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The relationship between cognitive style and a student's performance in architectural design education

Andrew Simon Roberts B.Sc, B.Arch, M.Sc.
Welsh School of Architecture
Cardiff University

Candidate for the Degree of Doctor of Philosophy
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SUMMARY

This research consists primarily of a longitudinal study into the relationship between the cognitive styles of three cohorts of architecture students and their performance in design project work.

The research has adopted a subset of learning styles theory, that of 'cognitive styles', referring to inbuilt and relatively fixed personality factors that can lead to individual differences in thinking and learning. Specifically, it addresses the Wholist-Analytic and Verbaliser-Imager dimensions of cognitive style as defined by Riding and Cheema (1991).

Cognitive styles were measured using Riding's Cognitive Styles Analysis (CSA) (Riding 1991). The students' performance was measured through their assessment grades at key points as they progressed from the first year of their university education to the third. The quantitative data collected during the longitudinal study has been supported by qualitative data derived from student interviews. The results were also related to the students' pre-entry qualifications as well as a measure of spatial ability.

The findings suggest that there may be a link, particularly related to the Wholist-Analytic dimension as measured by Riding's Cognitive Styles Analysis. Students who are labelled as having Analytic cognitive styles tend to gain higher marks for design than other students in the early years of their education. Nevertheless by the time they reach the third year of their course, cognitive styles appear to demonstrate little effect on the students' performance. The findings also suggest that an alternative measure of this dimension, the Approaches to Studying Inventory may not be suitable for architecture students.

The results also suggest that there is little difference in performance between students who are labelled Imagers and Verbalisers. Neither do the results suggest that spatial ability or entry qualifications form good predictors of final performance in architectural design education.

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CONTENTS

LIST OF TABLES

TABLE OF FIGURES

CHAPTER 1: INTRODUCTION

People differ from each other in the ways that they think and learn. Individuals have a preference for learning using particular sets of techniques, approach their study in particular ways or adopt particular strategies towards learning (Riding & Rayner 1998). Psychologists refer to these different ways of thinking in relation to learning as 'Learning Styles'. This thesis looks at the relationship between student architects' learning styles and their ability to learn to design. The research investigates whether learning styles identified by researchers in the fields of education and psychology are relevant as indicators of potential success in student architects.

The thesis draws upon research that occupies the boundary between the fields of educational theory and cognitive psychology. The former is concerned with how students learn, what motivates students to learn and how learning is influenced by the context in which it takes place, the goals and objectives set and the assessment strategies used. (Ramsden 1992, Entwistle 1981, Biggs 1999, Prosser and Trigwell 1999). The thesis also makes use of research that draws upon early psychological studies of how the mind perceives information and how that information is subsequently processed (Gardner et al 1960, Vernon 1962). It explores recent interest amongst cognitive psychologists on how differences in modes of perception can lead to differences in the ways in which individuals think. (Grigerenko and Sternberg 1995, Riding and Rayner 1998). The thesis also draws upon behavioural studies looking specifically at how architects think, work and perceive the world.

In tandem with the psychological research, there is currently much interest amongst neurophysiologists into the physiological background to individual differences, particularly with respect to the differing functions of individual parts of the brain (Carter 1998). For instance researchers have suggested that different types of thinking may occur in the left and right hemisphere of the brain and that a dominance of one of the hemispheres over the other, may lead to differences in personality and behaviour (Springer and Deutsch 1998).

There are many theories of learning styles, each with their own labels and constructs describing the characteristics of different categories of learner. Some theories suggest that students with particular learning styles will find certain teaching and learning activities easier than others; difficulties may arise when there is a mismatch between learning style and the nature of the learning activity being carried out. (Riding and Rayner 1998; Entwistle 1981; Schmeck 1988; Dunn & Dunn 1978)

Much of the previous research into learning styles has been carried out on school pupils and university students studying psychology and business studies. With its concentration on the design project as its primary vehicle for learning, student architects may face different challenges to these students, yet until the present study, very little research has been carried out looking at relationships between learning style and students' abilities to learn architectural design. The present research investigates how specific learning styles might facilitate or hamper a student's learning in architectural design.

This research has adopted a subset of learning styles theory, that of 'cognitive styles', for further investigation. The term 'cognitive style' refers to inbuilt and relatively fixed personality factors that can lead to individual differences in thinking and learning. The research specifically addresses two dimensions of cognitive style defined by Riding and Cheema (1991), which are considered by the author to be particularly relevant to architectural education:

- **Wholist-Analytic:** whether an individual has a preference for processing information as wholes, or by breaking it down into a series of parts

  and

- **Verbaliser-Imager:** Whether an individual has a preference for representing information visually or verbally.

These dimensions will be discussed in the forthcoming chapters, together with details of how they are measured using Cognitive Styles Analysis (CSA) (Riding 1991).

The research consists primarily of a longitudinal study into the relationship between the cognitive styles of three cohorts of architecture students and their performance in design project work. The latter was measured through the students' assessment grades at key points as they progressed from the first year of architectural education to the third. The quantitative data collected during the longitudinal study has been supported by qualitative data derived from student interviews.

1.1 Research Questions

In this research, the principal question was whether there is a relationship between a student's learning style and their performance in architectural design projects as assessed through the processes of critical review which are commonly used within schools of architecture.

Two related, but subsidiary questions were also addressed. The first looked at the extent to which students' performance in architectural design is related to their ability to manipulate three dimensional objects and space within the mind. The initial review of the literature suggested that spatial abilities may be related to certain measures of cognitive style. The second subsidiary question looked at the extent to which students' performance in architectural design was related to their entry qualifications, particularly with respect to those students' GCE 'A' level performance.

The subsidiary questions provide a useful basis for comparing the usefulness of the individual measures in predicting students' future performance in design learning.

The hypothesis was that a student who possesses a particular learning style, will find it easier to learn the relevant skills connected with architectural design than others who have different learning styles. This hypothesis could be tested by comparing some value related to the students' overall performance in their design project work (their grade marks or rank position within their cohort) and a measure of learning style.

The motivation behind the research was twofold. Firstly, in the UK the role of traditional 'A'-levels as a mechanism for the selection of students for higher education is currently being questioned (Schwartz 2004). In architectural education, there is little evidence to suggest that 'A' level results are a useful predictor of future academic performance. This provokes the question whether some other mechanism may be more accurate in selecting students with personalities suited to architectural education. This research investigates whether such a mechanism might develop from a better understanding of students' learning styles.

Second, it is possible that an architecture course may contain specific elements that suit students with particular learning styles. This may be a reflection of the aims and objectives of a course, the activities undertaken and the role of tutors and other students in the learning. It may be useful for teachers of architecture to be aware of individual differences when developing course programmes, and to recognise that the students may have a different learning style to their own and therefore not assume that the way that they think, necessarily reflects the way the student thinks.

1.2 Structure of the dissertation

Through a survey of the literature, the first part of this dissertation provides a review of the literature on learning styles, the nature of architectural education and an overview of behavioural studies conducted upon architects. Chapter 2 provides a review of the literature related to learning and cognitive styles. It begins by defining some of the key terminology, including learning styles and cognitive styles themselves. It then proceeds to identify the various style dimensions that have been reported in the literature and describes the means which have been used to measure these dimensions, particularly in terms of their validity and reliability. The chapter goes on to discuss how researchers have attempted to clarify the complex and often confusing array of learning styles by incorporating them into a single overarching dimension.

Chapter 3 provides an outline of relevant aspects of architectural education. It describes the methods by which the subject of architectural design is taught, learned and assessed within an architectural course.

Chapter 4 reviews the literature describing research carried out on practicing architects, students of architecture and other designers in order to determine whether any commonalities and individual differences exist in their ways of thinking. The chapter concludes by identifying those studies that have been conducted looking at the relationships between learning and cognitive styles and architectural education.

The second part of the dissertation provides a description of the field study carried out on three cohorts of architecture students from the Welsh

School of Architecture, in Cardiff University. Chapter 5 outlines the research methods carried out, including details of the sample of students used, how the relevant tests were selected, testing procedures and the methods of analysis used. Qualitative interview data was also collected and the process for obtaining this is included. The chapter also addresses the key assumptions that underpin the research concerned with both the data collection and the student sample. Chapter 6 provides an analysis of the results. It initially examines the collected data with respect to sampling, comparisons with standardised data, validity and reliability using standard statistical tests where appropriate. The second part of the chapter investigates the relationships between the data collected and the students' marks in architectural design. Chapter 7 provides a summary and an analysis of the qualitative interview data and relates this to the quantitative results previously collected.

The final part of the dissertation discusses the key research questions in relation to the results of the field study. It attempts to explain what has been learned from the study and to relate the findings to architectural education by looking at how the results of this study might be beneficial to teachers of architecture, admissions tutors and educational researchers. It also identifies directions for further research.

CHAPTER 2: LEARNING AND COGNITIVE STYLES

This chapter reviews literature related to learning and cognitive styles. It begins by defining some of the key terminology, including the definitions of learning styles themselves. The chapter then proceeds to survey the various style dimensions that have been reported in the literature and investigates the means by which these dimensions can be measured, particularly in terms of their validity and reliability. It subsequently reviews research that suggests that it may be possible to incorporate the multitude of labels and dimensions into a single overarching dimension, particularly with respect to personality centred cognitive styles.

2.1 Definitions of Learning Styles and Cognitive Styles

People differ from each other in the ways that they think and learn and individuals have a preference for learning using particular sets of techniques, approach their study in particular ways or adopt particular strategies towards learning (Riding & Rayner 1998). These ways of thinking in relation to learning are called 'learning styles'. A particular purpose of learning styles theory is to help students gain a better understanding of how they learn, in order that they might raise their achievement levels (Schmeck 1988: 334-345). This might be done either by encouraging learners to adopt appropriate strategies for learning, or by changing the learning context in order to suit the individual's learning style. In many cases research into learning styles is concerned that a mismatch between the nature of instruction and an individual's learning style does not hamper achievement. (Entwistle 1981: 95-96)

Researchers, principally from the fields of education, cognitive psychology and business studies, have developed models of learning style and have proposed numerous labels and psychological constructs which might be used to describe the individual characteristics of different types of learner. Armstrong & Rayner (2002); Riding and Rayner (1998); Riding and Cheema (1991), Jonassen and Grabowski (1993) and Messick (1984) illustrate the range of models that have been promulgated. These models are usually accompanied by psychometric tests designed to measure an individual's learning style. Few of these models are supported by sufficient evidence to demonstrate that they are accurate reflections of how people learn. Moreover there is also little evidence to suggest that the accompanying tests actually measure what their creators intend (Coffield 2004). Often learning styles have been the subject of small scale research projects that have not been supported by further investigation. These concerns were echoed by Curry (1991) who argued that models of learning style were often confused and unclear in their definition. This has led a number of authors (Riding and Cheema 1991; Curry 1983; Schmeck 1988) to propose learning style models which allow us to rationalise our understanding of the subject.

The term 'cognitive style' affords a narrower definition to learning style as it refers to an individual's preferred way of thinking, organising and representing information within the mind (Riding and Rayner 1998). This may lead to the adoption of particular ways of learning but may equally well impact upon problem solving or work place activities. Psychologists argue that cognitive styles are relatively stable aspects of the personality, that tend not to change over time. Furthermore, cognitive styles models are usually defined through the generation of two labels that represent extremes of a continuum; an individual's cognitive style is likely to fall somewhere between those extremes. For instance an individual may have a tendency to represent information in the mind verbally, another may have a tendency to do this through the generation of mental pictures. These would represent the extremes of the continuum. In reality most individuals would use a combination of words or pictures, but to differing extents and it is their relative preference (or bias) towards each of the extremes, that represents their cognitive style. Psychologists describe a continuum of this kind as a bi-polar dimension.

Cognitive styles contrast with other psychological constructs such as intelligence and ability in that the latter are not bipolar. (Figure 1) An intelligence scale will rate an individual as either high or low, rather than showing a bias or preference; these are referred to as unipolar dimensions. Cognitive styles are considered to be independent of intelligence or ability (Jonassen and Grabowski 1993).

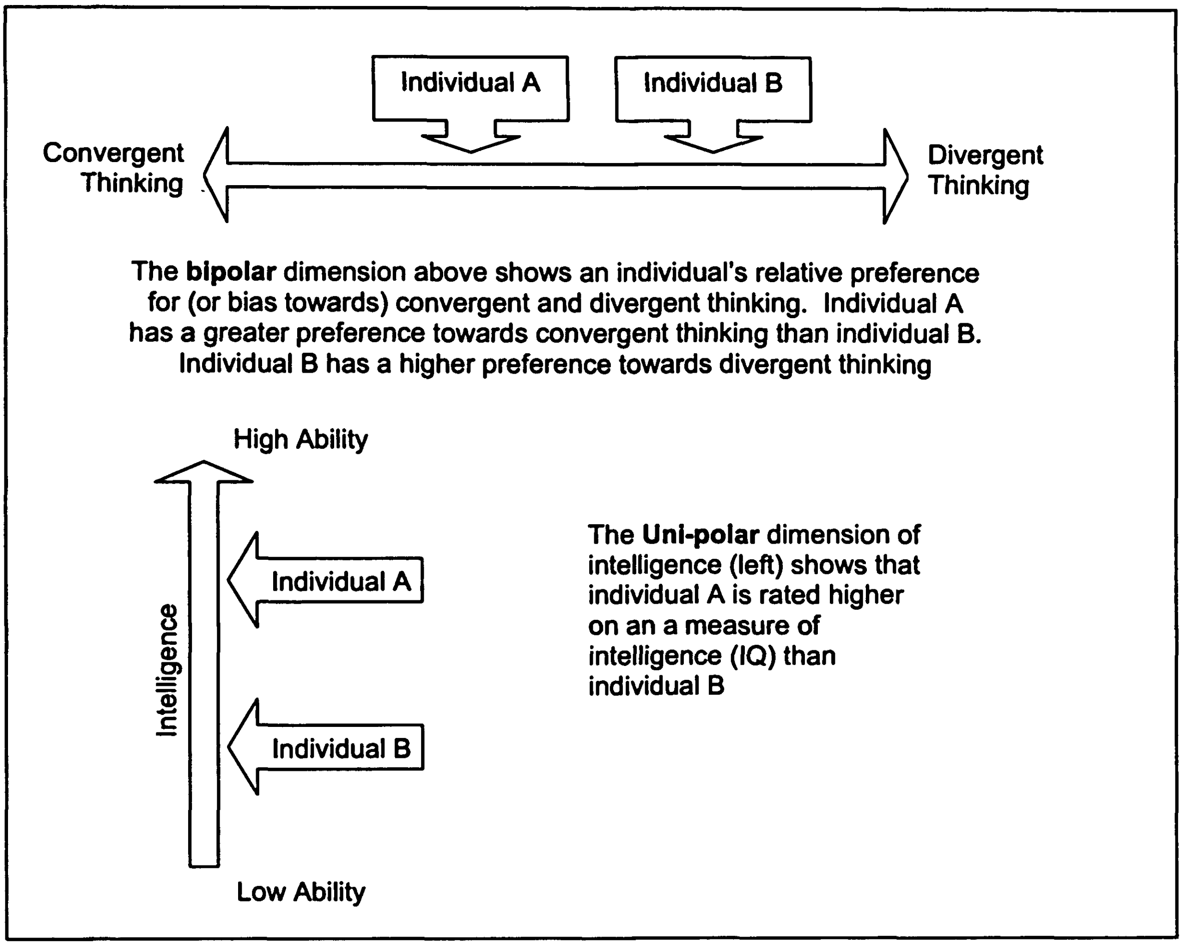

Figure 1 An example of the difference between unipolar and bipolar dimensions, using Hudson's Diverger-Converger cognitive style as an example

The contrast between bipolar dimensions of style and measures of ability is described by Hudson (1966). As we shall see later, he derived his bipolar cognitive style dimension by contrasting students' performance on two types of intelligence test: a conventional IQ test, designed to test a student's ability to generate a single correct answer; and his own test, designed to test a student's ability to generate a range of possible answers to an open ended question. Those who performed better on the former, he described as 'Convergers', those who performed better on the latter, he described as 'Divergers'.

> "...the convergence/divergence dimension is a measure of bias, not of level, or ability ... it is logically possible for a converger to have a higher open ended score than a diverger, either by virtue of having an exceptionally high IQ score, or by virtue of the diverger's IQ score being exceptionally low...Once again , it is the measure of bias which produces

the really striking discriminations, not the measure of level." (Hudson 1966:56)

It cannot be assumed that an individual's learning style is entirely influenced by their cognitive style. Other factors related to a student's motivation to learn will also play an important part. These factors may be derived from an individual's social background and interests and also from the context in which learning is taking place (Prosser and Trigwell, 1999). For instance individuals may tackle learning in a different way if they are interested in the subject (intrinsic motivation) or if they are motivated by the fear of failing an examination (extrinsic motivation). Educationalist Noel Entwistle (1981) described the impact of these motivational factors on a student's learning style as their 'orientation' towards learning. Entwistle argued that an individual's orientation, their cognitive style together with the nature of the learning task that is being carried out would lead to an individual's 'approach to learning'. which describes the extent to which students strive to gain a deep understanding of what they are learning.

Depending upon the circumstances students will adopt a particular 'learning strategy'. Riding and Rayner (1998) described these as a repertoire of procedures that an individual will acquire and use in a particular learning situation. They argued that different cognitive styles may encourage the adoption of particular strategies.

Curry (1993) suggested that the various models of learning styles could be categorised in terms of three levels that could be arranged as a series of concentric rings in the form of an onion (Figure 2). At the innermost level are the fixed personality factors that might be referred to as cognitive styles. These remain relatively stable over time, but have influence on the outer levels (for instance Witkin & Goodenough 1981; Riding and Cheema 1991; Myers 1978; Felder 1993). Curry described the second level as containing those models connected with information processing and the processes of learning (for instance Kolb 1984, Honey and Mumford 1992). This was concerned with how an individual might assimilate and accommodate new information within the mind. The outermost level of the onion was concerned with an individual's preferences for and response to external factors such as learning environments, expectations, motivation and educational contexts (for instance Dunn and Dunn 1978). As these contexts can change depending upon the nature of the teaching, the learning styles adopted by the student are unlikely to show individual stability over time.

