability. Skills are said to involve investigative skills, and clinical skills, and use of technology. It is argued that it is essential that these qualities are instilled by medical education, and therefore should underpin assessment (Miller, 1990). This study has demonstrated that one of the dimensions underlying academic performance in medical school indeed corresponds to a practical type of skills. Harden, Crosby, and Davis (1999) suggests that any outcome based model of medical educational outcome should identify, define, and communicate the knowledge attitudes and skills that doctors need to possess. Wass, Van Der Vleuten, Shatzer, and Jones, (1999) concur and suggest that that the educational objectives of medical education typically follow the assessment of knowledge, attitudes, and skills which require multiple assessment methods in order to measure competence.

It can be seen that the Interpersonal Skills Assessment component corresponds to the Attitudes component of Bloom's Taxonomy, in that is incorporates measurement of the underlying ethics, morals, empathy, and communication ability in medical students. The Practical Skills Assessment corresponds to the skills component of Bloom's Taxonomy as it incorporates investigative skills, practical skills, clinical skills, and use of technology. Therefore it can be seen that Bloom's Taxonomy of Educational Objectives corresponds to both desired outcomes of education, and actual academic performance in medical school. This is one of the first studies to demonstrate support for this structure in relation to actual outcomes in an education context rather than the desired outcome. In addition, this is the first time it has been examined in relation to the actual academic performance of medical students.

Previous research that has examined academic performance in medical school as an outcome variable has typically taken one of three approaches when operationalising performance as an

outcome measure. These include a macro approach, a micro approach, and an approach inferring competence from scores on final exams. A macro approach uses composite measures that aggregate assessments into one score which reflects total overall academic performance. A micro-approach involves using a single assessment score as an outcome measure of academic performance.

The findings from this study suggest that combining the diverse range of assessment measures into one single aggregate score reflecting overall performance in this manner may potentially obscure theoretically important differences in academic performance. This may result in a significant loss of potentially rich and useful information regarding individual differences in academic performance (2001). It is therefore necessary for academic performance research to examine whether there are other more meaningful ways that scores can be combined (Schuwirth & Van Der Vleuten, 2006a).

Schuwirth and Cantillon, (2004b) argue that using oversimplified composite academic outcome measures cannot give an accurate representation of competence and may lack the sensitivity necessary for detecting differences. They suggest that there is a need for a multidimensional approach to predicting outcome measures. Combining academic performance measures into a set of scores that considers the individual facets of academic performance which also provides more global information, may provide a rich but manageable quantity of information (2005). Thus achieving a balance between both single assessment scores, and multi-microlevel scores seems to be a more useful approach to defining academic performance as an outcome variable for research purposes. Therefore this analysis of the structure of academic performance variables was necessary and has gone some way to develop an explanation of academic outcome variables which may be more representative of the specific competencies that underlie medical student performance.

Therefore combining assessment measures based upon statistical interrelations has provided a useful framework for examining academic performance. In particular, the model provided in this thesis is a model of academic performance that is specific to medical education, and may provide additional explanatory variance when predicting performance using dispositional characteristics.

8.1.3 FINDINGS IN RELATION TO THE DIMENSIONALITY OF DISPOSITIONAL CHARACTERISTICS

The results of the Principal Components Analysis indicate that there are three broad dimensions that best explain the dispositional determinants of academic performance in medical school. The three component solution best corresponds to Emotionality, Intrinsic Motivation and Interpersonal Traits. It has been shown that this model of the determinants of academic performance in medical school correspond closest with Snow and Lohman's (1984) conceptualisation of Aptitude Complexes. It can be seen that the Emotionality component reflects the Affective aptitude complex, the Intrinsic Motivation dimension reflects a conative complex, and the Interpersonal complex reflects a medicine-specific trait complex.

8.1.4 PREDICTIVE VALIDITY OF TRAIT COMPLEXES

The results from this study have shown that A-levels and cognitive ability are consistent positive predictors of performance measures in the first two years of medical school. A-levels have been shown to be the largest predictor of overall Year 1 performance. These findings support previous research that has shown that A-levels are predictive of the preclinical years of a medical degree (McManus et al., 1998). Therefore, as A-levels are consistently predictive, it is justified that A-level grades are used in selection procedures in medical school as the predictive validity of these measures of prior academic achievement has been demonstrated.

McManus, Smithers, Partridge, Keeling, and Fleming (2003) suggest that there are at least two arguments as to why previous academic achievement is a useful predictor of medical student achievement. Previous academic achievement demonstrates that the candidate has a minimum level of competence and has the basic knowledge on which to build and integrate new knowledge. It has also been shown to be predictive of medical school academic grades (Ferguson et al., 2002; McManus et al., 2003). In addition, previous academic achievement has been shown consistently to be predictive of future performance in University (e.g. James and Chilvers, 2001, Rahbar, Vellani, Sajan, Zaidi, and Akbarali, 2001, Davidson, 2002). A-levels are considered to be a valid and reliable indicator of the academic potential of a student (McManus et al., 2003). Indeed, as Markert (1985) argues, the use of the criteria of high academic grades is adequate in assessing academic ability in candidates and predicting medical school academic performance. A-Levels have been shown to be predictive of career outcomes in doctors (e.g. McManus et al, 2003) and to final year examination performance but not related to clinical experience in medical students (McManus, Richards, Winder, and Sproston, 1998).

GCSE scores however, have previously been shown to be predictive of clinical performance (Arulampalam et al., 2004; Ferguson et al., 2000). The results from this study provide a possible explanation for this finding. GCSEs were shown to be predictive of Practical Skills Assessments in the preclinical aspect of the course. Therefore it is likely that GCSEs either require or endow students with the necessary practical skills prior to medical school. As the GCSE requirement for entry into medical school involves sciences, this could explain the relationship with practical examinations. As previous research has shown that GCSE sciences are practically oriented with no less that 20% of the total GCSE scores being related to practical assessment (Jenkins, 1995). However, A-Levels were not predictive of the Practical Skills Assessment. This suggests that where GCSEs are important for the practical aspects of medicine, A-Levels are important for the scientific knowledge aspect of medicine. The

practical applications of the findings therefore are that both GCSE and A-Levels are important for different but equally important aspects of medical student performance in the first two years of medical school. Therefore both A-Level and GCSE performance should remain an integral part of the selection procedures for medical education. There are two important points to note from this finding; A-Levels and GCSE scores differentially predict outcomes. That is GCSE predicts practical elements of the degree, whereas A-Levels predict the knowledge element of the degree. It is also useful to note that when the two previous academic performance measures are examined in relation to the composite measure of academic performance in the form of overall year score, this potentially important difference between the two predictors becomes obfuscated. Therefore it can be seen that delineating academic performance according to the underlying broad dimensions is useful for discerning where individual differences in academic performance lie.

Although prior academic performance is predictive of the preclinical phase of the medical degree, the validity of academic grades in relation to clinical performance has been questioned (Jenkins, 1995). It has been shown that previous academic performance only predicts around 23% of the variance in overall medical school performance (McManus et al., 2004; Salvatori, 2001). This study found that previous academic performance in combination with cognitive ability predicted only 16% of the variance in overall performance. In addition, previous academic performance has not been shown to be predictive of individuals who have disciplinary problems further in their career (Ferguson et al., 2002). This suggests that other characteristics may also be relevant for the prediction of clinical performance. However, this study found that in relation to academic performance, even the practical and interpersonal elements were not predicted by motivational or interpersonal components. This is not to say that interpersonal characteristics are not relevant to medical education, indeed one of the aims of the selection procedures for medicine is to select those candidates that have the necessary personal qualities for a medical career. It may just be that those qualities are not directly

measured by academic performance indicators. Therefore it seems appropriate to assess the most desirable stable dispositional characteristics at selection.

Previous research has shown that cognitive ability is a pervasive positive influence on performance across many life domains including academic performance (e.g. Arulampalam et al., 2004; Markert, 1985; McManus et al., 2003). It is hardly surprising that the results from this study demonstrate that cognitive ability predicts overall performance. Higher levels of cognitive ability have been found to be related to better performance both academically and occupationally, and related to higher occupational level, and higher income level (Papadakis, Hodgson, Teherani, & Kohatsu, 2004) which demonstrates the pervasive influence of cognitive ability on performance outcomes. Although cognitive ability is predictive of academic performance, it is likely that other factors may play an important role in influencing academic success (Schmidt & Hunter, 2004). This may be particularly the case in medicine as cognitive ability is not necessarily a reliable predictor of a successful career in medicine (Conard, 2006).