This distinction between the inner levels of the onion related to fixed personality constructs (cognitive style) and the outer levels related to the variable educational context is an important one. Riding and Rayner (1998) argue that it is the interaction of cognitive style and external context which combines to influence the strategy that an individual applies when learning.

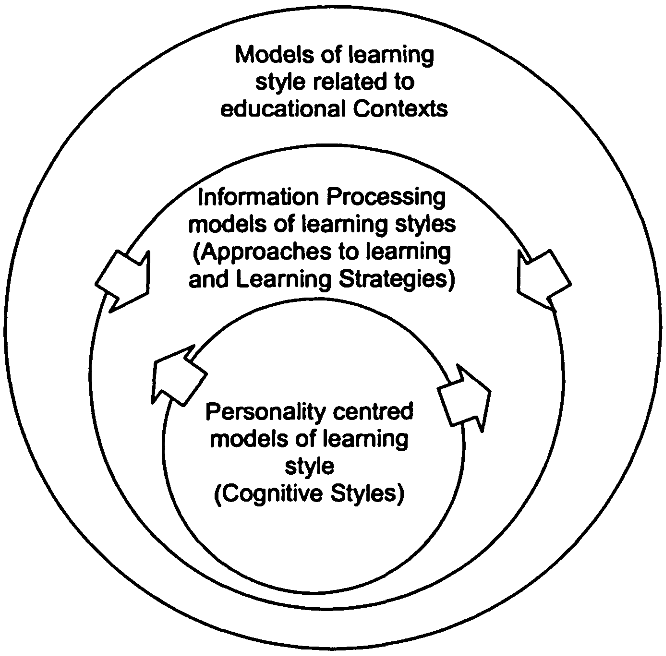

Figure 2 Diagram of Curry's Onion Model showing that the personality level in the core of the onion and the educational contexts can influence the information processing level.

2.11 Learning Styles in the wider educational context

Educational researchers including Biggs (1999), Ramsden (1992) and Prosser and Trigwell (1999) subscribe to a model of learning which argues that the influences on student learning are derived from a wider variety of sources than simply their learning styles, or indeed individual differences. The model concentrates upon three phases of the educational process as shown in Figure 3

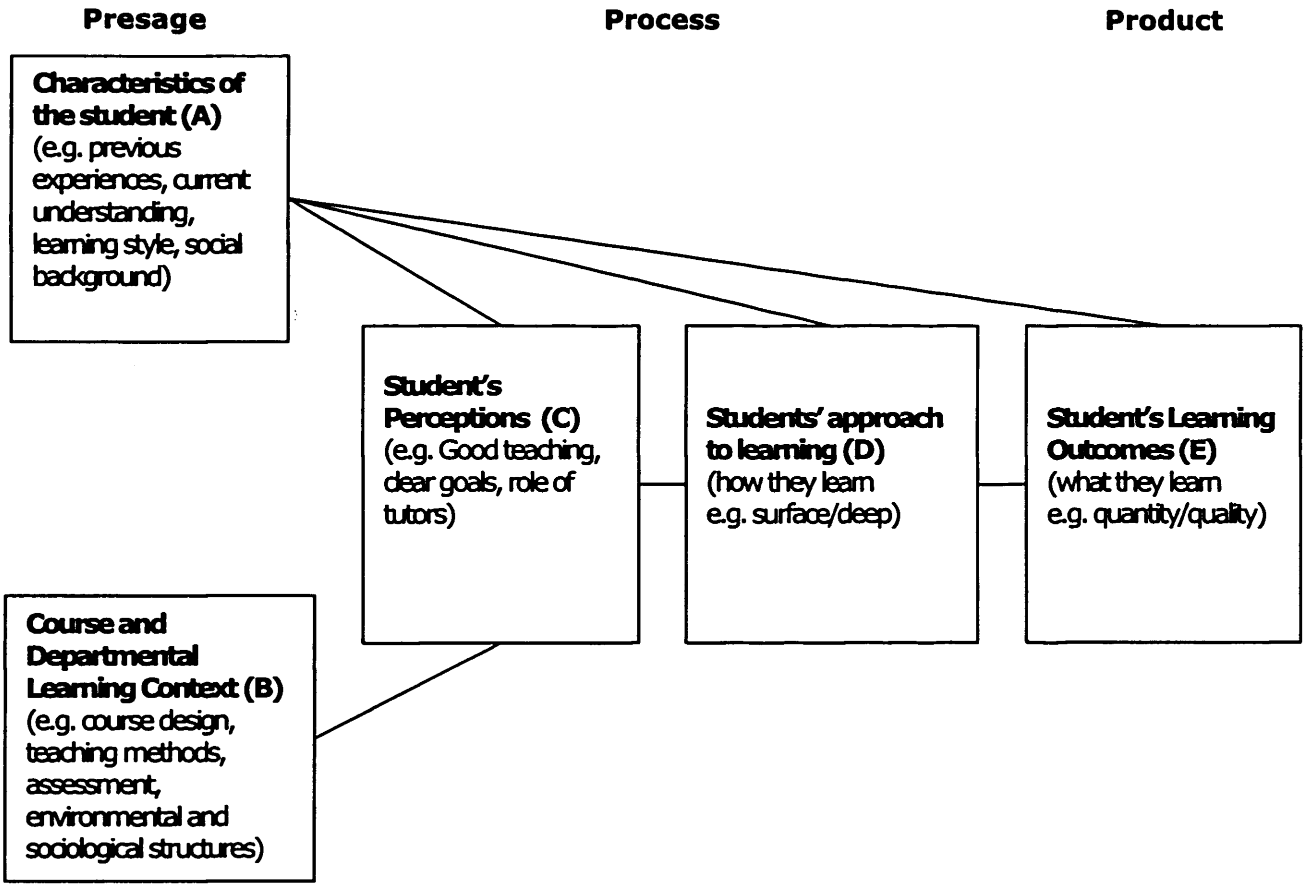

Figure 3 The Presage-Process-Product model (Biggs 1999)

The initial presage stage represents the learning context, in terms of the course design, teaching methods and assessments (B). Along with the learning context, the presage stage also considers what the student brings to the learning situation (A). This would include prior experience, current understanding and abilities, their learning style and their social background.

During the process stage, the individual characteristics of the student, will lead to different students having different perceptions of the learning context (C) and these perceptions will govern how the students approach their learning (D). The individual approaches will lead to the generation of a learning outcome (E).

Prosser and Trigwell (1999) argue that the perceptions that students form are crucial in determining the eventual outcome and that these perceptions can be managed by ensuring that the aims and objectives of the teaching are clearly communicated to the student and by ensuring that the assessment methods are closely aligned to the learning objectives (Biggs 1999). Whilst these perceptions might be influenced by the student's learning style, there will be many other factors that shape the perceptions, some of which are out of the control of the student and connected with the learning context. Personality factors including learning styles, according to this model, play only a partial role in the overall student learning experience. The advocates of this model argue that teachers should pay attention to clear communication to avoid the creation of misperceptions, rather than shaping the learning activities to meet the needs of those with individual learning styles. This model will be revisited as part of the discussion at the end of this thesis.

2.2 Methodology for review of learning style models

In this section a collection of learning style models, have been selected for more detailed review. Riding and Rayners' (1998) review of learning style models was used as the initial basis for this review. The list was augmented by a number of additional models which the author felt had a possible relevance to how students of architecture learn and think. Each model is described in terms of the typical characteristics displayed by individuals with that particular learning style and the methods of measurement used. Assessments of the models carried out either by the model's author, or by some third party reviewer are also discussed.

Learning style models are usually assessed in terms the **validity** and the **reliability** of their measurement. It is useful to define these criteria prior to commencing the analysis.

Validity

The validity of a particular psychological test refers to the extent to which it measures what it is intended to measure. For instance if a test was designed to measure a particular aspect of cognitive style, but actually measured ability, then this test would be considered to be lacking validity. A number of forms of validity can be expressed.

Face Validity refers to the extent to which a psychological test appears, to an expert or judge looking at a test's items, to measure what it claims to measure (Kidder and Judd 1986:55). Thus this is a subjective measure based upon the expert opinion of the judge. For instance educational psychologists might read a questionnaire that purports to measure an individual's learning style, and decide whether they feel that this measures what the testers claim.

Concurrent validity refers to the ability of a test to distinguish between individuals, who are known to differ, possibly through the use of some established test (Kidder and Judd 1986:55). For instance if a test had been produced that measured an individual's preference for learning in groups and that it was already known which students showed this preference, then a test with concurrent validity would need to correctly distinguish between the two groups of students.

Predictive validity refers to the extent to which a psychological test can be used to make predictions for the future (Kidder and Judd 1986:55). For instance Hudson's tests for divergent and convergent thinking, were successfully used to predict the career destinations of a number of schoolboys (Hudson 1966) and therefore his tests were shown to have a high predictive validity.

Discriminant Validity refers to the extent to which a psychological test measures something that is distinctive from another psychological measure (Kidder and Judd 1986:55). For instance, if a test for a particular dimension of cognitive style was found to produce results that correlated with ability, then this test would not discriminate between the two dimensions. A valid measure is one that discriminates between unrelated dimensions, but produces similar results to other tests designed to measure the same dimension.

A key difficulty in the validity of many learning style tests is the subjective nature of the questions asked. This is particularly apparent in self-report questionnaires, where individuals are asked to reflect upon their own personalities and describe how they would usually behave in a certain situation. This assumes that they know how they would behave in such circumstances, which is not always the case. Furthermore some subjects may try to portray themselves in what they feel is the best possible light (Kidder and Judd 1986:199).

Reliability

In addition to questions of validity, it is important to ascertain the reliability of particular learning style tests. All tests will contain a certain degree of error or inaccuracy in terms of what they measure. Nevertheless, if this error is large or inconsistent it may cause results to fluctuate and the test would be considered unreliable. It is possible to measure a test's **internal reliability**, for instance where a number of questions are designed to obtain similar information, we can ask whether these questions are being answered consistently. Often this is done using a **split half reliability** test, where the test is split into two halves. If results on each half are similar, then the test could be seen to have good internal reliability. If the results of each half are significantly different then the test may be unreliable. Reliability can also be assessed by administering the test to the same subjects on repeated occasions, if the results are consistent, then it is said to have good **test-retest reliability** or **external reliability.**

2.3 Models related to the processes of learning

2.31 Kolb's Cycle of Experiential Learning

Kolb developed a model of learning style (Kolb 1984) that was a development of the cycle of experiential learning originally proposed by Kurt Lewin. The learning cycle, which is shown in Figure 4, splits the learning process into four key stages of 'concrete experience', 'reflective observation', 'abstract conceptualisation' and 'active experimentation'. In the learning cycle each of these four stages follows each other sequentially and iteratively.

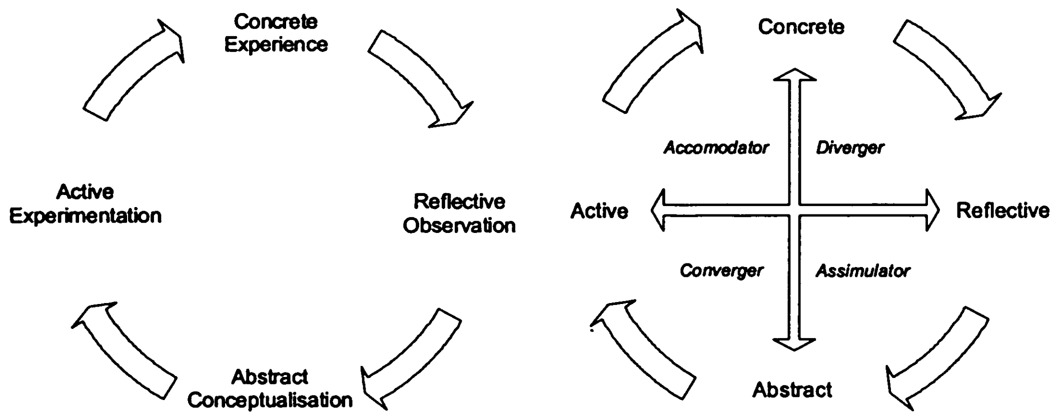

Figure 4 Lewin's Cycle of Experiential Learning (left) and Kolb's learning style model (right), from Kolb (1984)

Kolb argued that the cycle would be mediated by learning styles along two dimensions: perceiving and processing. The perceiving dimension (vertical in Figure 4), reflects how knowledge is created and represents a preference for concrete or abstract thinking with concrete learners preferring to acquire knowledge through practical experience, and abstract learners preferring to acquire knowledge through developing an understanding. The former would have a preference for the concrete experience phase of the learning cycle, whilst the latter would have a preference for abstract conceptualisation. The processing dimension (horizontal in Figure 4) reflects how knowledge is understood or transformed within the mind and represents a preference for reflective or active information processing. Reflective learners may concentrate upon the personal meaning of what they have learned, whilst active learners prefer testing their knowledge in practice. Kolb used the two dimensions to generate four descriptions of individual learners, which represent the four quadrants of the model in Figure 4, namely 'Diverger', 'Converger', 'Assimilator' and 'Accommodator'.

As we have already seen, Hudson (1966) made the distinction between divergent learners, who prefer open ended learning situations and convergent learners, who prefer learning situations where a single correct answer can be found. Piaget, in his genetic epistemology theory, (how people learn) (Piaget 1995) distinguished between processes of assimilation, where a new piece of knowledge is made to fit within the mind's existing knowledge structures and accommodation where existing knowledge is restructured in the mind in order to accommodate the new knowledge. Piaget argued that the brain has a natural tendency to regulate the relative amounts of assimilation and accommodation that happen in learning. Kolb's assimilators will have a tendency to assimilate new knowledge within existing knowledge, whilst his accommodators will show a tendency to modify their existing knowledge in order to accommodate the new knowledge.

Honey and Mumford (1992) developed a model based upon Kolb's learning style model, in this case learners were classified as 'Activists', 'Theorists', 'Pragmatists' and 'Reflectors', again each representing a particular stage within the learning cycle.

Both Kolb and Honey and Mumford have suggested that learning and teaching activities should be adapted to ensure that emphasis is placed upon all stages of the learning cycle, so that learners of all types can learn effectively (Honey and Mumford 1995).

Measurement

Kolb's model is measured by way of the Learning Styles Inventory (LSI) (Kolb 1999) which is a twelve item questionnaire where subjects have to rank four words in the order that best describes their preference for particular modes of learning. Honey and Mumford's (1992) Learning Styles questionnaire (LSQ) contains 80 fixed response questions aimed at determining the individual's learning preferences.

Validity and Reliability

Whilst Kolb's model of learning has attracted considerable interest from educationalists since its development, it is not clear as to the extent by which the learning cycle reflects how students learn. The model ignores the possibilities that certain processes could be completed simultaneously or perhaps in a non-sequential, more haphazard manner. It also fails to account for motivational factors, or that an individual may adopt a particular learning style in a particular educational context, and an alternative style in another (Percival et al 1993; Prosser and Trigwell 1999).

The reliability of Kolb's inventory has been questioned by a number of researchers cited by Riding and Rayner (1998) including Newstead (1992), Sims et al (1986), Cornwell et al (1991) and Atkinson (1988). Duff (2000) carried out a number of tests on Honey and Mumford's model with a sample of undergraduate business students. He concluded that whilst the Learning Styles Questionnaire presented a reasonable degree of test - retest reliability and of face validity, a factor analytic study[1] on the individual test questions revealed four factors which differed from Honey and Mumford's four scales, thus providing questionable construct validity. Duff also describes low ratings for predictive validity and questioned the relevance of the LSI to areas other than business studies.

[1] Factor analysis (in this case) refers to a process whereby the results for each of the test items are analysed in a way that a distinctive set of factors, that underpin the test results, can be derived.

2.32 Approaches to learning

A number of researchers have shown an interest in the links between learning style and how individuals approach learning. These include Entwistle (1981), Ramsden (1992) and Biggs (1999). Much of their work was inspired by the phenomenographical studies of learning carried out by Marton and Saljo (Marton 1988). Unlike Kolb's model, this school of thought realised the importance of context and motivational factors in determining an individual's approach to learning. They saw that a combination of these factors would lead to either a surface approach to learning, which typically might involve learning by memorising a set of facts, or a deep approach to learning which was concerned with gaining an understanding of those facts. Entwistle (1981) argued that students' learning styles were influenced by whether they were intrinsically motivated (that is learning as a response to a general interest in the subject), or extrinsically motivated (for instance by a fear of failure). He argued that those with extrinsic motivation were more likely to adopt a surface approach, which would be characterised by reproduction of taught materials, tightly bound by the constraints of the syllabus and characterised by rote learning. He described this type of student as having a 'reproduction orientation' towards learning. A student who is intrinsically motivated would adopt a deep approach to learning, leading to greater understanding of the meaning of what had been learned. He described this type of student as having a 'meaning orientation' towards learning. He also identified a third orientation which was motivated by a desire to gain the best possible results, using whatever methods seem appropriate at the time. He suggested that this 'strategic approach' would be carried out by students with an 'achieving orientation' towards learning. Biggs (1999) similarly argued that a student's motive would influence the choice of strategy used to complete a learning task. Ramsden (1992) and Biggs (1999) have argued that it is possible to encourage students to develop a deep approach to learning by ensuring that assessment tasks involve more than simply the reproduction of what was taught.

Measurement

The Approaches to Study Inventory (ASI) was developed by Entwistle and is available in several forms. The thirty item version (Entwistle 1981) contains items designed to determine a student's approach to learning based upon their prior learning experience. This version yields eight subscales including those for achieving, reproducing and meaning orientations, together with scales that attempt to measure the Holist-Serialist cognitive style dimension suggested by Pask and Scott (1972) that will be described later. Further versions of the inventory have been developed to include additional scales (Entwistle and Ramsden 1983; Entwistle and Tait, 1994).

The study process questionnaire (SPQ) (Biggs 1987) contains forty-two self-report items measuring a student's usual approaches to studying, in a similar way to Entwistle's questionnaire. The SPQ generates ten scales leading to the creation of six student profiles: deep, achieving, deep-achieving, surface-achieving and low-achieving.

Validity and Reliability

A number of studies exist which support particular versions of the ASI in terms of its reliability and validity (for instance; Newstead 1992; Duff 2000b; Richardson 1990; Jonnassen and Grabowski 1993). Riding and Rayner (1998) cite a number of reports suggesting a low internal reliability, and inconsistent factor loadings within the surface approach scale of the Biggs' SPQ.