In addition to GCSE's, A-Levels and cognitive ability, only emotionality; one of the dispositional dimensions identified in this study was predictive of both overall Year 1 performance, and of the Practical Skills Assessments component of the medical degree. Emotionality consists of characteristics such as; dispositional negative affectivity, neuroticism, motivational anxiety, and introversion. As such this was a surprising finding as negative affect has generally been considered to be detrimental to academic performance (McManus et al., 2003). Some affective aptitudes may operate as a negative influence on academic performance, such as neuroticism, and generalised negative affectivity. However, it may be that the pervasiveness of introversion in predicting academic performance overrides the influence of the affective components of this dimension.

It is well documented and recognised that the experience of medical school is highly stressful and intense due to the nature of the course and the responsibilities that are inherent in studying medicine (1991). It is likely that an individual's ability to maintain emotional control during this stressful period is likely to perform better than those individual's that are more prone to negative affectivity stress and anxiety pre and post examination periods (e.g. Sarid, Anson, & Bentov, 2005). However, this study has found that this is not the case. It is likely that differences in motivation, interest and personality influence how cognitive resources are used (Ackerman, 2003).

Motivational anxiety involves adoption of performance goals, in that they reflect judgments from others about the relative merits of the individuals' capabilities (e.g. McManus et al., 1998). Fear of failure that underlies motivational anxiety may drive a person to adopt performance goals (Kanfer & Heggestad, 2000), which have been linked with poor academic achievement (Dweck, 1986). A fear of failure has been linked with high levels of anxiety and low levels of academic performance (Sobral, 2004). In addition, a fear of failure is related to poor adjustment to university, which in turn is linked with poor academic performance (Fontaine, 1991). Therefore it can be argued that motivational anxiety may have a negative impact on academic performance regardless of mode of assessment. Nonetheless, the influence of introversion seems to overcome the impeding effects associated with affective characteristics such as anxiety. That is, although motivational anxiety, stress, neuroticism and depression, may negatively impact academic performance, the positive influence of introversion appears to be much stronger.

This study found that Emotionality and Cognitive factors were predictive of different types of performance. None of the other dispositional dimensions were predictive of academic performance in the first two years of medical school. Nonetheless, this does not suggest that the three dispositional domains should not be considered in medical education. As medicine is

a vocational degree, it is also necessary to examine the predictive validity of aptitudes in relation to the other goals of the educational context. Medicine requires that individuals that enter the profession are empathic, caring community oriented, ethical individuals (The General Medical Council, 2003). These qualities may not necessarily be components assessed by the academic structure of the medical degree it is possible that these dispositions are inherent to the individual. In addition, it may be that these qualities are more predictive of outcomes once the students have qualified and become professional physicians. These outcomes could include factors such as the perception of the physician by their patients, and colleagues (e.g. Sitzia & Wood, 1997) or disciplinary problems further in the practitioners career (Papadakis et al., 2004). Therefore potential future research could examine the three broad dispositional factors identified in this research in relation to practice outcomes in medicine. This would be in order to determine whether these dispositions are important to include into the selection procedures for medicine.

As previous academic performance has not been shown to be predictive of individuals who have disciplinary problems further in their career (Halamandaris & Power, 1999). It suggests that other aptitudes may also be relevant for the prediction of clinical performance. Therefore it can be seen that although the components of the cognitive ability and previous academic performance predict academic performance, it is likely that other factors may play an important role in influencing the ultimate success of medical students when they become practicing physicians (Horowitz, Miller, & Miles, 2004).

Negative affect has generally been considered to be detrimental to academic performance. Previous research has shown that emotional stability has been shown to be positively related to academic performance in further education with high emotional stability being related to higher A-level grades, (e.g. Entwistle and Ramsden, 1983) and also in higher education where it is related to higher undergraduate grade point average (e.g. Furnham, 1992) this seems

intuitive as low scorers on emotional stability are likely to be highly anxious and stressed and thus these emotions are likely to interfere with academic productivity (Furnham, 1992).It can be argued that affect may influence performance through its effects on both cognitive functioning and motivation. Therefore it exerts its influence through how cognitive resources are used.