2.4 Models related to an individual's cognitive style

The models described in the previous section were all specifically designed to assess how individuals prefer to learn. They represent the outer, less stable levels of Curry's onion model that are influenced by the learning context. We now move on to look at some of those models of individual differences that represent the more stable, personality centred factors found in the inner levels of Curry's onion model. These models of cognitive style reflect a wider scope of information processing than learning.

2.41 Field Dependence – Independence

The earliest attempts to understand cognitive style emerged from work carried out on the psychology of perception during the second half of the twentieth century. Research led by Witkin (summarised in Witkin and Goodenough 1981) investigated individual differences in how subjects were able to perceive what was considered to be upright. Using instruments such as the Rod and Frame Test (RFT)[2], Body Adjustment Test (BAT)[3] and Rotating Room Test (RRT)[4] they could determine whether the subjects had a tendency to judge the upright through clues related to the immediate visual field, or those related to bodily clues based upon a perception of gravity. They determined that there was a high self-consistency between the results for each of these tests, showing that some people have a higher reliance on the immediate visual field than others. They labelled those subjects who relied on the visual field in order to make necessary judgements as 'Field dependent', and those who were able to ignore the visual field and rely on bodily clues as 'Field independent'. It was seen that field independents perform better in

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[2] In the Rod and Frame Test, subjects were seated in a darkened room in front of a luminous frame, with a moveable rod pivoted about the centre of the frame. Both the rod and frame could be moved independently and the subject was required to adjust the rod to a position that was perceived to be vertical, whilst the frame remained at a particular angle of tilt. Measurements were taken to determine the extent that the subjects relied upon the position of the frame to determine what was vertical.

[3] In the Body Adjustment Test the subject would be placed in a tilting chair within a small room which could also be tilted along the same axis. The subjects were asked to return the tilt of the chair to the upright position. Measurements were based upon whether they returned their chair to the gravitational upright, or to what they perceived to be upright based on the tilting room.

[4] In the Rotating Room Test a small upright room is driven around a circular track and thus a centripetal component is added to the gravitational force changing overall direction of the force on the body. Subjects were asked to return the chair to the upright and measurements were based upon whether the chair was adjusted according to the force on the body, or relative to the visual perception of verticals within the room.

certain tests (RFT and BAT) and field dependants perform better in others (RRT). Thus this construct could be described as a cognitive style as it represented a bipolar dimension between two ways of thinking.

Relevant Manifestations

Witkin found that field independents were often more successful in solving intellectual problems where the solution demanded that the subject extracted a key element out of its context, and intellectually restructured it within a different context, even when this task was not related to perception. (Witkin et al, 1962). This led to Witkin formulating the wider cognitive style designated as 'Articulated Field vs Global Field Approach'. Thus someone who can analyse, structure and articulate information as discrete from its context would be labelled as having an 'Articulated Field Approach' whilst those who tended to see the information holistically, taking account of the context would be labelled as having a 'Global Field Approach'. An Articulated Field Approach is commonly referred to as 'Field Independence', and a Global Field approach is commonly referred to as 'Field Dependence'.

Witkin *et al* (1962) also suggested a link between field dependence and independence and a personal need to seek assistance from authority in decision making. The research found that field dependents tended to demand more guidance, were less able to define their own tasks, showed less confidence in their own ideas and were less independent or autonomous as individuals than field independents. Further research (Witkin and Goodenough 1977, 1981) suggested that field dependent people tend to show high levels of interpersonal skills, whereas field independents are often seen as impersonal. Field dependents will show attributes such as empathy and concern for others compared with field independents who could be seen as demanding, inconsiderate and manipulative.

The construct of field independence and field dependence has also been linked with spatial abilities. Witkin and Goodenough (1981) cited extensive literature linking spatial-visualisation ability with a field independent cognitive style. Typically subjects are shown an image of a three dimensional object and are asked to imagine how that object would look if viewed from a different position and this was found to be easier for field independents.

Measurement

Whilst it is possible to measure the construct of field independence/dependence using the mechanisms reported above, on the whole these are complex and costly to administer. Further research by Witkin showed that it was possible to measure field dependence/independence in situations where there was no influence of gravity. This lead to the development of tests such as the Embedded Figures Test (EFT) which measured the extent to which it is possible for an individual to disembed an object from its context. Subjects were required to find a simple shape hidden within a larger and more complex shape; it was necessary to mentally deconstruct the larger shape so as to expose the smaller shape. Witkin discovered statistically significant correlations between the EFT and the gravitational based tests, implying that that those who found it easy to find the hidden shape were likely to be from the same group of subjects who were able to filter out the room or frame, from their perceptions of the upright (field independents) and visa versa (Witkin et al. 1962). Thus the EFT and subsequent variations on the test, the Group Embedded Figures Test (GEFT) and the Children's Embedded Figures Test (CEFT) became used as standard measures for the Field dependence-independence construct.

Validity and Reliability

Following a factor analytic study of a large number of perceptual tests, Lynn and Kyllonen (1981) suggested that field independence as measured by the EFT fell into a cluster of tests that measured what they described as *cognitive restructuring ability;* the ability to mentally restructure visual-spatial information. This was seen as distinct from those tests measuring an individual's perception of the upright. Cognitive restructuring is an ability and would be considered unipolar, and not be classed as a cognitive style dimension. This cast doubts upon whether field dependence or Independence as measured by the EFT was in reality a measure of cognitive style. Similarly, Grigerenko and Sternberg (1995) argued that field independence was a measure of "fluid ability" - a combination of intellectual skills and strategies. Entwistle (1981) argued that whilst the EFT measures an ability to impose a structure on a perceptual situation (and thus demonstrates analytic, articulated thinking) this does not mean that an inability to impose structure implies global thinking. Without a comparative measure of global thinking, the EFT is not properly measuring a bipolar cognitive style. Most criticisms of the construct are related to its measurement through use of figure tests, rather than through those tests that rely upon the gravitational field. Riding and Rayner (1998) suggest that although the construct of field dependence is valid, the EFT represents a flawed method of measurement.

2.42 Holist-Serialist

This label was initially used by Pask and Scott (1972) following a series of observations on children carrying out a complex sorting and classification exercise that required the children to show a high level of understanding. The children were asked to establish the principles of classification for two imaginary species of Martian, but were initially given incomplete information. This required the children to formulate hypotheses and to subsequently request further information with which to test their hypotheses. The children were monitored in terms of the process carried out, the information requested and the hypotheses formulated.

Pask and Scott discovered that the children adopted two distinct approaches to their learning task. Those who worked in a step by step fashion, based upon the latest information were described as 'Serialists', whilst those who were able to formulate complex hypotheses, based around a wider picture were described as 'Holists'.

Other researchers including Gregorc (1982) and Das (1998) have suggested similar learning style models to Pask and Scott, responding to a tendency to process information in either a step by step or holistic manner.

Relevant Manifestations

Pask (1972) argued that holists would typically adopt an approach to learning that involved developing broad overviews of the subject areas, considering several aspects of the topic simultaneously. By adopting this approach, the learner is able to make sense of the connections between aspects, gain an understanding of the structures of a topic and to relate key concepts to prior experience. Serialists, are more likely to adopt an approach to learning that concentrates upon individual details and is characterised by a sequential, step by step process. Pask (1988) later described a further type of learner; the 'versatile learner' who was able to adopt either a serialist or holist strategy for learning, depending upon the circumstances in order to obtain a deep understanding of a topic. He also identified two pathologies which educationalists would need to address: 'globetrotting' represented a tendency to concentrate upon an overview, without accounting for any detail, and was associated with a tendency to make rash decisions based upon insufficient evidence. 'Improvidence' referred to a tendency to concentrate upon the details without accounting for the global context.

Furthermore, Pask (1976) demonstrated that performance in learning situations improved dramatically where a close match occurred between learning style and mode of instruction. Where a mismatch occurred, performance was deemed to be inferior.

Measurement

Initial measurements on this particular dimension were based upon observations of small samples of children and Pask's tests tended to be complex to administer (Jonassen and Grabowski 1993). However other researchers (Entwistle 1981; Felder 1993) have produced instruments for the measurement of dimensions of learning styles, based upon Pask's work, that incorporate this dimension within their subscales. The Approaches to study inventory (ASI) (Entwistle 1981) has subscales that include comprehension learning (a manifestation of a holist learning style) and operations learning (a manifestation of a serialist learning style). Additional scales also were presented for the versatile learner, and the learning pathologies identified by Pask. The Felder-Silverman Learning Style Model (1993) was developed as a means to understand the relationship between the learning style and teaching style within undergraduate engineering education and consists of five bipolar dimensions including a sequential-global classification similar to Pask's dimension. A 44 item questionnaire has been developed to measure four of the five dimensions of this model[5] including the sequential-global dimension, which like the ASI, questions students' attitudes towards study and their typical study behaviours.

Validity and Reliability

Pask (1988) argued that the holist-serialist construct could be regarded as a stable element of human perception. Unfortunately given the complexities of measurement, there appear to be no studies relating Pask's construct to other style dimensions. A number of studies exist which support the Approaches to Study Inventory in terms of its reliability and validity (for instance; Newstead 1992; Duff 2000b; Richardson 1990;

[5] This can be found at http://www2.ncsu.edu/unity/lockers/users/f/felder/public/ILSdir/ILS-a.htm

Jonnassen and Grabowski 1993). Nevertheless, this inventory measures the approach taken by the student, from which their cognitive style can only be inferred. Furthermore, the results of the questionnaire classify the holist-serialist dimension as two unipolar scales, rather than as a single bipolar dimension necessary to provide a measurement of an individual's cognitive style. The Felder-Silverman model does generate a bipolar dimension, but there is little empirical evidence to relate this to other measures of cognitive style, particularly outside the disciplines of engineering. These inventories may also suffer from the difficulties associated with self report questionnaires, which have already been identified.

2.43 Diverger - Converger

This dimension was initially proposed by researchers including Getzells and Jackson (1962), Guildford (1967) and Hudson (1966) and represents an individual preference to think in an open ended (or divergent) manner or to be more focussed (or convergent). The dimension has received particular attention within the fields of creativity, although this may provide excessive simplification of the nature of creativity (Hudson 1966).

Hudson discovered that he could use standard intelligence tests to predict whether schoolboys would choose to study arts or science subjects at university. This was achieved initially by assessing the bias between their scores for the verbal and the numerical items on the test. This bias proved to be more useful as a predictor of academic specialisation than a score for intelligence itself. Getzells and Jackson also discovered that certain students would perform badly at traditional IQ tests, but may perform better at what they refer to as 'creativity tests'. The tests for IQ would require the subject determine a single correct answer to a problem such as:

> "Brick is to house as Plank is to ... Orange, Grass, Egg, Boat, Ostrich"

The 'creativity tests' demanded open ended responses to statements where there was no one correct answer such as:

> "How many uses can you think of for a brick".

Getzells and Jackson became interested in the bias between the students' scores in the two tests leading to a bipolar dimension ranging from High Creative to High IQ. Hudson, subsequently substituted the terms 'Converger' and 'Diverger' in place of 'high IQ' and 'high creative' to avoid any confusion related to the definition of creativity. An all rounder was an individual who did equally well on both tests.

Hudson found that he could use these measurements to predict a student's likely choice of university subject – that is into the arts or the sciences, with divergers tending to study arts based subjects and convergers tending to study science based subjects.

Manifestations

In addition to career choice, Hudson discovered that convergers and divergers showed varying interpersonal characteristics. divergers, when drawing, tended to include people in their drawings, whilst convergers tended to omit people. divergers produced more responses to the open ended tests that suggested violence although those convergers and all-rounders who suggested violence tended to be far more gruesome than the divergers. Socially, convergers had a tendency towards conformity whereas divergers tended to be liberal, non-authoritarian, and of independent mind. Hudson also found divergers had a broad range of cultural interests, where as convergers tended to have a narrow range of practical and technical interests outside school. He also suggested that in problem solving activities, convergers preferred formal problems that were well structured and demanded a greater logical ability whereas divergers preferred more open ended tasks with uncertain conclusions. A number of these manifestations appear to be similar to those highlighted by Witkin with Field Dependents tending to show divergent characteristics.

This connection between field dependence and divergent thinking has been described by Pascual-Leone et al (1978) as being related to a weak 'interrupt function' within the mind of the field dependent. They argued that this interrupt function acts to filter out those ideas that might be considered irrelevant or unorthodox. Field dependents are more likely to exhibit divergent thinking characteristics, without concern that an idea might be inappropriate.

Divergence and convergence has often been connected with creativity although as we shall see in chapter 4, the relationship between these aspects is rather more complex than it might initially appear.

Measurement

There are no specific tests for the diverger-converger dimension; typically research has been conducted using a series of standard closed and open ended psychological tests. The Learning Style Inventory (Kolb 1999) categorises learners into one of four categories including diverger and converger, however this does not give a representation of the range between the bipolar extremes of converger or diverger.

Validity and Reliability

The author is unaware of any empirical studies related to the validity of the construct beyond those carried out by Getzells and Jackson, Guildford and Hudson. Riding and Cheema (1991) reported a number of studies showing that particular approaches to teaching can impact upon levels of creative thinking, which is thought to be related to divergent thinking. They suggest that certain rule bound or conservative strategies for teaching may suppress an individual's tendency towards divergent thinking.

Bergum (1977) and Morris and Bergum (1978) described research carried out on a group of architecture and business studies students who were asked to rate themselves in terms of how creative they regarded themselves. The architecture students rated themselves as more creative than the business students, and were on the whole, more field-independent. This contrasts with the suggestion made earlier that divergent thinkers exhibit similar characteristics to field dependents, but the results could be explained by the possibility that the Embedded Figures Test used to measure field independence may have measured spatial ability rather than cognitive style and that the students were asked to self-report their creativity.

2.44 Impulsivity and Reflectivity

The impulsivity-reflectivity dimension was first suggested by Kagan (Kagan et al 1964) and relates to the speed by which an individual makes decisions in uncertain circumstances. Psychologists have traditionally measured this dimension by comparing the number of errors made in a test, to response speed. Those subjects who provide fast but inaccurate responses are referred to as 'cognitively impulsive'. Those who have slow but accurate responses will be referred to as 'cognitively reflective'. Subjects who are fast and accurate or those who are slow and inaccurate are labelled fast and slow respectively.

Manifestations

Messer (1976) cites a number of reports outlining the relationship of the impulsivity-reflectivity dimension on other personality constructs. In most cases these studies were carried out on school children. He describes a number of significant relationships between the field dependent-independent dimension and impulsivity and reflectivity, with reflectives appearing more field independent than impulsives. This may be partially because the tests for field independence (the Embedded Figures Test) and the impulsive-reflective dimension are of a similar graphical nature. Nevertheless, relationships also existed when the rod and frame test was used to measure field dependence. Messer suggests that response uncertainty may be a common factor in all three tests. Reflectives were seen to perform better than impulsives in problem solving activities. They were also observed to be making more efficient use of information and showing a greater degree of maturity. Socially reflectives were seen to have longer attention spans than impulsives, were less aggressive and were seen to be more autonomous, although the latter was not found in all studies. Zelniker and Jeffrey (1979) found that reflective children performed better than impulsive children on those tasks that required detail processing, yet impulsives performed no better than reflectives in those activities that required holistic processing. Messer (1976) also suggested that it was possible for impulsives to develop as reflectors, and that an individual's response to any tests for impulsivity and reflectivity, might be determined by levels of anxiety. Jonassen and Grabowski (1993) suggested that reflectivity increases with age.

Riding and Wigley (1997) explored the relationship between impulsiveness and cognitive style. They concluded that impulsiveness was related to a specific combination of cognitive style from Ridings 'verbaliser-imager' and 'wholist-analytic' dimensions which will be discussed later. The least impulsive were those whose cognitive styles reinforced each other (wholist-visualisers and analytic-verbalisers), whereas the opposite appeared to be true of those whose cognitive styles complimented each other (wholist-verbalisers and analytic-imagers). Riding and Wigley proposed impulsiveness was a personality trait that whilst independent of cognitive style, could be moderated by it. It should however be noted that they measured indecisiveness rather than reflection as the opposite pole to impulsivity and as such it cannot be assumed that being reflective is the same as being indecisive.

Measurement

The Matching Familiar Figures Test (MFFT) is commonly used as a test for this dimension. Here a picture or diagram is compared to a number of similar, but slightly different figures. The subject is asked to select the one figure that exactly matches the original. The subjects are measured for speed of response and accuracy. A reflective person would be likely to have a lower response speed, and higher accuracy, whereas an impulsive would be likely to have a higher response speed, but lower accuracy.

Kolb's Learning Style Inventory measures a dimension, which he refers to as Active-Reflective. The Felder-Silverman Learning style Model (Felder 1993) also contains a scale for the active-reflective dimension. Nevertheless there is no empirical evidence to suggest that these measure the same dimension as the MMFT.

Validity and Reliability

Messer (1976) outlined a number of studies that showed reasonable test-retest reliability of the MFFT, although he argued that much of this research may have been flawed in terms of sample selection and that subjects may have memorised some of the test items leading to better accuracy and speed in subsequent tests. He also outlined reports of reasonable internal consistency for both response speed and number of errors. Nevertheless he expressed concern about the stability of the dimension over time particularly with school children, although there appears to be little evidence of a lack of stability in adults.

Messer also cited a collection of studies that looked at the relationship between the results from the MFFT and intelligence, showing low correlations between response speed and intelligence but with accuracy correlating with intelligence. Research by Zelniker and Jeffrey (1979) and Jonassen and Grabowski (1993) suggested that in many circumstances those who are reflective will perform better than those who are impulsive, perhaps suggesting a link with overall ability, rather than representing a true bipolar cognitive style.

2.45 Leveller – Sharpener

The leveller-sharpener construct developed by Holzman, Klein, Gardner, Linton and Spence, looked at particular preferences for memory processing particularly with regards to visual images (Gardner et al 1960). Levellers preferred to assimilate new visual stimuli with previously stored ones, focussing on interconnections; whilst sharpeners tended to accommodate new stimuli as discrete entities.

Manifestations

The manifestations of this cognitive style definition, have distinct similarities to the descriptions of the Holist-Serialist dimension referred to earlier. Holzman and Klein (1954) noted that levellers tended to oversimplify their perceptions whilst sharpners perceived information in a more detailed and differentiated manner. Much of the research into the leveller-sharpener dimension was based on the persistence of memory, with sharpeners having clear, visual and well differentiated memories of past events, whilst levellers tended to have more generalised, and blurred memories.