It has previously been argued that measures of cognitive ability rarely predict academic performance in isolation, this study has shown that it is the most pervasive predictor of performance when examining overall year performance. nonetheless, other dispositional characteristics have been shown to be influential in predicting academic performance in medical school. It should be noted however that even those characteristics that were not predictive of academic performance in medical school may be more beneficial and influential further in their career as a practicing physician. Therefore the interpersonal and motivational characteristics should not be overlooked. Interpersonal traits in particular may be important for a career in medicine. However, they may not be so important for the academic component of the medical degree. Interpersonal dispositions should maybe be examined in relation to other appropriate outcomes such as patient satisfaction and team working ability. for example, empathy has been shown to be key in the development of a trusting relationship between a practitioner and patient (Hojat et al., 2002). However empathy was not predictive of any of the medical school outcomes used in this study.

Previous research findings have demonstrated that conscientiousness is an important characteristics in predicting academic performance, however, this study has failed to replicate this finding. Instead it appears that introversion and affective characteristics are more predictive of academic performance in medical school.

CENTRAL QUESTIONS ANSWERED

The key aim of this research is to test the thesis that clustering academic performance and clustering dispositional characteristics into more parsimonious components provides a more comprehensive explanation of the different qualities necessary to be successful in medical school. It aimed to do this by answering three research questions:

1) What is the most explanatory number of components that adequately summarises academic performance in medical school.

2) What is the most explanatory number of components that adequately summarises student's personal characteristics measured at entry to medical school

3) What combination of characteristics best predicts academic performance in medical school.

This research has shown that using a statistical approach to identifying the broad components underlying academic performance in medical school has been fruitful. Using this multidimensional approach to academic performance as an outcome variable has shown that there are three broad dimensions to academic performance. It was shown that there was differential predictive validity of dispositional characteristics when performance was delineated from a single overall outcome variable. In addition, A-Levels and GCSE's differentially predict the practical skills and the scientific knowledge dimensions of academic performance. This could help to understand why A-levels and GCSEs may differentially predict preclinical and clinical aspects of medical student performance as GCSEs are more practically based whereas A-Levels are more knowledge based.

The findings also suggest that there are three broad dimensions underlying the characteristics of medical students, however only Emotionality was predictive of academic performance. None of the other dimensions were predictive of any of the academic outcome types. Nonetheless the dimensions may still be useful as they may reflect more distal influences in academic performance, but become more proximal further in the career of a practicing

physician. Therefore the study has demonstrated that clustering academic performance variables provides a more parsimonious and comprehensive explanation of academic performance. However, there is a need for further investigation of the influence of trait complexes further in the career of a practicing physician.

8.2 CRITICAL APPRAISAL OF THE STUDY

This section will outline the strengths and weaknesses in this research and recognize the contribution that this research has made to medical education research. By discussing the strengths, weaknesses and implications of the findings future research ideas will be suggested.

8.2.1 LIMITATIONS, CONTRIBUTIONS AND FUTURE RESEARCH

It is argued that it is necessary to more accurately represent academic performance by taking a multidimensional approach, and by exploring the underlying structure of models of performance and subjecting them to statistical analysis (Schuwirth & Van Der Vleuten, 2004a). This thesis has attempted to satisfy the initial suggestion. It has explored the underlying dimensions of academic performance, and has suggested that there are three underlying dimensions of assessment; Scientific Knowledge, Interpersonal Skills, and Practical Skills. However, this study was conducted on a single cohort of medical students, in a single medical school in the UK. Therefore it is possible that this model of academic performance is only applicable to either this cohort alone; this medical school; or the UK medical education system. It therefore would be beneficial to subject the identified exploratory statistical model to confirmatory analysis using different samples, different cohorts in different countries, in order to clarify the universality of this dimensional construction of academic performance. Nonetheless, it provides the first step in identifying and explaining the underlying structure of academic performance and provides a tentative framework for operationalising academic performance as an outcome variable.

It should be noted that a statistical approach has been used to identify the broad basic dimensions underlying the dispositional characteristics of medical students, and the structure of academic performance. It has been argued that using principal components analysis is an atheoretical method for assessing underlying dimensionality of characteristics (e.g. Block, 1995), however, this thesis has also attempted to provide an explanation for the linkages between the dispositions, based on previous research findings.

A potential strength of the models presented in this thesis is that it acknowledges the multivariate nature of performance outcomes. It suggests that different aspects of performance require different characteristics in order to achieve at a particular level. In addition, instead of the use of a single predictor characteristic, alongside cognitive ability, or previous academic performance, this thesis has examined 19 other potentially relevant characteristics in relation to academic performance. Although the research found that the most pervasive predictors were indeed academic performance and cognitive ability, it can be argued that this study has used a wide array of characteristics as predictors. This may demonstrates the strength of the predictive validity of cognitive ability and previous academic performance variables in predicting different medical educational outcomes. It has also provided support for the use of both GCSE and A-Level scores in predicting academic performance as they were shown to predict different types of medical education outcomes. Therefore it can be seen that the use of both A-Levels and GCSEs in the selection procedure is important as they both predict important outcomes in medical education.

This research has also taken into consideration an aspect of the educational context by examining the influence of trait complexes on different types of assessment. This is in accordance with the suggestions made by Snow and Swanson (1992) who argued that in any

theory relating to education, it is necessary to consider the influence of the academic context. Modes of assessment are only one component of a multifaceted academic context, nonetheless, it is important to identify those components that may have an effect on determinants of performance (Snow, 1996b). It is argued that it is essential that coherent descriptions of the interactions between characteristics, instructional design, achievement situations, and population are formulated, and boundaries are identified whilst integrating the the four essential factors. This thesis has gone some way to fulfilling this requirement, by defining broad dimensions of medical student's dispositional characteristics and relating them to the different dimensions of assessment. However, in order to fulfil the recommendations made by Snow (1989), it may be useful in future research to examine trait complexes in relation to performance in more innovative problem-based curriculum medical schools where formative assessment is common. This may provide valuable information regarding the influences of the different trait complexes and their influence on volitional assessment where it is likely that motivational influences may play a role. It can be argued that a higher educational setting requires more volitional and emotive characteristics to successfully adjust and achieve in these types of academic settings.

It can be seen that this is the first study to incorporate measures of narcissism, need for cognition, and motivational traits when examining medical undergraduate performance. It can be argued that as well as examining beneficial characteristics for successful performance, it is also necessary to examine those qualities that would be detrimental for either performance in academic tasks, or detrimental for a career in medicine (Snow, 1989). This study is one of only a handful that examine the influence of potentially detrimental characteristics such as narcissism on medical school performance (Powis et al., 2005). Therefore future research should consider the impact of such negative characteristics as narcissism in medical students in order to elucidate the consequences of these types of negative characteristics. It may be useful to examine the negative interpersonal traits such as narcissism in a non-clinical sample,

and from a social-adjustment perspective in order to understand the mechanisms by which the interpersonal trait complex operate, particularly in relation to group work and collaborative learning.

Conard, (2006) suggested that the relationships between the psychological characteristics of the learner and academic performance need to be examined in a systematic manner. It can be seen that this study has attempted to systematically examine the psychological characteristics of the learner, has examined the structure of assessment, and has explored the differential predictive validity of learner characteristics in relation to different types of measures of medical student academic performance. Therefore has attempted to integrate a predictor-centric and an outcome-centric approach to academic performance in one study.

The results of examining the interrelationships and predictive validity of trait complexes in relation to various outcomes may prove beneficial to the selection system as it could be further used to investigate success in a medical career. For example if a person does well on a particular part of the course, and the performance is related to a particular characteristic, this could then be further related to models of both job satisfaction, stress and burnout in a doctor's career (e.g. McManus, 2004), this kind of information may be crucial to informing the selection procedures as to what type of person is successful both in medical school and in a career in medicine, in addition, it may be useful for identifying those individuals at risk of struggling and provide a basis for interventions (e.g. Yates & James, 2006).