Measurement

The Schematising test (Hozman and Klein 1954) requires subjects to observe a number of squares of light in a darkened room. The squares are of increasing size, and subjects are asked to estimate the sizes of the squares. In most cases subjects under-estimate the sizes of the squares, however it appears that levellers tend to make smaller errors than sharpeners.

Validity and Reliability

Jonassen and Grabowski (1993) reported a number of studies investigating the leveller-sharpener construct, although they suggested that there was insufficient data to confirm the reliability of the schematising test and a lack of research existed related to normal learning situations. Riding and Rayner (1998) described a factor analysis that was carried out on several dimensions of style and found that the leveller-sharpener dimension loaded onto the same factor as field independence-dependence as measured by the GEFT.

2.46 Adaptors – Innovators

Kirton (1994) suggested a cognitive style dimension that measured an individual's preference for doing things better, or doing things differently and that this would impact upon strategies in problem solving and decision making in response to change. These preferences, that were assumed to be stable personality traits, could be described as a continuum between 'Adaptors', who would tend to follow existing rules and frameworks, and 'Innovators' who have a desire to pursue new ideas outside existing structures.

Manifestations

Kirton (1994) suggested that Adaptors would tend to show a precise methodological approach, relying upon established practices and structures. They often show a preference for carrying out detailed and repetitive work. 'Innovators' are seen to approach tasks in a random and non-sequential manner, showing signs of divergent thinking. They tend to show a high degree of confidence in their own ideas and willingness to stray from conformity.

Measurement

The dimension is measured by the Kirton Adaptor-Innovator Inventory (KAI), which primarily reports upon an individual's performance in the workplace and how this relates to their cognitive style.

Validity and Reliability

Kirton (1994) reported a factor analytic study with the KAI and a number of other personality tests, which loaded onto factors similar to those measured by the KAI. Riding and Rayner (1998) also report a number of studies supporting the reliability and validity of the inventory. It should be noted that most work related to this has been carried out as part of workplace activities, and may not translate into the educational sphere. Nevertheless Kirton's description of the construct appears to have a high face validity and shows similarity to a number of other cognitive style dimensions already discussed.

2.47 Right Brain – Left Brain

A number of researchers have suggested the existence of a duality between the left and right hemispheres of the human brain (Springer and Deutsh 1993). Much of this research has stemmed from experimentation on brain injured patients, especially those whose corpus callosum (the connection between the left and right hemispheres) has been severed, leading to two independently functioning (or split brain) hemispheres. The research suggests that the two hemispheres are able to perceive and process information in independent and different ways, and tend to specialise in particular activities. For instance the left hemisphere is seen to be responsible for the development of language, rational thought and logic, whilst the right hemisphere is seen to be responsible for non-verbal, intuitive and spatial thinking. Whilst it may be considered a gross over simplification to describe the brain's functioning in this way, a dominance of an activity connected with one hemisphere of the brain, over that of the other could be seen as leading to the development of a particular cognitive style.

Manifestations

Torrance has developed a model of cognitive style that is based around the functions of the left and right hemispheres of the brain, such that subjects could be described as 'Left Brain' or 'Right Brain' dominant (Torrance and Rockenstein 1988). Those who had a tendency towards analytic, verbal, logical and temporal thinking would be classified as having a 'left brained' cognitive style, whilst those who had a tendency towards nonverbal, holistic, concrete, intuitive thinking could be described as having a 'right brained' cognitive style. Those with a tendency to express elements of both hemispheres were described as having an 'integrated' cognitive style. Much of Torrance's work is related to his work on creative thinking (Torrance and Rockenstein 1998). He argues that creativity is a whole brained activity that requires an integrated cognitive style that uses both hemispheres. Nevertheless, his research has suggested that in carrying out a number of tests of creative thinking, those with a right brained cognitive style tended to perform better. One possible manifestation of a dominant right hemisphere is a tendency for an individual to be left handed. (Peterson and Lansky 1974,1977)

Measurement

A number of tools have been developed to specifically measure the dominance of a particular hemisphere of the brain. The Herrmann's Brain Dominance Instrument (HBDI) (Herrmann 1988) is a 120 item self report questionnaire requiring subjects to respond to items related to handedness, careers, personality descriptions, hobbies, energy levels and a tendency toward motion sickness. The questionnaire yields a profile with four quadrants: cerebral-left, limbic-left, cerebral-right, and limbic-right.

Your style of learning and thinking (SOLAT) (Torrance et al 1977) and its sister test the *Human Information Processing Survey* (HIP) (Taggart and Torrance 1984), designed for workplace purposes, are fixed response questionnaires that categorises individuals into four categories – 'Left Brain'. 'Right Brain', 'Mixed' and 'Integrated'.

Validity and Reliability

There is little evidence of independent data outlining the validity and reliability of either of the brain dominance tests. However Taggart and Valenzi (1990) claim that both tests have had considerable usage with the HBDI having over 500,000 usages world wide and SOLAT/HIP being used on tens of thousands of occasions world wide. Taggart and Valenzi cite validity and reliability studies for the HBDI carried out by the WICAT education institute (Hermann 1988: 337-79). Validity and reliability studies for the SOLAT/HIP appear in the administration manual for the HIP test (Taggart and Torrance 1984). Schwartz and Mattei (1982) claim that correlations have been found between SOLAT and Kirton's Adaptor-Innovator test.

2.48 Verbaliser – Imager

This dimension of cognitive style concerns the way in which information is represented within the mind, whether as mental pictures or as words. MacFarlane-Smith (1964) suggests a verbal-spatial dimension where individuals have a preference for either verbal activities, or for visual-spatial abilities. Paivio (1991) devised a dual coding theory which suggests that two cognitive subsystems exist within the mind, one which specialises in the processing of non-verbal objects and events (i.e. imagery) and the other which specialises in language. Pavio's research was primarily concerned with understanding mental processes connected with imagery, rather than the determination of a cognitive style dimension. This work is useful in that it outlines the influences on a verbaliser-imager style, connected with such things as the vividness of images, speed of recall from memory and visual-spatial abilities. The work was further developed in connection with cognitive style by Riding and Taylor (1976) who argued that learning performance was affected by the way in which knowledge was represented during thinking, either visually or verbally.

Manifestations

Riding and Taylor (1976) investigated the time that 7 year old school children took to respond to verbal stimulus that required them to form a mental picture in order to give a correct answer. They found a significant interaction with subject's abilities to recall information from prose passages; those who formed images quickly responded well to an abstract passage, those who formed images slowly responded better to passages containing concrete information. It was inferred that the latter group had more dominant verbaliser abilities.

Riding et al (1995) carried out research suggesting a connection between the verbaliser-imager dimension and social behaviour. Verbalisers tended to show characteristics of being outgoing, lively and humorous, whereas imagers were more likely to be shy and quiet. Riding argued that verbalisers were likely to be externally focussed, whilst imagers are likely to be internally focussed. Riding and his co-workers also conducted studies related to the mode of presentation of learning materials and the Verbal-Imagery dimension. As was expected in a test of 74, 11 year old pupils, verbalisers preferred verbal presentations, and imagers preferred presentations containing images (Riding and Ashmore 1980, Riding and Douglas 1993)

Measurement

Early self report questionnaires such as Paivio's Individual Difference Questionnaire (IDQ) (Paivio 1971) and Richardson's Verbal Visualiser Questionnaire (VVQ) (Richardson 1994) attempt to measure an individual's tendency to create images in the mind, however they make no attempt to measure the verbal dimension of the construct, these are simply inferred from a low score. Whilst Riding and Cheema (1991) cited studies that showed a moderate level of reliability for the IDQ, they argued that there was insufficient evidence for the validity of the tests.

Riding and Calvey (1981) developed the Verbal-Imagery Code Test (VICT) that measured verbal abilities in addition to the visual abilities measured by Riding and Taylor. By taking the ratios of times taken over the two tests, they were able to determine a preference for verbal or imaginal representation. Thus subjects were labelled as 'Verbalisers' if they had a preference for representing information verbally and 'Imagers' if they had a preference for representing information visually. Those who either had no clear preference, or were able to switch easily between the two faculties were labelled as 'Bimodals'. For ease of administration the test was further developed into a computer application, The Verbal Imagery Learning Style Test, a refinement of which is incorporated into Cognitive Styles Analysis. (Riding 1991)

Validity and Reliability

Riding and Cheema (1991) reported that there had been little research on the use of either Paivio's Individual Differences Questionnaire or Richardson's Verbal-Visualiser Questionnaire and therefore it was difficult to find evidence to support their validity and reliability. Riding and Rayner (1998) have cited a number of studies, using their own measures which they claim support the validity of the dimension. This includes EEG measurements taken on the surface of the brain by Riding et al (1997).

A number of recent studies have questioned the reliability of Riding's tests for the verbaliser imager dimension. In order to test reliability, Peterson et al (2003) administered a second parallel which recreated the conditions of Riding's test, but with different test items, and found no significant correlations between the two. She argued that the verbaliser-imager dimension of CSA is particularly unstable. Nevertheless, in response, Riding (2003) argued that the sample size for this study was small, the replicated tests did not correctly calculate the cognitive style ratio, that some of the test stimuli were inappropriately chosen and that an insufficient test-retest interval was given between the original test. Redmond et al (2002) also found poor test-retest reliability coefficients. However this research is likely to be flawed by an insufficient test-retest interval. Riding (1998) recommends that at least a year should elapse between retests. Redmond's research used 12 days, Peterson's second test was carried out immediately after the first.

2.49 Uncertainty – Certainty Orientation

The construct of uncertainty-certainty Orientation was developed by Sorrentino and co-workers (Sorrentino and Short 1986, Rooney and Sorrentino 1995) based upon the earlier work of Rokeach, looking at open, and closed minded (or dogmatic) personalities. Rokeach argued that the open minded (or gestalt) person would possess a cognitive belief system that is orientated towards the generation of new beliefs, ideas and information. The closed minded person would possess a belief system oriented towards familiar or predictable events. Sorrentino and Short argued that the uncertainty oriented (open minded) person would have a desire to attain clarity about themselves and their environment. The certainty oriented person, who prefers familiarity, may have a mistrust in the world and anything that would appear to be unconventional.

Witkin carried out a number of psychological tests linking field independence/dependence with an ability to impose a structure onto materials that may be ill defined in nature[6]. The work was carried out on school children, taking tests of abstract reasoning. The results suggested that field independent subjects had a greater tendency to impose structure, where as field dependants were happy to leave their perceptions ill defined (Witkin et al 1964).

Manifestations

Sorrentino and Short (1986) argued that the uncertainty oriented person, would have a high tolerance to ambiguity, would be unlikely to be prejudiced, bigoted or opinionated but would be likely to show characteristics connected with autonomy and independence. The certainty oriented person may have a high dependence upon authority a low sense of autonomy and may lack interpersonal skills. Huber and Huber (2001) found no differences in learning preferences and outcomes between the two orientations in a number of 8th grade school pupils. Nevertheless,

[6] As measured by Rorschach inkblots

they did find that those with a high uncertainty orientation appeared to show a greater influence in group work.

Measurement

The projective measure of need to reduce uncertainty (nUncertainty) (Sorrentino et al 1992) requires subjects to construct stories from four sentence leads, three of which are accompanied by pictures, the fourth contains no picture, but is included for the purpose of assessing uncertainty. Stories are scored by a trained expert scorer as containing signs of uncertainty-resolution.

Rooney and Sorrentino (1995) also claimed that the 22-item acquiescence-free authoritarianism scale (Cherry & Byrne, 1977) could be used to assess uncertainty orientation because it involves orienting toward familiar and predictable events. They claim that numerous studies, support the validity of the use of this measure to assess uncertainty orientation and have yet to find another measure that predicts scores on the nUncertainty measure so well.

2.410 Jungian Personality Types

Psychologist Carl Jung (1971) suggested that variation in human behaviour were not due to chance, but to basic and observable differences in the ways people prefer to use their minds to gather and process information. He proposed a complex model of personality types based around how individuals perceived and judged the world. He described *perception* as the means by which an individual becomes aware of people, things, events and ideas whereas *judgment* is the means of coming to conclusions about the information perceived. He argued that individuals would have a preference for perceiving things either by sensing through the physical senses of sight, sound, smell, taste and touch or through intangible, unconscious intuition. Individuals would also have a preference for judging things either objectively, based upon rules and factual information (thinking) or subjectively, based upon relationships and values (feeling). Jung also believed that individuals had preferences for introversion, and extroversion. Extraverts are oriented primarily toward the outer world; thus they tend to focus their perception and judgment on people and objects. He argued that introverts tended to be oriented primarily toward the inner world; thus they tend to focus their perception and judgment upon concepts and ideas .

Measurement

The Myers Briggs Type Indicator (MBTI) was developed in an attempt to make Jung's theory of personality type of practical use (Myers and Myers 1990). The self report questionnaire is available in a variety of forms of differing lengths, some of which are administered by computer. Individuals administering the test must be appropriately qualified and certified by the MBTI certification program. This ensures that test subjects are given appropriate feedback as to the meaning of their test results.

The test measures four bipolar dimensions, based upon Jung's personality types, namely: sensing-intuition; thinking-feeling; extrovert-introvert and; judging-perceiving. Subjects are classified into 16 personality types based upon these dimensions.

Validity and Reliability

Ring (1998) cites a number of studies into the reliability and validity of the MBTI including extensive data from Myers and McCaulley (1985) showing high levels of reliability and validity. She cites Harvey (1996) as having independently evaluated and summarized results of research on the MBTI's reliability and validity over a ten year period, also suggesting high levels of reliability and validity.

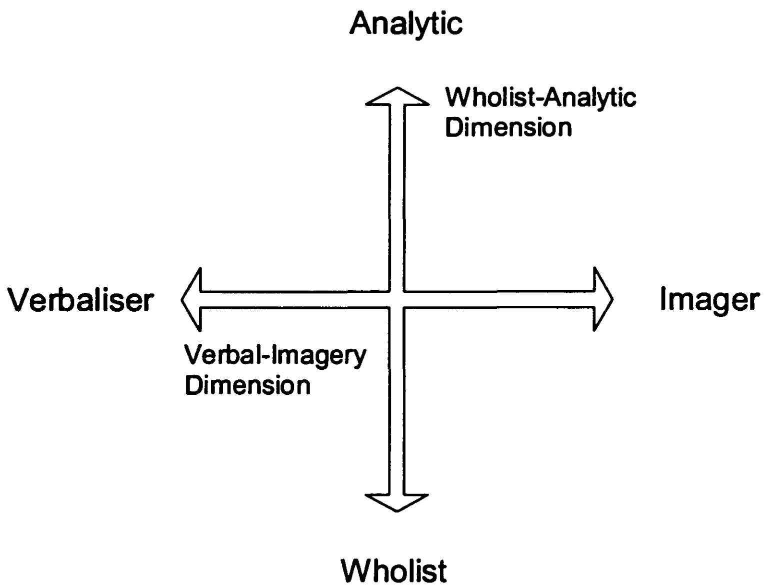
2.411 Super-ordinate dimensions of cognitive style

Whilst it might be argued that the number of labels representing cognitive style represents the complexity of cognition, it is apparent from the above description that there is some overlap in definition between the various styles referred to.

Schmeck (1988), argued that many dimensions of cognitive style covered in his book were abstractions of a single dimension that he labelled 'Global vs Analytic'. Schmeck argued that this dimension represented two ends of a continuum, with the ultimate development position being the synthesis of the extremes. An individual who is able to function at both extremes could be described as possessing a 'synthetic' or 'versatile' cognitive style. Schmeck describes people with an extreme analytic style as being field-independent, having high attention to detail and preferring a step by step, sequential organisation. They have a tendency to separate feelings from concrete facts and are gifted at critical and logical thinking. Individuals with a global cognitive style are field-dependent, with a tendency to focus upon an overall impression, rather than a specific detail. They prefer random rather than sequential organisation and have a tendency to be able to consider material simultaneously. They tend to think in an intuitive manner, involving personal feelings in decision making activities and they tend to be able to spot similarities rather than differences between objects.

Allinson and Hayes (1996) suggested a similar 'super-ordinate' cognitive style dimension claiming that the many labels are "simply different conceptions of the same dimension". Their dimension has extremes of intuition and analysis, which are used to represent the principal modes of right and left brain thinking. Intuition (right brain) refers to "immediate judgement based on feeling and the adoption of a global perspective". 'Intuitivists' tend to be non-conformist, approach thinking in a random, non-sequential manner, adopt an open ended approach to problem solving, and retain spatial images easily. Analysis (Left Brain) refers to "judgement based upon mental reasoning and a focus on detail". 'Analysts' favour a structured approach to problem solving, depend upon systematic methods of investigation, recall verbal material easily and are most comfortable with ideas that require a step by step analysis.

Riding and Cheema (1991) offered an alternative perspective to that proposed by Schmeck and Allinson and Hayes. They suggested that cognitive style can be described by two independent dimensions that represent how information is organised and how information is represented during thinking (Figure 5). The 'Wholist-Analytic'[8] dimension, reflects whether an individual organises information into wholes or parts and the 'Verbaliser-Imager' dimension reflects whether an individual is inclined to represent information during thinking verbally or in mental pictures. Riding and Rayner (1998:20) provided a list of cognitive style models that fall into each dimension, although it should be noted that the majority of these models fall into the wholist-analytic category. Nevertheless, Riding and Rayner admitted that there was often little empirical evidence linking many of the cognitive style measures to the super-ordinate dimension.



[8] Riding uses the term 'wholist' rather than 'holist' to describe that particular pole of his dimension. The term Wholist will be used in this thesis only when describing results connected with Riding's dimensions.