Aptitude testing and identification is a process that could be used for identifying those individuals with a readiness to succeed in a particular educational context where their ability can be further developed and utilized (Conard, 2006). Thus it may be considered a person-environment-fit approach to career selection. This approach however should be used with caution and is not intended as a selection tool based on the highest scores instead; the

aptitudes of the individuals could be matched to a particular educational context where it is more likely that they will be successful. In addition, new instructional methodology, and assessment types can be developed and measured thus ensuring that everyone who has the potential to succeed is in the best educational environment to support their needs (Snow & Swanson, 1992). This may be particularly useful for medical education when students are deciding the specialist medical field to embark upon.

It has been argued that the fields of educational outcome and the field of determining academic performance have previously been divergent. This thesis has contributed by attempting to combine a predictor-centric and outcome centric-approach to understanding the prediction of academic performance in medical school. By attempting to integrate a dimensional model of medical student dispositions with a dimensional model of academic performance, it has provided some insight into the nature of medical education and medical student performance.

Future research should incorporate potentially useful characteristics such as emotional intelligence into the trait complexes to increase the predictive validity and provide a more comprehensive combination of and understanding of theoretically similar traits. This research has shown that complexes other than aptitude can be influential in predicting performance in medical school. Thus there is a need for research to begin to examine conative and affective complexes in more detail as previous research has tended to focus upon the cognitive aspects of aptitude (Glaser, 1976).

When talking about the necessity to examine assessment from a theoretical perspective, it is not suggested that student performance indicators are altered for students. It is instead suggested that it may be more beneficial for researchers to examine the structure of assessment in order to fully understand and interpret the educational context. By combining

constellations of aptitudes into complexes and creating a profile of the characteristics that differentially predict academic performance may enable comparisons of types across situations and educational contexts and be useful as a tool for medical student selection procedures. Therefore in conclusion, it can be seen that an aptitude complex approach to determinants of medical student performance provides an alternative look at the approach to predicting performance in medical school. Instead of examining determinants in an individualistic fashion, this thesis has systematically examined the interrelations between psychological characteristics, the modes of assessment, and the differential predictive validity of different types of aptitudes on different modes of assessment. This provides a basis for future research to operationalise outcomes in and clinical performance for research purposes and comparative accounts.

8.3 CONCLUSIONS

The key aim of this research was to test the thesis that categorising academic performance and categorising characteristics into more parsimonious components provides a more comprehensive explanation of the different qualities necessary to be successful in medical school. The findings of this research suggest that it is beneficial to classify academic performance into broad dimensional components as this can elucidate differential predictive validity of the characteristics of medical students. It also suggests that A-Levels and GCSE scores alongside cognitive ability measures are useful as tools for selection procedures. However further exploration of trait complexes is necessary in order to determine their usefulness in predicting performance beyond medical school.

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APPENDICES

APPENDIX A: PARTICIPANT CONSENT FORM.

University of Nottingham Medical School

'Predictors of Success in Medical Education'

We are very grateful to you for agreeing to take part in our ongoing programme of research. This project is part of an on-going 8-year project to identify factors that predict successful performance in the undergraduate medical course.

Your participation will help us to achieve our long term aim of optimizing our selection criteria so that we admit medical students who will be successful, not only on the course, but also in their careers as doctors.

The current study would involve you completing a set of standard questions designed to assess different characteristics (such as intellectual reasoning, attitudes and character) that are not traditionally used in the assessment process.

We would emphasise these points about this research project:

- **Your participation is entirely voluntary**
- **You have no obligation to take part and can withdraw at any point**
- **Your participation (or not) will not influence your progress on the course**
- **The data will be used for research purposes only and not as part of the selection process**
- **All the information you provide will remain confidential and anonymous**
- **The consent forms will be retained separately from the questionnaire to ensure anonymity**

The data from today's studies will be related to your undergraduate performance. However, only the research staff will be aware of the scores. Those responsible for marking or assessing work on the course will be unaware of this information. Thus your performance on the course will not be influenced by completing these questionnaires.

If you are happy to continue with the study, then please sign below.
Remember signing this form does not mean you have to complete the study.

"I confirm that I have read this participant information form, and that this study has been explained to me to my satisfaction. I agree to take part in this study"

Signed Participant:_____ Date:____/____/____

Syndicate code: _____

Signed Researcher:_____ Date:____/____/____

APPENDIX B: GOLDBERG (1992) BIG FIVE MARKER SCALE

Below are sets of personality descriptors, please Circle the number that best describes you, not as you wish to be but how you are, please answer as honestly as possible:

	Very		Moderately		Neither		Moderately		Very	
Introverted	1	2	3	4	5	6	7	8	9	Extraverted
Unenergetic	1	2	3	4	5	6	7	8	9	Energetic
Silent	1	2	3	4	5	6	7	8	9	Talkative
Timid	1	2	3	4	5	6	7	8	9	Bold
Inactive	1	2	3	4	5	6	7	8	9	Active
Unassertive	1	2	3	4	5	6	7	8	9	Assertive
Unadventurous	1	2	3	4	5	6	7	8	9	Adventurous
Cold	1	2	3	4	5	6	7	8	9	Warm
Unkind	1	2	3	4	5	6	7	8	9	Kind
Uncooperative	1	2	3	4	5	6	7	8	9	Cooperative
Selfish	1	2	3	4	5	6	7	8	9	Unselfish
Disagreeable	1	2	3	4	5	6	7	8	9	Agreeable
Distrustful	1	2	3	4	5	6	7	8	9	Trustful
Stingy	1	2	3	4	5	6	7	8	9	Generous
Disorganised	1	2	3	4	5	6	7	8	9	Organised
Irresponsible	1	2	3	4	5	6	7	8	9	Responsible
Negligent	1	2	3	4	5	6	7	8	9	Conscientious
Impractical	1	2	3	4	5	6	7	8	9	Practical
Careless	1	2	3	4	5	6	7	8	9	Thorough
Lazy	1	2	3	4	5	6	7	8	9	Hard working
Extravagant	1	2	3	4	5	6	7	8	9	Thrifty
Angry	1	2	3	4	5	6	7	8	9	Calm
Tense	1	2	3	4	5	6	7	8	9	Relaxed
Nervous	1	2	3	4	5	6	7	8	9	At ease
Envious	1	2	3	4	5	6	7	8	9	Not envious
Unstable	1	2	3	4	5	6	7	8	9	Stable
Discontented	1	2	3	4	5	6	7	8	9	Contented
Emotional	1	2	3	4	5	6	7	8	9	Unemotional
Unintelligent	1	2	3	4	5	6	7	8	9	Intelligent
Unanalytical	1	2	3	4	5	6	7	8	9	Analytical
Unreflective	1	2	3	4	5	6	7	8	9	Reflective
Uninquisitive	1	2	3	4	5	6	7	8	9	Curious
Unimaginative	1	2	3	4	5	6	7	8	9	Imaginative
Uncreative	1	2	3	4	5	6	7	8	9	Creative
Unsophisticated	1	2	3	4	5	6	7	8	9	Sophisticated

APPENDIX C: SHORTENED STUDY PROCESS QUESTIONNAIRE (R. A. FOX ET AL., 2001)

Please indicate how far each of the following statements applies to the way in which you approach studying, whilst responding to the statements, please keep in mind the following scale:

1 = Rarely true
2 = Sometimes true
3 = True half of the time
4 = Frequently true
5 = Usually true

		Rarely true				Usually true
1	While I am studying, I often think of real life situations to which the material that I am learning would be useful.	1	2	3	4	5
2	I chose my present courses largely with a view to the job situation when I graduate rather than their intrinsic interest to me.	1	2	3	4	5
3	I find that at times studying gives me a feeling of deep personal satisfaction.	1	2	3	4	5
4	I want top grades in most or all of my courses so that I will be able to select from among the best positions available when I graduate.	1	2	3	4	5
5	I think browsing around is a waste of time so I only study seriously what's given out in class or in course outlines.	1	2	3	4	5
6	I try to work consistently throughout the term and review regularly when the exams are close.	1	2	3	4	5
7	I would see myself basically as an ambitious person and want to get to the top whatever I do.	1	2	3	4	5
8	I find that I have to do enough work on a topic so that I form my own point of view before I am satisfied.	1	2	3	4	5
9	I try to do all of my assignments as soon as possible after they have been set.	1	2	3	4	5
10	I find that studying academic topics can sometimes be as exciting as a good novel or film.	1	2	3	4	5
11	I usually become increasingly absorbed in my work the more that I do.	1	2	3	4	5
12	I generally restrict my study to what is specifically set as I think it is unnecessary to do anything extra.	1	2	3	4	5
13	I almost resent having to do further years studying after leaving school, but feel the end results make it all worthwhile.	1	2	3	4	5
14	I see getting high marks as kind of a competitive game, and I play it to win.	1	2	3	4	5
15	I find it best to accept the statements and ideas of my lecturers and question them only under special circumstances.	1	2	3	4	5
16	Whether I like it or not, I can see that further education is for me a good way to get a well paid or secure job.	1	2	3	4	5
17	I try to relate new material, as I am reading it to what I already know on the topic.	1	2	3	4	5
18	I keep neat, well organised notes for most subjects.	1	2	3	4	5