Figure 5 Riding's dimensions of cognitive style

The models proposed by Torrence and Taggart related to hemispheric functioning suggest that Riding's two dimensions are related, with 'wholist' organisation, and imager representation occurring in the right hemisphere, and analytic organisation and verbal representation occurring in the left hemisphere. Jonassen and Grabowski (1993) also suggested that the verbaliser-imager dimension may be related to a holist-serialist dimension with visualisers being more holistic. Other researchers including MacFarlane-Smith (1964) have related visual spatial abilities with field dependence (holistic thinking) again suggesting that the two dimensions are related. Nevertheless, Riding's two dimensional classification, may also imply that a left brain - right brain dichotomy is over simplistic. Indeed research carried out by Riding et al (1997) relating cognitive style and electrical activity measured by an EEG[9] at the surface of the brain, suggested a correlation of 0.5 between a measurement of an individual's verbaliser-imager cognitive style and a ratio of electrical activity between electrodes on each side of the scalp whilst a pre-determined mental activity was being carried out. The research implied that there was more activity on the left side of the brain for those with a Verbaliser cognitive style and more activity on the right side of the brain for those with an imager cognitive style. By contrast the wholist-analytic dimension provided a significant interaction with the midline between the hemispheres, rather than the hemispheres themselves. In this case activity was higher for those with a wholist cognitive style towards the rear of the brain, whilst those with an analytic cognitive style showed more constant activity along the midline. However these results cannot be seen as more than tentative due to the limited sample size of 15 and the fact that EEG measurements only reflect activity at the surface of the brain, ignoring that which is contained within. Riding and Rayner (1998)

[9] Electrical activity was measured by way of an electroencephalogram or EEG, generated from sensitive electrodes positioned at key positions across the surface of the brain.

also suggested that the mental task provided was one of a particularly analytic nature, and it is unclear if the results would differ, should a task that was more 'holistic' in nature have been administered.

Riding argued that whilst his two dimensions are independent[10] it is often their combination that will yield particular individual differences in learning and other personality measures. Riding and Rayner (1998) suggested that certain style combinations could complement each other, and allow one style dimension to provide a substitute for a weakness in the other. For instance, through visualisation it might be possible for someone with an analytic cognitive style to see a whole picture. Similarly through verbalisation an individual with a wholist cognitive style might perceive something analytically. In this respect it is possible that those with an analytic-verbaliser combination of cognitive style could be considered as 'extreme analytics' with no apparent facility to see things as a whole. Similarly individuals with a wholist-visualiser combination of cognitive styles could be classed as 'extreme wholist' as they have no apparent facility for performing analysis.

Measurement

In order to measure their analytic-intuitive dimension Allinson and Hayes developed the Cognitive Styles Index (CSI). This is a 38 item self report questionnaire where individuals respond to a series of questions related to 29 style labels that they had previously identified (Hayes and Allinson 1994). Response is in the form of Agree, Disagree or Uncertain. On the whole, questions tended to be related to problem solving, particularly in business and management situations, rather than related to learning. The items were structured so that subjects who generated a low score were rated as intuitive, and with a high score as analytic.

[10] A standardisation sample of 999 subjects using Riding's Cognitive Style Analysis (CSA) (Riding 1991) showed a low and insignificant correlation between the two dimensions (Riding 1999)

The Cognitive Style Analysis (Riding 1991) is a computer based test that measures Riding and Cheema's (1991) two dimensions of cognitive style, wholist-analytic and verbaliser-imager. Unlike the CSI and many other style inventories, the CSA is not a self report questionnaire but rather measures a direct response to visual and verbal stimuli. This ensures that results are not skewed by an error in an individual's self perception.

The test consists of three sub tests, the first of which measures an individual's tendency to process information in terms of words or images – the Verbaliser-imager dimension. The second and third subtests measure an individual's tendency to think 'wholistically' or 'analytically' and this works in a similar way to the Embedded Figures Tests of Witkin. Witkin's tests, tested for analytic, field independent thinking by asking a subject to disembed one shape from another, but perhaps wrongly assumed that an inability to disembed a shape implies global, field dependent thinking; as we have seen, this may in reality be measuring ability rather than cognitive style. Riding's test differs from Witkin's in that subjects are tested for both 'analytic' thinking, by disembedding a shape, and for 'wholistic' thinking, by comparing two shapes for similarity. By testing both ends of the scale the test is able to counteract concerns that the EFT was in effect measuring ability rather than cognitive style.

The Cognitive Styles Analysis was selected as the principal test in this research. Chapter 5 contains a detailed description of how and why it was chosen.

Validity and Reliability

Allinson and Hayes (1996) reported a number of studies suggesting the reliability and validity of their instrument, the CSI. Factor analysis showed internal consistency with all questions loading onto a single factor, thus supporting their argument that the CSI measures a super-ordinate dimension of cognitive style. They also reported good test-retest and internal reliability. Construct validity was measured by comparing the scores from the CSI with five other psychometric tests which were designed to measure the intuitive-analytic dimension. Significant correlations were found in four of the tests. Finally they suggested that concurrent validity was supported as the test successfully differentiated between groups that would be expected to have differing cognitive styles. These results have been corroborated by other researchers including Murphy et al (1998) and Sadler-Smith et al (2000). Hodgkinson and Sadler-Smith (2003) suggested that the dimensions of intuition and analysis should be conceived as separate dimensions. Sadler-Smith et al (2000) also suggested that the CSI does not assess the wholist-analytic dimension of style as measured by the, Cognitive Styles Analysis (CSA).

Cognitive Styles Analysis (Riding 1991) has been used extensively by its author and co-workers to measure the relationship between cognitive style and factors related to personality, and learning performance, the results of which have been widely published; Riding and Rayner (1998) provided a comprehensive review of this research. Whilst the software has been used by a number of other researchers, there have been few serious independent studies of the instrument's reliability and validity. Riding (1998) argued as the measurements carried out by CSA are independent of a number of other individual differences such as intelligence and personality traits then this is evidence for construct validity. This is supported from evidence in the EEG tests (Riding et al 1993, Riding et al 1997). Other studies carried out by Riding and co-workers show the predictive validity of the tests in terms of learning and behaviour summarised in Riding and Rayner (1998).

Measurements of the reliability of the CSA are problematic. In terms of temporal stability, Riding (through personal contact), claimed that it is difficult to carry out a test-retest reliability measurement because the test relies upon subjects being unaware that their response times are being measured; ensuring that subjects work in a natural manner. This is less likely on a second test occurrence where subjects may have become aware that response speed is important. Similarly any recollection of the test items from a previous test may also increase speed of performance. Riding (1998) also claimed that testing for split half reliability was problematic as the number of test items is the minimum needed to get a reliable result. Inconveniently there is no mechanism within the software to isolate the times for the individual test items.

Peterson et al (2003) published research questioning the reliability of the CSA particularly with respect to the verbal imager dimension. This was done through the administration of specially produced parallel version of the test immediately after the original test. They argued that the tests for the wholist-analytic dimension have a low split half reliability, but by introducing a second parallel test, in effect doubling the number of test items, then split half reliability becomes acceptable. Riding (2003) disputes this argument by saying that extending the number of items would make the test overly long, especially for younger participants and that it is possible that the answers to the early questions could be more valid whilst the test is still novel. As has been previously mentioned, Peterson et al found the Verbal-Imager dimension particularly unstable, even if the test was extended. Redmond et al (2002) found poor test-retest reliability coefficients for subjects carrying out the CSA. However this research is likely to be flawed by an insufficient test-retest interval. It should be noted that the CSA was selected as the principal element for this research before the research by Peterson et al and Redmond was published.

2.5 Summary

This chapter has reviewed a number of models of learning and cognitive styles, and examined their methods of measurement. It is clear from the review that there is no universally accepted model of learning style and that there are concerns about many of the models mentioned in terms of reliability and validity. This concern has been raised most recently by

Coffield (2004) who questions the reliability and validity of many of the learning style tests mentioned, particularly in response to a lack of independent validation. He also questions the value of matching learning and teaching styles. Nevertheless, he argues that learning styles can provide teachers and learners with a language with which to discuss their learning preferences although this may form only a one of a number of factors likely to impact upon a student's eventual learning outcome.

CHAPTER 3: ARCHITECTURAL EDUCATION

Having discussed theories of learning and cognitive styles, it is now necessary to consider the nature of architectural education, the pedagogic context in which student architects learn to design. This chapter describes the methods by which the subject of architecture is taught, learned and assessed within universities and colleges. The descriptions are informed by the author's experiences as a student and tutor within schools of architecture, and through interviews with staff members in a selection of UK and European schools of architecture through work with the UK Centre for Education in the Built Environment.

The education that students of architecture receive is mainly conducted in schools of architecture within higher education institutions. Architecture is usually considered by students and the educational establishments in which they study as a vocational subject. Many students will go on to become members of the architectural profession and practice architecture. In the UK as well as many other countries, the successful completion of a course in architecture, normally exempts student architects from the need to take certain professional examinations.

Much of architectural education is concerned with developing the students in order for them to become well rounded, competent and imaginative designers of buildings and the spaces between them. For this reason a large proportion of the time that students spend in schools of architecture is allocated to working on design projects. A description of a typical contemporary architectural education in the UK can be found within the UK's Quality Assurance Agency (QAA) Benchmark Statement for Architecture, Landscape Architecture and Architectural Technology (QAA 2000). This document describes the components of an architectural education in terms of design, cultural context, technology and environment, communication and professional studies. The benchmark statement argues that architecture draws upon knowledge and skills from the human and physical sciences, the humanities and the fine and applied arts in order to address the accommodation of human activity and needs, and that the knowledge, understanding and skills that an architecture education imparts is broad and holistic. The Joint International Union of Architects/UNESCO Charter for architectural education (UAI 1996) describes the field of architectural education as being:

> "in a field of tension between reason, emotion and intuition, [and] architectural education should be regarded as the manifestation of the ability to conceptualize, coordinate and execute the idea of building rooted in human tradition"

The charter argues that whilst the methods of education and training of architects do vary depending upon which part of the world architects study, there is common ground in terms of the pedagogy used (for instance in the use of design projects) and many of the aspirations of schools of architecture.

3.1 The design project

In a design project, students will be given a brief, programme or set of requirements, from which they are expected to develop a set of proposals that address those requirements. These may take a variety of forms; for instance they may be for an individual building, a proposal for the development of an area of a town or city or possibly a detailed study of a building component or piece of furniture. Typically students' proposals will be in the form of a series of drawings or three dimensional models. Design projects may last from a single day, where the emphasis will be upon the rapid generation of ideas to an entire semester, where there will be a greater emphasis upon the resolution of particular issues. Students may be asked to work within the context of a particular building typology or set of issues in order to produce a design proposal. Often they will spend time exploring and researching background information that can inform the design either at the beginning of the project, or simultaneously with their design proposals (Ledewitz 1985). Their responses will entail a complex process of interpretation, reflection, critical analysis and synthesis of a variety of ideas, information and approaches, taking into account issues such as the site, cultural context, user needs, philosophical values, economics and technical demands (RIBA 2003). Often it will be difficult to satisfy all of these demands simultaneously giving additional complexity to the situation (Lawson 1997). Through a process of learning by doing, students gain an understanding as to the application of theory into practice as well as developing the necessary skills required to produce architectural design (Schon 1983; 1985). Students will typically be encouraged to use methods of sketching, drawing, three dimensional modelling and computer aided design to explore and develop their design work. In many schools of architecture, this is carried out in specially designated design studios which students share with their peers. This enables them to collaborate and to learn from each other (Cuff 1991).

Unlike education in some other disciplines, the design project does not seek a single correct answer; rather the student is invited to make propositions which are often speculative and exploratory in nature. The student's responses are likely to be unique and individualistic, and owe more to interpretation and intuition than to a logical or formulaic process or the application of a rational body of knowledge (Schon 1985). In many cases the initial response to the brief would be the development of a further set of questions or issues that the student would need to address. In some cases these problems may never be resolved and thus the student's design work becomes open ended and often uncertain (Brawne 1995).

Although the design project briefs are often carefully crafted to encourage students to integrate theoretical, professional and technical issues into their learning, it is usual for design studio teaching to be supplemented by lectures and seminars to ensure that these areas are fully covered.

The teaching of design takes place through individual and group tutorials. The nature of these tutorials varies depending upon the departmental context and also with the nature and background of the individual tutor and the level of the student. In The Design Studio, Schön (1985) described a particular tutor-tutee interaction which encompassed a master class approach to design teaching whereby a student learns by observing an experienced designer in action. Through this, Schön argued that the student learns not only about her current project but also the process of designing. In other situations, design tutors may simply raise questions or provide critical comments on the student's progress. It would subsequently be expected that the student develop further proposals in line with these comments. At other times design tutors may make suggestions for further development of aspects of the scheme, although they may stop short of making a full proposition that the student could use directly; encouraging the student to think independently. In some cases, students may learn about the process of designing by trial and error, rather than by some direct process connected with the actions of a studio master (Salvestrini 1995). Invariably a combination of these methods will be utilised in a single tutorial. There is no recognised 'correct' way to teach design.

Much learning in architectural education occurs informally through interaction of students within a design studio, sharing ideas and learning collaboratively (AIAS 2002). Cuff (1991) argued that a good 'studio culture' can incite good students to set the pace for their peers. The idea of this form of collaborative learning was first developed in 19th century France by students of the Ecole de Beaux Arts. The school's formal activities, consisted largely of theoretical lectures and the setting of monthly design competitions but there was little opportunity for design tuition. To rectify this, students independently established workshops (or ateliers in French), inviting and paying qualified architects to assist them with their design work. This system has continued into the 20th century, initially within the offices of architects, for instance the atelier of Le Corbusier, subsequently within schools of art and design, and more latterly within schools of architecture in universities and technical colleges (Broadbent 1993). Schools of architecture adopt different models of how this learning might occur. In some situations (the year system), students from a single cohort will all work on the same project, within a shared studio environment. In other situations (the unit or atelier system) students from across a number of cohorts may work together in a similar way to the Beaux Arts ateliers. This enables the sharing of expertise from experienced to inexperienced, usually under the guidance of a 'unit master'; a teacher of architecture, possibly also working in architectural practice, who will impart his or her expertise onto the student's design work (Weaver 1999).

3.2 Assessment of Design Project Work

In addition to regular design tutorials, students are expected to submit their work to critical review in a process known as a 'crit' or jury (Anthony 1991). Students will present their proposals in front of a jury of academics, visiting critics and peers in order to obtain constructive (and sometimes negative) criticism. In itself, the crit is a valuable method of formative assessment, providing feedback from which students are able to reflect upon their progress. In some circumstances, the crit also provides an opportunity for design tutors and jurors to determine and agree a mark that can be used to distinguish the level of a student's academic performance.

The derivation of an accurate assessment grade for design project work can be a difficult task (Lowe 1970; 1972). Often assessors make a judgement on the product of the student's design work, for instance the building that has been designed and presented. In some cases consideration is also given to the process followed by the student whilst developing their design proposals. An assessment of this process may be indicative of the learning that has taken place to a greater extent than an assessment of the final project. Further evidence of learning may be expedited by asking students to submit their rough sketches, or to outline their processes as part of their presentations. In some schools of architecture, assessments are made at individual design tutorials as well as after the final crit.

The assessment of design work often depends upon the involvement of experienced, respected and discriminating assessors. The judgements made by these assessors are complex, often internalised and often based upon un-stated criteria; it remains difficult to prescribe explicit criteria for success. Often a process of moderation and collaboration between assessors is used to ensure fairness of grading between students. Under pressure from institutions responsible for academic quality, many UK schools of architecture have produced assessment criteria. In some cases assessment criteria are used to assist in resolving conflict amongst assessors. In other cases the criteria is used to provide feedback to a student on how a particular mark may be interpreted (Webster et al 2001).

3.3 External Demands on Architectural Education

In order for graduates to enter the architectural profession, they must meet the educational requirements of the relevant professional bodies. In many cases, for instance those of the Architects Registration Board in the UK, these bodies have a specific legal status in ensuring the protection of the general public through the monitoring and upholding of professional standards. Other organisations such as the Royal Institute of British Architects (RIBA) demand particular standards simply for membership of their institutions. Furthermore, many countries, including the UK are now party to international charters on architectural education such as the Joint UAI-UNESCO Charter for Architectural Education (UAI 1996) and the European Directive on Architectural Education (EU 2001). These directives enable architects qualified in one country to work in another.

Qualifications from most schools of architecture in the UK allow students exemption from its professional organisations' own examinations, although the ARB and RIBA insist that schools' curricula must meet certain criteria in order to be validated for this exemption. These criteria have been jointly agreed between the two bodies and are listed in the ARB's *Prescription of Qualifications* (ARB 2002) with the RIBA providing an annotated version in the form of *Tomorrow's Architect* (RIBA 2003) which provides guidelines to schools as to how these criteria may be met. It should be noted that whilst these criteria for validation have changed during the period of this research, the general thrust of design education (in the school in which the research has been carried out) has changed little. In many cases tensions exist between schools of architecture and professional institutions regarding the need to develop professional and technical standards, with educators sometimes perceiving that excessive attention to these issues can be seen as limiting the development of student's design, cultural and intellectual abilities, especially at the early stages of a student's education (Cook 2003).

Cuff (1991) observed a key difference between practice and academia in the USA. She argued that academia was able to ignore external pressures to a greater extent than practice. In academia design projects could pay little heed to regulatory frameworks as it was considered important to focus upon on other issues. Furthermore, she claimed that for a student to perform badly in a design project, could be considered a learning experience, whereas in practice failure would be detrimental to a practitioner's reputation. Cuff suggested that in the schools of architecture that she studied, design values dominated over other issues because these determined the reputation of the school. She found an emphasis upon creativity, personality, talent and convictions at the expense of authority, power, economics and group decision making. Cuff argued that the desire to filter out certain real world elements represented a paradox, between setting students designs that will incite them to think as practitioners and allowing them to learn the basics of architecture. She identified a number of dialectics faced by architectural practitioners, which schools of architecture provided little opportunity to resolve. These included the need to work as part of a team, and the maintenance of the integrity of ones own thoughts; the need to be artistic, but to instil a good management ethos; and between the needs of a client and the artistic desires of the architect. She argued that these could act as a catalyst to high quality design.

3.4 The novice architectural student

Most students of architecture enter higher education with little experience of architecture as a discipline, and therefore a large part of architectural education is concerned with the development of new abilities, values and conceptions, so that eventually they are able to think and do as architects. Architecture as a subject is generally not offered at secondary education level and students are admitted to schools of architecture on the basis of a wide selection of pre and post 16 qualifications from the arts, sciences and humanities. This ensures that students enter schools of architecture with a wide variety of backgrounds with experience of different disciplines and modes of study. In the UK, the grades required by individual schools of architecture, vary between 8 and 24 A level points[11]. A number of schools also require applicants to demonstrate competence in graphic thinking and presentation through the compilation of a portfolio of work or through the completion of a drawn test.