APPENDIX D: SHORTENED FORM MARLOW-CROWNE SOCIAL DESIRABILITY SCALE (STRAHAN & GERBASI, 1972)

Read each statement carefully and please tick whether the statement is true or false of you, remember to be honest and there are no right or wrong answers.

		True	False
1	I never hesitate to go out of my way to help someone in trouble	☐	☐
2	I have never intensely disliked someone	☐	☐
3	I sometimes feel resentful when I don't get my own way	☐	☐
4	I like to gossip at times	☐	☐
5	There have been times when I felt like rebelling against people in authority even though I knew they were right	☐	☐
6	I can remember playing sick to get out of something	☐	☐
7	There have been occasions when I took advantage of someone	☐	☐
8	I'm always willing to admit it when I make a mistake	☐	☐
9	I always try to practice what I preach	☐	☐
10	I sometimes try to get even rather than forgive and forget	☐	☐
11	When I don't know something I don't at all mind admitting it	☐	☐
12	I am always courteous even to people who are disagreeable	☐	☐
13	At times I have really insisted on having things my own way	☐	☐
14	There have been occasions when I felt like smashing things	☐	☐
15	I would never think of letting someone else be punished for my wrong doings	☐	☐
16	I never resent being asked to return a favour	☐	☐
17	I have never been irked when people expressed ideas very different from mine	☐	☐
18	There have been times when I have been quite jealous of the good fortune of others	☐	☐

APPENDIX E: SHORT FORM NEED FOR COGNITION SCALE. CACIOPPO ET AL, 1996)

For each of the statements below please indicate to what extent the statement is characteristic of you. Please circle the number under the statement that best describes you. There are no right or wrong answers. As you are completing the questionnaire, please keep in mind the following scale as you rate each of the statements below:

1=Extremely uncharacteristic of me

2=somewhat uncharacteristic of me

3=neither uncharacteristic, nor characteristic of me

4=somewhat characteristic of me

5=extremely characteristic of me

		Rarely true				Usually true
1	I would prefer complex to simple problems.	1	2	3	4	5
2	I like to have the responsibility of handling a situation that requires a lot of thinking.	1	2	3	4	5
3	Thinking is not my idea of fun	1	2	3	4	5
4	I would rather do something that requires little though than something that is sure to challenge my thinking abilities.	1	2	3	4	5
5	I try to anticipate and avoid situations where there	1	2	3	4	5
6	I find satisfaction inn deliberating hard and long for hours	1	2	3	4	5
7	I only think as hard as I have to.	1	2	3	4	5
8	I prefer to think about small, daily projects to long term ones.	1	2	3	4	5
9	I like tasks that require little thought once I have learned them	1	2	3	4	5
10	The idea of relying on thought to make my way to the top appeals to me.	1	2	3	4	5
11	I really enjoy a task that involves coming up with new solutions to problems	1	2	3	4	5
12	Learning new ways to think doesn't excite me very much	1	2	3	4	5
13	I prefer my life to be filled with puzzles that I must solve	1	2	3	4	5
14	The notion of thinking abstractly is appealing to me	1	2	3	4	5
15	I would prefer a task that is intellectual, difficult, and important to one that is somewhat important but does not require much thought	1	2	3	4	5
16	I feel relief rather than satisfaction after completing a task that required a lot of mental effort.	1	2	3	4	5
17	Its enough for me that someone gets the job done; I don't care how or why it works.	1	2	3	4	5
18	I usually end up deliberating about issues even when they do not affect me personally.	1	2	3	4	5