In their prior educational experience, students may have been set problems that can be solved through the application of some rational body of knowledge or theory which often leads to the narrowing down of the problem to a single correct answer against which the student is able to measure success. For new students in architecture, a move to a system where the answers are uncertain, and the route to that endpoint ambiguous (Lawson 1997: 113-127) and not following any set methodology, may prove a frustrating and difficult challenge. As they progress, they will develop ways of countering these difficulties, which places a demand on schools of architecture to instil new ways of thinking and doing in their students from an early stage.

A number of authors have argued that architectural education, particularly in the early stages is about the development of intellectual frameworks within which the process of designing can take place. Many have written books, with the intention that they be used by novice architectural students to assist in the development of these frameworks and represent a series of studies of precedent: analysed examples of existing buildings. The authors' standpoints on architectural education are generally summarised within the introductory and concluding chapters, although it should be recognised that these are often grounded in the author's experience as a teacher and learner of architecture, rather than from some empirical study of how architects learn.

[11] Determined from GCE Advanced Level (or equivalent) grades with 30 points representing 3 A grades.

Unwin (1999, 2000) suggested that architecture was an activity that utilised the mind's capacity to give some form of order or intellectual structure to the organisation of the physical world. Through the identification of a number of both physical elements such as walls and roofs, and modifying elements such as light, sound, time etc..., he placed particular emphasis upon how these have been structured to enable the identification of place. Fawcett (2003) also used precedent studies to identify frameworks through which architecture could be viewed, in order to assist students in the development of their own ideas.

Unwin (2000) suggested that architecture could be compared to language and that learning 'to do architecture' might be considered to be comparable to learning language. He argued that both architecture and the development of language were intellectual activities that involved making sense of the world around. He claimed that in both cases, learning is carried out through the examination and experience of prior examples. In language, this is done by reading, writing and listening, whilst in architecture, this is about making sense of architectural precedents.

3.5 Imagination and Rationality

A number of writers on architectural education have highlighted an apparent tension between the technical and rational nature of some areas of the architectural curriculum and the open ended, creative approaches demanded as part of design project work.

Schon (1985) highlighted a dialectic between what might be described as an open ended and creative approach to design and an approach that was to a greater extent based upon and rational, possibly formulaic principles. He described the latter as 'technical rationality' in design – the generation of design from complex theories rather than from more intuitive processes. He argued that technical rationality failed to account for practical competence in 'divergent' situations where there are no clearly defined ends. Instead he argued for a processes of 'knowing in action', referring to the development of tacit knowledge and understanding, and 'reflection in action' referring to the processes of thinking about doing something, whilst actually doing it. As we have seen, in architecture this involves a simultaneous combination of visualisation (drawing, sketching and modelling), experimentation and reflective thought. Schön argued that both knowing in action and reflection in action referred to spontaneous, heuristic[12] judgements and actions, rather than through reference to predetermined processes and formulae. In his descriptions of an architectural design studio he described the competent tutor as constructing a "web of moves" with a succession of ideas generating further possibilities.

Schön admitted that many educators did not accept the concept of reflection in action and were

> "locked into a view of themselves as technical experts [and] find nothing in the world of practice to occasion reflection...For them uncertainty is a threat; its admission a sign of weakness. Others more inclined toward and adept at reflection in action, nevertheless feel profoundly uneasy because they cannot say what they know how to do, cannot justify its quality or rigor." (Schon 1983:69)

Proudfoot (2000) described an attempt to restructure a course in architecture in the University of New South Wales. He highlighted the difficulties encountered by the separation of 'vertical' subjects such as construction and history into discrete areas of the curriculum, which in reality had considerable overlap and outlined the further difficulties that this caused when trying to integrate each of these subjects into the 'horizontal' design project. In a similar way to Schön, Proudfoot detailed the disparity between certain staff members in his department: those who subscribed to a positivist, rational approach to architectural design and

[12] Heuristic judgements are essentially rules of thumb that designers use to provide a quick solution to a problem, often based upon personal experience, rather than rational processes or theories. (Lawson 1997: 188)

those who subscribed to an intuitive, or as Proudfoot described it, a 'phenomenological' approach. He claimed that intuition and reflection, which he saw as critical to design, were being overshadowed by testable scientific approaches taught in a number of peripheral subjects. This dichotomy has also been described by a number of authors including Seamon (1982), Maxwell (1985) and Stevens (1989; 1998)

Proudfoot argued that a scientific approach to design "only fetters the imagination" through an attempt to make increasingly perfect 'solutions' to a design 'problem' even though a perfect solution might not be possible. Like Schon, he described the design process as intuitive rather than requiring the application of a complex theory.

Schön took his argument against technical rationality further by rejecting the notion that design practice needed to be grounded in established theory, arguing that theoretical knowledge can intimidate a student. By contrast, Llewellyn Davies (1960) in his inaugural lecture to the Bartlett School of Architecture, called for an integrated stance to the design of an architectural curriculum. He argued that a student's design thinking must be firmly underpinned by an understanding of the technical subjects. He claimed that "art and science interlock". Roberts and Marsh (2001) describe how technical subjects can be used to underpin design thinking in the school of architecture studied in this research.

Ochsner (2000) developed Schon's arguments by claiming that reflection in action is an extension of creative play experienced during childhood, where actions are not excessively influenced by the reality and rationality of the world outside the child's mind, but where uncertainties and ambiguities are rarely questioned. Both authors suggest that key to the education of the architect is the development of the abilities to reflect in action, to experiment with design and see this as a learning process not necessarily related to any immediate measure of success or failure.

By way of examples, (Schon 1985) identified and contrasted two fictional students seen to be typical of those in architectural education. The first student was willing to accept the concept of reflection in action, to experiment with design without undue concern that her immediate efforts would be successful. The second student was less willing to experiment with his design, preferring to impose some preconceived, possibly formulaic solution onto the problem. Ultimately Schon suggested that the former would be the most successful. Ochsner suggested that the difference between the two students may have been linked to the students' ability to play creatively as children and perhaps in the second case, play represented a painful experience that the student was unwilling to repeat. This represented a block to the learning experience and made the student more difficult to teach. Schön's example placed a different teacher with each student and it might also be necessary to question the nature of the teacher in encouraging the student to adopt a reflective approach.

3.6 The Sociological Perspective of Architectural Education

A number of authors have attempted to examine architectural education in terms of its sociology, suggesting that the successful development of architects has more to do with sociological context than upon an individual's psychological make up.

Cuff (1991) carried out a study in which she was able to compare and contrast the social structures of both architectural education and professional practice. She argued that becoming an architect required more than the development of creativity and knowledge, but rather, was a process of discovering "socially appropriate avenues for creativity". She claimed that much of architectural education was about developing a common language with other architects and about understanding the values, dialect, rituals and roles within the professional subculture. This, she argued, may lead to a disregard for non-architects, who she suggested were less likely to be found teaching in schools of architecture than those who had trained as architects. She felt that the disparate values of non-architects were considered by architects to be a hindrance, which could potentially confuse students.

Ultimately, Cuff argued that the purpose of architectural education was to encourage students to learn to make sense of the social environment rather than to learn about problem solving and decision making. This, she suggested, required the student to adopt a wide viewpoint of the world, taking into account the many dialectics faced by practice. This could best be developed through working collaboratively order to develop a better understanding of these issues.

Stevens (1998) argued that architectural education was a mechanism for maintaining the cultural status of the architectural field. Unlike Cuff, whose work was based around empirical studies of practicing and student architects, Stevens attempted to adapt the theories of French sociologist Pierre Bourdieu to architecture in order to gain an understanding of the nature of the field of architecture, and its methods of reproduction – architectural education. Stevens argued that the purpose of architectural education was the maintenance of a cultured elite, from which those without the necessary credentials, habitus and symbolic capital, were excluded. Habitus, according to Bourdieu, referred to a set of internalised dispositions that inclined people to act in particular ways. These may refer to ways of seeing or doing things that were inherited from parents, teachers or peers. Stevens suggested that, habitus was the social equivalent of genetic inheritance. Bourdieu also described symbolic capital as one's cultural standing in the world and may have consisted of qualifications, ownership of cultural objects such as works of art, membership of social networks and most importantly a general appearance of being cultured. He considered symbolic (or cultural capital) to be analogous to economic capital whereby large amounts of it could be built up, and used to an individual's advantage. According to Stevens:

> "Architectural education is intended to inculcate a certain form of habitus and provide a form of generalised embodied cultural capital, a cultivated disposition. Of course young architecture graduates must know how to draw, of course they must understand building codes, the rudiments of structural analysis, the principles of construction; but right from the moment they sit down at the drawing board of their first office to the day they retire, the smoothness or difficulty of their career will be mediated by their habitus acting through their cultural capital" (Stevens 1998:187-188)

Stevens went on to argue that architectural education operated to the advantage of the socially privileged, and to the disadvantage of those with little symbolic capital (to a greater extent than in other disciplines) and claimed that the latter would eliminate themselves from the education process. The values of architectural education, he argued, were those of the dominant culture, a culture which could be difficult to change[13]. Those who are willing and able to accept this dominant culture are more likely to succeed than those who think otherwise. He claimed that the culture of architectural education stratifies the subjects taught in architecture according to the symbolic capital that they are able to offer; where design remained of prime importance followed by history and theory. Construction, environmental science and structures were often perceived as having less cultural capital and were therefore less revered. Stevens used this to explain why history and theory occupied the major research areas of most of the full time teachers of architecture in his own school of architecture.

3.7 Summary

This chapter has outlined the context within which this research has taken place, architectural education, in terms of its structures, philosophies and sociologies. Whilst the chapter has provided a general overview of

[13] Changes in the dominant culture are infrequent. Examples stated by Stevens include the incorporation of the modern movement into American schools in the 1940s and the deconstruction movement of the 1980s

architectural education, there is no standard way to teach architecture and there are considerable differences between the structures and organisational systems and values operating in many schools of architecture. A detailed description of the structures and systems from the school of architecture selected for investigation in this research is included in chapter 5 - Research Method.

CHAPTER 4: RESEARCH INTO THE CHARACTERISTICS OF ARCHITECTS AND ARCHITECTURAL STUDENTS.

This section reviews literature describing research carried out on practicing architects, students of architecture and other designers in order to determine whether any commonalities and individual differences exist in their ways of thinking. The sources reviewed were gleaned from a hierarchical search of literature, using bibliographies by Lawson (1997) and Broadbent (1988) as a starting point. Sources were limited to those that specifically addressed individual differences, either between groups of architects, or between architects and non-architects. The majority of the research reviewed uses professional architects as subjects and therefore it cannot necessarily be assumed that any findings would also be a reflection of student architects. Nevertheless, for the purpose of the research it is assumed that on the whole many of the characteristics that can be found in professional architects will be present in a number of architecture students or will be developed as part of their education.

4.1 Creativity

Lawson (1997) summarised a number of examples of creativity in a variety of fields but questioned whether certain individuals are innately more creative than others. Hudson (1966) criticised writings in creativity as being unclear in definition as to what creativity referred to. He argued that "Creativity...applies to all those qualities of which psychologists approve". As we saw in chapter 2 he derived two distinct personality types: the diverger, who showed a bias towards open ended activities and the converger who preferred activities that led to a single answer. Hudson claimed that it cannot be assumed that one of these types is more creative than the other. Moreover Lawson described as a myth, suggestions that divergent thinkers were likely to be more creative as a "red herring". MacKinnon, (cited in Broadbent 1988:2) defines creativity as:

> "It involves a response or an idea that is novel or at the very least statistically infrequent. But novelty or originality of thought or action, while a necessary aspect of creativity, is not sufficient. If a response is to lay claim to being part of the creative process, it must to some extent be adaptive to, or of reality. It must serve to solve a problem, fit a situation, or accomplish some recognisable goal. And thirdly, true creativity involves a sustaining of the original insight, an evaluation and elaboration of it, a developing to the full"

This quotation mirrored Hudson and Lawson's comments that creativity was more than just the ability to generate large quantities of ideas (i.e. divergent thinking), but also had something to do with the ability to make good use of those ideas. This definition suggests that an idea in itself will not suffice, unless it is technically possible to utilise the idea. In architecture, it is possible to generate a vision for a new building, but that vision must fit into the preconceived brief in order to meet social, technical and environmental needs.

MacKinnon's study of the psychology of architects (Mackinnon 1962) investigated 120 architects, categorised according to a perceived level of creativity. The groups were Architects 1: who were seen as 'creative' Architects, Architects II: who were perceived to be less creative and Architects III: who were ordinary practitioners. The level of creativity was determined by an 'expert' panel of academics and architectural journalists, although subjects participated on a voluntary basis. Each group was subjected to a number of personality tests and clear distinctions were found between each group. For instance, when asked to choose adjectives that represented a perception of themselves, Architects I tended to describe themselves as inventive, determined, independent, individualistic, enthusiastic and industrious. By contrast Architects II and III tended to describe themselves as responsible, sincere, reliable, dependable, clear thinking and understanding. The findings also suggested that the more creative architects tended to show traits of individuality and determination whereas the less creative architects tended to show more empathic qualities. Fisher (2000) has suggested that empathic qualities are important for the modern day architect particularly with relation to team working and client relationships.

Mackinnon's findings suggested that there was no significant link between intelligence and creativity above a particular threshold of intelligence. Moreover, he suggested that members of the highly creative group showed certain psychopathic tendencies to a greater extent than the other groups (although these tended to be well controlled) and that there was a tendency for creative males to show feminine qualities to a greater extent than their less creative counterparts. Creative individuals were also seen to prefer complex, asymmetrical, artistic images, where as the less creative groups preferred simple, symmetrical forms. Mackinnon claimed, that creative subjects preferred the richness of the disordered to the stark bareness of the simple and appreciated the challenge of the need to impose order. Mackinnon's subjects also showed a correlation between creativity, and the judging - perceiving dimension of the Myers Briggs Type Indicator that was particularly strong with Architects. Creative architects appeared to have a greater tendency to perceive the world as it is, rather than to make judgements on it. Myers & Myers (1995) suggested that those with a perceptive personality often appeared to be open-minded, flexible and spontaneous, where as those with a judgmental personality placed more emphasis upon control and regulation. Architects were also shown to have intuitive personalities, described by Mackinnon as a tendency to look

> "expectantly for a bridge or link between that which is given and present and that which is not yet thought of, focussing habitually in possibilities".

This was particularly significant as only 25% of the general population show a preference for this type of thinking, yet 100% of Mackinnon's highly creative architects were shown as intuitive as measured by the Myers Briggs test. Furthermore 84% of Architects II and 59% of architects III had intuitive ratings, suggesting that on the whole, architects are more intuitive than the population as a whole.

Mackinnon suggested that creative talent may have been derived from a child's upbringing, with excessive parental authority and educational criticism limiting creative development.

Karlins et al (1969) carried out a series of creativity tests on a small group of architecture students. These tests were designed to measure the accuracy by which teachers of architecture could judge creativity. The two participating professors were asked to provide a rating for 6 personality traits (including creativity), based upon a pre defined scale and criteria. They were also asked to provide a personal rating of the students' creativity based upon their own judgement. Correlations were measured between each of these traits, together with the results of tests for mathematical and verbal reasoning, the students mark for design work, and standardised tests for creativity, spatial relations, visualisation and intelligence.

As with Mackinnon's findings, Karlins found no significant correlations between intelligence and any of the measures of creativity. Moreover, the results from the creativity test failed to correlate with any of the other measurements including design mark. It is possible that this test may have measured a different type of creativity than that encountered by architects.

In addition the tests for spatial relations correlated significantly with the professors' rankings for creativity, suggesting that perhaps architectural creativity may be linked to an ability to think spatially. This will be discussed later in this chapter.

4.2 Parallel lines of thought

Lawson (1993,1994) investigated the approaches architects take when they are designing. Through a series of interviews with leading architects and studies of their drawings, he showed that designers often approach the design process using a number of 'parallel lines of thought' in a simultaneous, rather than sequential manner He argued that architects can organise information in an infinite number of ways, or modes of thought (Lawson 1993). For instance, he suggested these might be in terms of spatial configuration, structural systems, or the components from which a building is made. From his research it was apparent that designers are able to address many of these modes simultaneously and often independently of each other. These, he argued, were carried out through an extended and intense 'conversation with the drawing' (c.f. Schon 1983) and only when much development of the various lines of thought had taken place, could they be resolved into one single solution. He cites architect, Michael Wilford as comparing "a juggler who has got six balls in the air [to] an architect [who] is operating on at least six fronts simultaneously." He continues "if you take your eye off one of them and drop it, you're in trouble". Lawson (1997: 226) argues that some of these lines of thought may be vague, whilst others may show detailed exploration and concludes that:

> "good designers are able to sustain several 'conversations' with their drawings, each with slightly different terms of reference, without worrying that the whole does not yet make sense. This important ability shows a willingness to live with uncertainty, consider alternative and perhaps

conflicting notions, defer judgement, and yet almost ruthlessly resolve and hang on to the central idea."

Parallel lines of thought may enable designers to maintain a holistic overview of the design whilst examining it at the detailed level, but also enable them to understand the inter-relationships between individual aspects of their schemes. Rowe (1987) argued that in architecture one can only understand the meaning of the whole if there is have a simultaneous understanding of the parts, but in isolation our understanding of the parts will be difficult if there is no understanding of the whole. For instance it may be possible to deconstruct architecture into a series of elements for instance (aesthetics, spatial arrangements, construction, satisfaction of human needs etc...) but in doing so one may lose the holistic judgement. To gain a full understanding one must be able to address the wholes and the parts together with their interrelationships simultaneously using parallel lines of thought. In some respect this may demand a type of thinking similar to that referred to by Schmeck(1988) as an integrated cognitive style, where an individual can think at both the global and analytic levels simultaneously.

4.3 Styles of Designing

Van-Bakel (1995) has attempted to categorise designer's individual styles[14] of working. Whilst this was an early attempt to see if certain working styles are more appropriate with Computer Aided Architectural Design (CAAD) than with traditional design media, this research has wider ramifications. Essentially it was hypothesised that every designer has a personal, preferred method of working. However given particular design situations they may or may not use that particular style. These personal styles may be connected to the mind of the individual designer, some of which will be mentioned elsewhere in this chapter. Van-Bakel's research

[14] Van Bakel distinguishes between two types of style: Object style, which is the style of the built form (i.e. classical, modern etc...) and Subject style, which is connected with the individual working method of the designer.

consisted of asking 11 experienced, male architects to complete a structured interview and participate in a design exercise. During the design exercise, they were able to ask for further information as and when it was required. Van-Bakel recorded the order in which particular pieces of information were requested and used it to gain a sequence of priorities. The subjects were also asked to participate in a card sorting exercise that was used to determine the priorities of the designer when the design problem is not an influence. From this it was possible to determine the architect's priority for Programme (P), Environmental Situation (S) and Concept (C). In this way it is possible to derive six principal design styles from the combinations of the three elements.

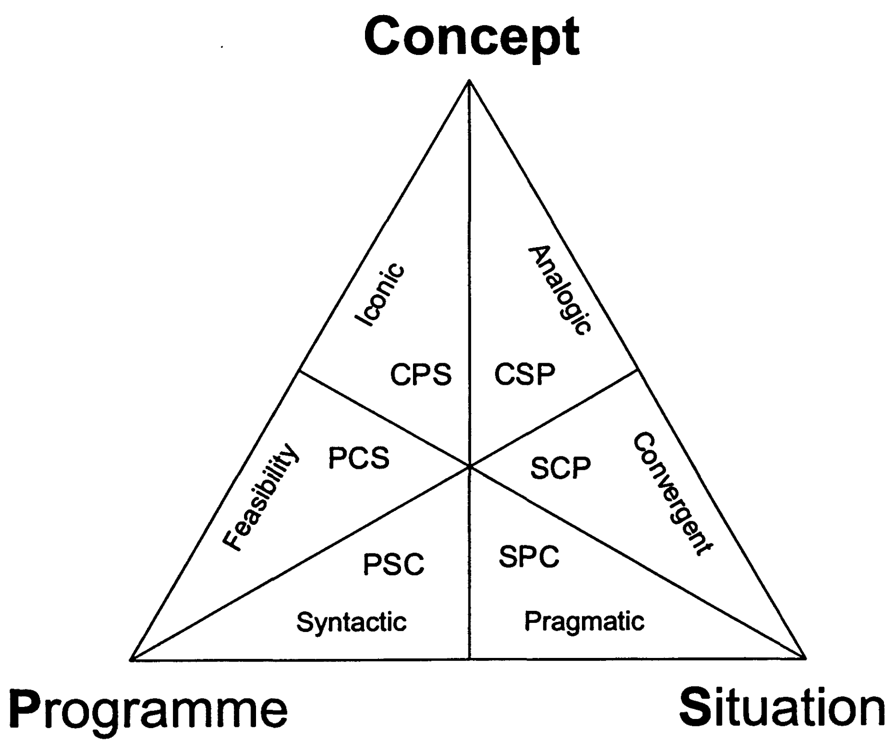


Figure 6 Styles of Designing from Van-Bakel (1995)

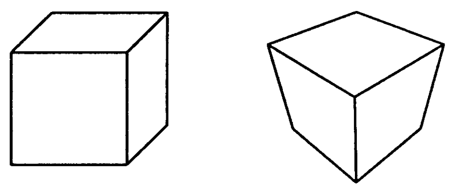
Figure 6 shows Van Bakel's attempt to map the 6 design styles onto Broadbent's (1988) typologies of architecture (i.e. pragmatic, analogic, and iconic), suggesting that a particular working style may lead to a tendency to generate a particular type of architecture. For instance a working style which looks at concept then site then programme may lead to analogic design.

In further investigations Van-Bakel (1995: 198) surveyed a number of architects and found that whilst they did vary in terms of their preferred styles of designing, the largest number preferred a programme centred approach which he described as a syntactic oriented style. A large proportion also preferred a pragmatic designing style. Fewer of the subjects showed a preference for a concept centred styles of designing which he described as analogic or iconic. In some respects this suggests that his architects had a tendency towards rational approaches to design, rather than the intuitive approach that was discussed in the previous chapter. He also related his styles of designing to key aspects of human temperament in terms of emotionality, thrill and adventure seeking, lack of inhibition, impulsivity and extroversion. He found groups of subjects with particular design styles, showed significantly higher scores on certain temperaments. It is possible that architects with different personality temperaments would have a preference for adopting different strategies for designing.

4.4 Spatial / Visualisation abilities

It might generally be expected that architects demand high visualisation and spatial abilities in order for them to do their work. Indeed, MacFarlane-Smith (1964) identified a number of key architects who he felt had particularly high spatial skills (although it is not clear how this conclusion was reached). He defined a number of components of spatial-visualisation ability including those which enabled an individual to understand visual patterns and relationships between shapes and to mentally manipulate a three dimensional shape within the mind's eye. He claimed that the latter was necessary for the reproduction of an object through drawing.

As a test of the relevance of spatial abilities to architects, Peterson and Lansky (1980) carried out an exercise on architecture students. First year students were asked to draw a simple cube. Generally two types of cube were drawn, which Peterson and Lansky classified as 'visual' and 'cognitive' (see Figure 7). They described the visual cube as one of isometric projection, whilst a cognitive cube was drawn using an oblique projection, where the student would draw a square and project backwards. This was thought to be less visually correct. The research found that those who drew the cognitive cube tended to perform less well in their design work than those who drew the visual cube, with a higher drop out rate for the former. The students were re-tested during their second year and some students who originally drew a cognitive cube, were now drawing visual cubes. This group still performed less well than those who drew visual cubes in the first year, but better than those who were continually drawing cognitive cubes.



Cognitive Cube Visual Cube

Figure 7 Two means of representing a cube identified by Peterson and Lansky

The role of drawing within architecture has played an important role since mediaeval times. Schon (1983) describes a designer having a "conversation with his drawing" using it to explore the possibilities available. Research by Lawson (1997: 241-259), based upon interviews with a series of respected architects, showed that they regarded drawing as an essential part of the design process. Lawson suggested that the drawing is a means of holding an idea in place, whilst another is considered; a means of enhancing parallel lines of thinking. In a similar study, Robbins (1994) argued that drawing provides architects with a freedom to rapidly experiment with design without the constraints present in physical construction of buildings. It is perhaps possible that drawing could be used as a substitute for some other limited spatial or holistic facility; but the role of drawing is probably more complex that this. Lawson argues that design drawings need not be complete, accurate depictions of the building, but become aids to the mind for the further development of ideas. This is an idea that is supported by Renzo Piano who argues that:

> "Unless you draw something, you do not understand it. It is a mistake to believe that 'now I understand the problem and now I draw it'. Rather, right at the time you draw you realise what the problem is and then you can rethink it". (Robbins 1994: 127)

Furthermore, Robbins (1994), concluded that the role of drawing has an important sociological and cultural influence. Drawings, he argued, can be used to provide architects with a sense of authority, allowing them to define the discourse on design.

4.5 People skills

Mackinnon's studies on architects' creativity suggested that the most creative architects claimed to show a degree of social individuality. Broadbent (1988) compares Mackinnon's work with a number of other studies of personality not necessarily related to architects, but recognises some key similarities in terms of individual traits. For instance he contrasts Mackinnon's Highly Creative with Allport's Prejudiced person. This second type of person tended to follow strict moral guidelines, found it difficult to tolerate uncertainty and related well to authority and group situations. This relates in some respects to Hudson's converger. By contrast the high creative person is described by Broadbent as "high in self acceptance and flexibility, low in conformity and desire to belong to groups". This relates in some respects to the description of a diverger given by Hudson and the tolerant or non-prejudiced person given by Allport. The tolerant person was more likely to show empathy than the prejudiced person. Nevertheless, in Mackinnon's study, the most creative individuals, were less inclined to show empathy; indeed Broadbent (1988) argued that a number of well known architects have been shown to exhibit a particular lack of these traits. MacFarlane Smith (1964) suggested that these architects could be described as having schizothymic characteristics, which are commonly seen in individuals with high spatial abilities. Schizothymes tend to separate the intellectual world from the emotional world, leading to independence and intolerance of others. Cyclothymes by contrast find it easier to relate to other people. Research by Roe (cited in Hudson 1966) suggests that her subjects could be divided into those interested in people, and those interested in things. The latter group showed this similar emotional withdrawal to the spatially talented architects described by Macfarlane-Smith. Hudson also suggested that his subjects with tendencies towards convergent personalities showed similar characteristics. Karlins et al (1969) found that a measure of visualisation ability correlated with personality traits of social dependence and independence, although their report does not confirm the direction of this correlation.

4.6 Handedness

Research by Peterson and Lansky (1974, 1977) suggests that there were a significantly higher proportion of left-handers in the university of Cincinnati School of Architecture than in the population as a whole. In addition a significantly higher proportion of left-handers graduated from that school over a period of three years. In a factor analysis, handedness loaded onto the same factor as a test connected with a simple drawing task, and with the students' design marks, suggesting that left handers may have had some advantage over right-handers in pursuing their course.

4.7 Learning Styles and Cognitive Styles

Much of the research on cognitive styles has been carried out using either school children, or those from the fields of management or psychology. However some limited studies of architectural student's cognitive style do exist.

Bergum (1977) and Morris and Bergum (1978) described research carried out on a group of architecture and business studies students who were asked to rate themselves in terms of how creative they regarded themselves. The architecture students generally regarded themselves creative, where as this was not necessarily the case with the business studies students. The architecture students were also on the whole, more field-independent (analytic cognitive style) than the business studies students. If we were to assume that creativity is related to divergent thinking, then this result contradicts the suggestion made in chapter 2 that divergent thinkers exhibit similar characteristics to field dependents (global cognitive style). The results could be explained by the possibility that the Embedded Figures Test used to measure field independence may measure spatial ability rather than cognitive style and that divergent thinking may not in itself be a measure of creativity.

By contrast, research by Peterson and Sweitzer (1973) suggested that architecture students were on average more field dependent (holistic, or global cognitive style) than the student population as a whole and that they were less variable in their measurements of field dependence. It is possible that field independents are filtered out of the educational process during the admissions period.

Lawson (1984) described an experiment to investigate whether cognitive style differences influence the ways in which design problems are tackled. Initial results suggested that final year science students worked in a very different way to final year architecture students when tackling a specific problem. Whilst the scientists adopted a rational process orientated approach the architects tended to work in a more experimental manner similar to that described by Schon as showing 'reflection in action'. This marked contrast in approaches was present to a lesser extent for younger students, which might imply that the individual differences are determined (or reinforced) by the educational process that those students experience. However the sample sizes here were small, and the difference may refer to strategies that had been developed, rather than an inbuilt cognitive style.

Demirbas and Demirkan (2003) have attempted to relate the design process undertaken by student architects to Kolb's cycle of experiential learning (Kolb 1984), specifically looking at whether students with particular learning styles, perform better at particular stages of the architectural design process. They found that students with an accommodating style performed better than students with an assimilating style when designing a simple staircase following their first lecture on staircase design. Accommodators were particularly strong at the Active Experimentation and Concrete Experience stages of the learning cycle and Demirbas and Demirkan suggested that their success is due to a preference for hands on experience. They also found that the assimilators performed better than all other types when building a model. Assimilators show a preference for reflective observation and Abstract conceptualisation. Demirbas and Demirkan suggested that as the three dimensional design for a staircase is an abstraction of a real staircase which may be why that group did particularly well. Nevertheless, if this was to be the case, then it would be expected that the converger students would also have done well.

Durling et al (1996) administered the Myers-Briggs type indicator to 71 'arts based' design students from two UK universities. Their results suggested that whilst the learning styles of the students do differ, 79% of the students had a preference for intuitive thinking. They suggested that business managers, mechanical engineers and the general population as a whole tended to show less intuitive profiles than architects and fine artists. This supports the results generated from Mackinnon's studies of architects, four decades earlier.

Riding and Rayner (1998) carried out an analysis of cognitive styles based upon professional occupation. They tested subjects from a variety of occupations including architecture using the Cognitive Styles Analysis (Riding 1991). Each was allocated a cognitive style along the two dimensions of the CSA. The results showed that a high proportion of architects had a combination of wholist and bimodal cognitive styles. A smaller group had a combination of analytic and imager styles. The research however, is weakened by the arbitrary sample selection [15] which made no reference to the roles and abilities of the individual architects, or how they performed as students.

4.8 Summary

This chapter has outlined a number of pieces of research designed to look at the behaviour of architects, students of architecture and other design subjects. The examples of research were selected in an attempt to determine what individual differences might impact upon an individual's ability to do and learn architecture. Whilst much of the research is quite disparate in nature, there would appear to be a general trend that creative architects have a tendency to think in an intuitive manner, are happy to consider a number of trains of thought holistically and in parallel and have good spatial skills. On the negative side, there are suggestions that some architects may exhibit poor social skills, showing attributes such as prejudice and intolerance.

The next part of the research takes a detailed look at the relationship between cognitive style and performance in architectural education of three cohorts of students within a particular school of architecture. A number of the strands investigated in the present chapter will

[15] From personal contact with Richard Riding

subsequently be revisited in the discussion section of this thesis when they are related to the present research.

CHAPTER 5: RESEARCH METHOD

Having looked at theories of learning styles and described the nature of architectural education, it is necessary now to see how the two can be brought together in the form of a field study, designed to ascertain whether a test for learning style can predict success or failure in architectural design education.

The principal research question behind this dissertation is to determine whether students with particular learning styles are likely to perform better than students with other learning styles, when learning architectural design. In order to answer this question a longitudinal study was carried out. Three successive cohorts of architectural students were asked to take a learning style test and a test of spatial ability, the results of which were compared to their assessment marks for architectural design project work at key stages during the three years of their undergraduate course. The students' assessment marks were also compared to their post 16 qualifications. This chapter outlines how the particular tests were selected, how they were administered and how they were related to the student's assessment marks.

5.1 Student Sample

The sample for the research comprised three cohorts of students studying for a B.Sc in Architectural Studies at the Welsh School of Architecture, Cardiff University between 1999 and 2002. Cardiff University was chosen because it was the author's host institution. All students within each of the cohorts were expected to participate.

Within the scope of this research, it was not possible to make a cross comparison with other schools of architecture and the author is not aware of any examples of other schools of architecture where the learning styles tests chosen have been used. This research is based upon the assumption that the profile of students within the Welsh School of Architecture is typical of that of other schools of architecture and thus can be considered a reasonably representative sample. This can be justified upon the following grounds:-

- That the students come from a wide range of types of academic backgrounds, with no particular emphasis in the arts and sciences. Whilst some schools of architecture do place more of an emphasis towards the arts in their selection of students, it was felt that for the purpose of this research, having a sample selected from a wider range of backgrounds was likely to yield more meaningful results.
- The students are generally expected to be highly qualified in terms of A-Level results (more so than most other UK schools of architecture), with the school requiring a minimum 'A' level score of ABB at the time of the study. It is however suspected amongst staff that these results are poor predictors of the students' future academic performance and as we will see in the forthcoming chapters, this research confirms this to be the case.
- Staff at the school consider that students enter the school with a wide and varied range of skills, showing both strengths and

weaknesses in drawing, information technology, social skills, study skills, time management etc...

- Staff also consider students to come from predominantly middle class backgrounds. Data from Cardiff University suggests that 79% of architecture students in the school have parents with managerial, professional and technical Backgrounds. This compares to 55% of university students across the UK[16]. Unfortunately no comparable data is available for architecture students in the UK as a whole. Nevertheless it might be expected that students of architecture will be predominantly middle class given that students are expected to study for up to 6 years before qualification; consequently having financial implications on students from poorer backgrounds. Approximately 10% of the students come from countries from outside the UK, predominantly from the Far East, with a variety of cultural backgrounds.

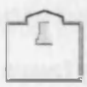
The Welsh School of Architecture is considered by many of its staff to be a practical and practice orientated school. It should be recognised that this reputation may distort the intake compared to other schools where a different bias is perceived.

5.11 Design project work within the Welsh School of Architecture, Cardiff University

The Welsh School of Architecture offers degree schemes that aim to help students to become well-rounded and capable architectural designers. Students leave the school with a broad understanding of the historical and cultural context of architecture; the foundations of technical competence, an understanding of professional responsibility and an ability to integrate these into architectural design. A detailed outline of the student experience at the Welsh School of Architecture is included in Appendix 1.

[16] Data obtained from the Universities' Central Admissions Service (UCAS)

Notionally, design work accounts for 2/3rds of the students' time in the school and assessment is weighted accordingly. In reality many students would argue that they spend rather more time on design than this. In undergraduate years, each semester contains a number of projects lasting from a few days to the entire length of the semester. On the whole projects are carried out sequentially. Unlike some schools of architecture, this school does not operate a unit or atelier system; instead, all students in a cohort will normally participate in the same projects. In most cases the projects ask the students to respond to a set brief, the scale of which increases as the student progresses through the school. Projects are tailored to give the students experience in particular building typologies (i.e. a school, library, or housing scheme) and to encourage exploration of issues facing the architectural world. A summary of all the projects undertaken by students during the course of this study are included in Table 1

Summary of Design Projects Undertaken				
	Typical Projects	**Cohort 1: 1999-2002**	**Cohort 2: 2000-2003**	**Cohort 3: 2001-2004**
First Year Projects				
	**House 1.** A small scale house, using traditional construction	**A Place to live 1 (4 wk)** To accommodate a comfortable existence	**A Place to live 1 (4 wk)** To accommodate a comfortable existence	**A Place to live 1 (4wk)** To accommodate a comfortable existence
	**House 2** A small scale house inspired by 20th Century Precedents	**A Place to live 2 (4 wk)** A small inspirational place for a creative person	**A Place to live 2 (4 wk)** A small inspirational place for a creative person	**A Place to live 2 (4wk)** A small inspirational place for a creative person
	Warm Up Short Project to prepare students for major design	**Viewpoint (1 wk)** A shelter with a view	*Not run with this cohort*	**Urban Intervention (1wk)** Rapid response to impressions gathered of urban area
	**Major First year design** Small public building encompassing a sequence of spaces	**Artists Spaces (7 wk)** An artists studio and accompanying gallery	**Framing (11 wk)** A small gallery to provide a frame for seven specific exhibits	**Body, Perception Framing (9 wk)** The design of a suite of thermal baths

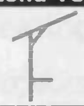
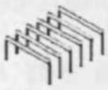
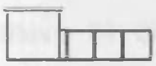
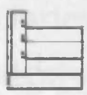
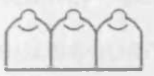
Second Year Projects				
	**Summer Project** Short untutored project	*No design project run with this cohort*	**Viewpoint** A Shelter with a view	**Brecon Beacons Garden** An educational/play space
	**Urban Housing Project.** Town study followed by design of small group of houses	**Ludlow Housing (6 wks)** 10 dwellings, with brief established by students	**Cardiff Housing (5 wks)** Housing in an urban infill site in inner city Cardiff	**Inhabiting the city (8 wks)** 10-12 dwellings for special needs users
	**Space and Structure** Design of a large span building	**Space and Structure (3 wks)** The design of a market place or performance space	*Not run with this cohort*	**Space and Structure (2wks)** A large, elegant, multi-purpose structure
	**Major Second Year Design** Community building, combining large and small spaces	**Sustainability Project (9 wks)** Community school or centre for sustainability	**Library (8wks)** The design of a small community library	**School or Museum (9wks)** Accounting for social and cultural context
			Philosopher's Garden (2wks) Short group project, inspired by reading key texts.	
Third Year Projects				
		Critical Awareness (3wks) Analytical project on the critical exploration of buildings		
	**Autumn Semester Project.** Public building with moderate complexity	**School of Architecture (7wks)**	**Landscape Institute (9wks)** and school of landscape design	*Completed after the submission of this thesis*
	**Degree Project** Major public building with complex brief	**Museum(10 wks)** Large museum or archive building with a selection of briefs.	**Art Centre (11wks)** Large gallery, library and archive in urban setting	

Table 1 Projects undertaken by students during the research

During the period of the research, projects in the students' first year were about the development of their architectural vocabulary. These were often short in duration, domestic in scale and provided the first opportunity for students to experience the design process. The first semester consisted of a series of short exercises which culminated in the design of two houses. The first house was designed following a study of traditional Welsh architecture, and students were expected to use similar materials and methods of construction. The second house was designed following the study of a number of key 20th century houses and students were expected to use these studies as precedent for their own schemes.

In the second semester, the students undertook longer design projects, creating small public buildings, containing a sequence of spaces. The projects provided a strict framework of stages that the students were required to follow, with all students being issued with a workbook of exercises that they were expected to carry out as preparation for and as assistance with their design project work.

In the second year students initially concentrated upon urban housing, where proposals would be made for a small community of houses within a town or city previously researched. In the 'Space and Structure' project students were asked to design an elegant medium-spanned steel-framed structure, to accommodate a variety of functions. In the second semester, students are asked to design a community building, such as a library or school, containing a variety of small and medium sized spaces.

By the third year, projects had increased in size to the extent that students were generating proposals for major public buildings such as galleries, museums and university buildings. In doing so they were expected to integrate many of the issues that they had covered in their earlier years together with issues that were likely to be key to their subsequent employment outside the school. Unlike in the earlier years of the course, these projects were not so rigidly structured, allowing students greater freedom to interpret the briefs as they felt appropriate and to work to their own timeframes. The year consisted of two major projects and in the first cohort studied, a short urban design project, where students were expected to produce a master plan for the redevelopment of an area of a major town or city.

In parallel to the design projects, students attended two lecture courses per semester. One was related to building technology, including environmental design, construction and structural design. The other was related to either the cultural or professional context of architecture. Attempts were made in a number of these lecture courses to relate the teaching to the design projects that the students were currently undertaking, so that their designs could be informed by the lecture's contents and to contextualise the knowledge imparted. Students also received tuition in research and library skills, the use of information technology and computer aided design.

Following the three years of residential study in the school, students spend one year on a placement within an architect's office. They then return to the school for a final year during which the will pursue a project of their own choice at a level of detail beyond that which they have previously studied. The students attain a degree of B.Sc after 3 years of study and a second degree of B.Arch after a further 2 years. The data for this research was based upon the initial B.Sc Course.

5.2 Data Collection methods

5.21 The measurement of student's performance in design project work

In this research, there is a need for some reliable and valid measurement of a student's performance whilst learning architectural design. The students' assessment marks in design project work were felt to be convenient measurements of this. For the purpose of the research the marks used were the final overall marks in their design modules as approved by the Board of Examiners.

Formal assessment of design work is usually carried out as part of the process of critical review. As has been described earlier, at the end of each project the students' work is presented to a jury of design and visiting tutors, who offer immediate feedback to the student. Following the presentation, the student is assigned a provisional mark which is determined by the expert opinion of each member of the jury. This assessment is based upon the student's approach, work and presentation, and in many cases may also take into account the developmental process that has informed the design work. These marks are collated and moderated by a second group of tutors.

Often, where a lecture course has been integrated into the design project work, an element of assessment for that course may also be derived from the student's design work. This may amount to a reflective essay in a written examination discussing a student's design intentions, or through the submission of a supplementary document related to the current design project, looking in detail at a particular aspect of a student's scheme, for instance its environmental performance. This document is assessed as part of the lecture module, rather than the design project.

At the end of the session all student work is then reassessed, often by a third group of tutors. When all student work is exhibited together it is possible for this group to gain an insight into the progress of the student throughout the year and a final mark is given to reflect that. In the second and third year the assessment processes are overseen by independent external examiners, who also provide an additional level of moderation of the students' marks. In each year design work is assessed as part of a single 80 credit module, which contains all design projects, plus a number of supplementary exercises, usually related to research used to support design work.

The complexity of the assessment of design is highlighted in the assessment policy of the Welsh School of Architecture (see appendix 2) which has been approved by the UK's Quality Assurance Agency. This document does not go as far as prescribing specific criteria for assessment but outlines two independent dimensions representing the extent to which students demonstrate:

> "Imagination, creativity, innovation, adventure, and intellectual rigour in design including:
>
> - the ability (in various ways) to generate (exciting, engaging, intriguing, stimulating...) ideas for architectural design (propositions), and to

advocate and employ sensible bases for evaluating their aptness to the brief in hand;

- the ability to develop architectural ideas rigorously (through divergent exploration and the convergent processes of clarification and refinèment) into a resolved state, in terms of intellectual intention, contextual relationships, spatial organisation, and tectonic realisation... all in relation to the explicit, implicit, and interpreted requirements of the brief;

- the ability to present the underlying ideas and the resolved state of the work in clear, informative, accurate, appropriate and attractive ways, visually and verbally, including the ability to 'sell' a design proposition to critical others;

- the ability to reflect thoughtfully on the process of design and the influences impinging on its development, and to structure and present lucid rationales.

Competence and a professional attitude to design including:

- the ability to research and interpret a brief and analyse its conditions (including: the cultural and social context and aspirations of the client; the proposed site and its physical context; available resources; contemporary issues such as sustainability; the regulatory and planning frameworks...);

- the ability to gather and apply the knowledge and information needed to progress a design;

- the ability through design to generate and apply tectonic principles, and employ appropriate structural organisation, environmental strategies, constructional systems involving detail design and the choice of materials; professional discipline and self-criticism in progressing a piece of work, and confidence and accuracy in presenting it visually and verbally.

These dimensions may not apply equally in every design project and it is rare that a student will achieve highly on all dimensions. Assessors of design work will normally trade high achievement on some against lesser achievement on others, usually to the advantage of the student. For example, one piece of work might be rewarded for being particularly imaginative, whilst another might receive a high assessment for its competence in terms of technical resolution. Nevertheless the ability to generate and develop architectural ideas is usually considered to be the core contribution of an architect, and therefore is of pre-eminent importance when considering student work. During the degree scheme as a whole, students are expected to achieve a reasonable level on most (if not all) of these dimensions. It should be noted that it is not normal for tutors to give individual marks for each of the given dimensions, rather the assessment policy is an attempt to explain an intuitive process that assessors undertake when deriving an overall mark for design work.

The end of year marks collected for this research do include some 'non-design' supplementary exercises: usually research that supports the design. Nevertheless the overall mark is considered by staff in the department to be a reasonable reflection of a student's ability to design. In addition marks were collected for individual design projects.

The validity of students' design marks as a measurement of performance in design project work and as a measurement of learning rests upon a number of assumptions outlined as follows.

Students' marks in design project work are a reflection of their learning.

In chapter 3 it was suggested that within schools of architecture, it is common to assume that a measure of student learning can be derived from some assessment or judgement on the product that the student has created (often a design proposal for a building).

Nevertheless, this assessment will take into account a wide array of factors, often related to the extent to which a student has satisfied the design brief, the value set of the assessor and the values embedded in the student's design itself. The fact that this mechanism of assessment is common within schools of architecture suggests that teachers of architecture, on the whole, regard this as a valid measure of student learning. It is also accepted as a valid method of measurement by professional bodies responsible for the validation of courses in architecture.

Any variation in emphasis placed upon certain aspects of a students design within an individual project will balance itself out over a period of time.

It is possible that the emphasis of assessment may vary between students and projects depending upon the nature of the design project work. The assessment criteria of the Welsh School of Architecture refers to 'trade-offs' occurring between assessments for competence and imagination rather than basing an assessment on fixed criteria. This implies that it might be possible for a student to progress through the course, without satisfying all necessary aspects of architectural education. If this was so, theoretically a student could complete the course having being assessed highly for imaginative designs, without demonstrating any competence in terms of knowing how the building might be constructed. To prevent this, all work is reassessed at the end of each year on the basis of the student's entire portfolio to ensure that their overall marks represent a balanced view of their performance over the year.

Any inconsistency in measure, resulting from the individual value set of an assessor will be counteracted by the process of moderation.

Assessors of students' work will have their own individual interests and value sets which may to some extent mediate the final marks given. Lowe (1970) and Lowe (1972) suggested that a process of moderation by other assessors ensures that marks remain consistent across an entire cohort. This practice is maintained within the Welsh School of architecture. Furthermore, over the period of a student's studies they will be assessed by a range of different staff so any bias will be compensated.

Coolican (1996) suggests that where data is derived from subjective measurements, based upon the viewpoints of individuals (for instance student marks), then it is appropriate for the data to be converted into rank order, and it should be this rank data that is used in statistical analysis rather than the absolute mark. This reflects an assumption that it is easier for a tutor to accurately determine whether student A is better than student B, than it is to determine whether student A is a certain percentage better than student B.

When relating student marks to learning styles in a longitudinal study of this type, it is also important to identify whether the performance of students with particular learning styles have improved or declined in comparison to their peers by monitoring their assessment grades at key points during the study, for instance their marks for each project or their overall marks attained at the end of each academic year. Pure rank data would be problematic here as over time some students, for what ever reason, leave the cohort and as such rank positions for the remaining students would change. For the purpose of this research and in order to aid the comparison of marks over time, the student mark data has been converted into percentile ranks, such that the student who obtains the highest mark in each cohort will be allocated a rank position of 100, whilst a student with the lowest mark will be allocated a rank position of 1. All other students will be placed equidistantly on the scale according to their marks. This means that if a student has percentile rank of 60, then he will have achieved and equal or higher mark than 60% of his peers. This is a common method of reporting educational assessments, especially where year on year comparisons are necessary (Rogosa 1999).

5.22 Learning style tests

Choice of test

It was necessary to select a measure of learning style that was suitable for use with architecture students and then to compare the results from these tests with the students' assessment marks for architectural design.

Chapter 2 of this dissertation differentiated between those models of learning style that were deemed to be a product of some innate part of the personality and those that were to a greater extent influenced by the learning context. It also distinguished between those tests for learning style that consist of self-report questionnaires that ask the subject how they might respond in a particular circumstance and those tests that measure learning style through some response to perceptual stimuli. It was suggested that the former could produce invalid results if the context from which the questions were derived is unfamiliar to the students. For instance, some questionnaires ask students to provide descriptions on how they learn in particular situations but these often relate to conventional text and lecture based teaching and learning activities rather than to the type of activity that typically occurs in architectural education. These questionnaires are likely to be less appropriate for students who will find it difficult to relate to the situations given in the test items. The following criteria, devised by the author, were applied when selecting an appropriate test:-

1. The test should measure how students learn in a context that would be relevant to architectural design education or should be context free,
2. The test should measure a constant or fixed learning style, rather than an approach or strategy that might vary depending upon the circumstances.
3. It should be apparent from literature that the test is valid and reliable
4. The test should be easily obtained at low cost and should be easily administered.

Whilst it may have been advantageous to supplement the above criteria by carrying out a pilot of a selection of the tests with a group of architecture students, this would have led to an undue burden on the students' time. Furthermore, it was not the intention of this study to carry out a detailed cross-comparison of a selection of learning styles tests in order to determine which model was the most suitable for architecture students. Therefore, it was preferable to use established research data to support the selection of a test. It was also possible to reject some tests on the grounds of ease of availability: for instance the Myer's Briggs test can only be used by a qualified researcher, other tests such as the Herrmann's Brain Dominance Index were unduly expensive, The remaining tests, assessed against the criteria, are listed in Table 2 and are subsequently analysed.

Test	Dimensions Measured	Measures Style, rather than strategy		Question Relevance to Architecture		Validity and Reliability	
Learning style Inventory (LSI) (Kolb 1984)	Diverger Converger Assimilator Accommodator	✓	Represents an individual's preferred method of learning, so could be described as style.	✓	Asks subjects to rank values in order of preference, thus questions do not directly refer to specific situations.	✗	Reliability and validity heavily criticised by Newstead (1992), Sims et al (1986) and other authors cited in Riding and Rayner (1998) There is little evidence that the learning cycle is an accurate reflection on how students learn
Learning Style Questionnaire (Honey and Mumford 1986)	Pragmatists Reflectors Activists Theorist	✓	Represents an individual's preferred method of working, so could be described as style.	✗	Questions related to particular ways of working, especially in work place situations	✗	Doubts expressed by Allinson and Hayes (1988), and Duff (2000a)
Approaches to Studying Inventory (Short Form) (ASI) (Entwistle 1981)	Holism (Comprehension Learning) Serialism (Operations Learning)	✓ ✗	Certain elements of the ASI measure a students approach to learning which may vary depending upon the circumstances. However the scales for operations learning and comprehension learning purport measure the Holist-Serialist style dimension described by Pask (1976)	?	Whilst questions refer to specific learning situations that differ from those carried out within schools of architecture, It may be appropriate to administer the questionnaire to 'fresher' students who can reflect upon their prior learning experience.	✓	Supported by a number of studies including Sadler-Smith (1996) and Jonnassen and Grabowski (1993), Duff (2000b)
Felder-Silverman Learning Style Model Felder (1996)	Sensing-Intuitive Visual-Verbal Inductive-Deductive Active-Reflective Sequential-Global	?	Claims to measure a number of style dimensions, which have been researched by others. However there is little evidence to support this to be the case.	✓	Questions reasonably generic, although the self report format may lead to choosing the answer which may be perceived to be correct.	?	Little independent evidence available to support this test
Group Embedded Figures Test (GEFT) (Witkin 1950)	Analytic or Global Field Approach	✓	Attempts to measure an individual's stable and consistent cognitive style	✓	Does not use a self report questionnaire, so responses are independent of context.	✗	Believed to measure ability rather than style. (Grigerenko and Sternberg 1995)
Cognitive Styles Index (CSI) Allinson and Hayes (1996)	Analytic-Intuitive super ordinate dimension	✓	Based upon a collection of other measures of cognitive style	✗	Questions tend to be related to problem solving in business management situations,	✓?	Authors of test claim high levels of reliability and validity (Allinson and Hayes 1996), however there is little independent evidence to support this model

Your style of learning and thinking (SOLAT) (Torrance et al 1977) and Human Information Processing (HIP) Taggart and Valenzi (1990)	Left Brain Thinking (Rational) Right Brain Thinking (Intuitive) Whole Brain Thinking	✓	Schmeck (1998a) claims that this represents cognitive style as it shows a continuum between two ways of thinking	✗	The SOLAT test is designed for use with school children, the HIP test focuses upon problem solving in business and management that undergraduate architecture students have little experience of.	✓?	Authors of test claim high levels of reliability and validity (Taggart and Valenzi 1990). However there is little independent evidence to support the test.
Cognitive Styles Analysis (CSA) (Riding 1991)	Wholist Analytic Verbaliser Imager	✓	Attempts to measure two dimensions of cognitive style. Claims to eliminate relationship with ability and the wholist-analytic dimension that has proved problematic in the (GEFT).	✓	Does not use a self report questionnaire, so responses are independent of context.	✓?	Author of test claims high levels of validity and reliability are built in to the test to a limited extent. (Riding 1999), However the nature of the test makes it difficult to measure reliability. Riding and Rayner (1998) highlight a number of studies show the test to have a high predictive validity. At the time of selection there was little independent evidence to questioning the validity or reliability of this test

Key: ✓ Meets criteria, ✓? Meets criteria, but little independent evidence, ✓✗ Meets criteria for some but not all its scales ✗ Fails to meet criteria, ? Insufficient evidence available

Table 2 Criteria for selection of learning style test.

Criterion 1: What dimensions do the tests measure?

The dimensions measured by this selection of tests are wide and varied at least in nomenclature. Nevertheless, as we saw in Chapter 2, some researchers have suggested that the many labels may form components of an overarching or super-ordinate dimension which ranges from holistic, divergent, global, intuitive thinking at one extreme to serialist, convergent, analytic, sequential thinking at the other. Both the CSA and CSI were derived as measures designed to assess this super-ordinate dimension. All the remaining measures have elements associated with them, which could be classified along this super-ordinate dimension. The CSA also has an additional dimension that covers the representation of information verbally or through images, although this forms part of the Right Brain-Left Brain dichotomy measured in the SOLAT/HIP tests.

Criterion 2: Does the test measure a fixed style, rather that a variable strategy or approach?

All of the tests considered, with the exception of some scales of the Approaches to Studying Inventory, claim to measure a preference for a particular way of learning rather than a strategy or approach that would vary depending upon the circumstances. The Comprehension/Operation learning scales of the Approaches to Studying Inventory were derived from Pask's work on holist and serialist thinking and so these scales may represent dimensions that are relatively fixed.

Criterion 3: Is the test relevant to Architecture?

The test items in the Learning Styles Questionnaire, the Cognitive Styles Index and the SOLAT/HIP tests are based on contexts either connected with workplace activities or with children's education and therefore would not be relevant to architectural education. The Approaches to Study Inventory is also situation specific, but in this case it may reflect a context that a new undergraduate would find familiar from their secondary education. The Learning Style Inventory and Felder Silverman tests are less situation-specific and therefore the subject's response is less likely to be skewed by context described in test items. The GEFT and CSA tests use diagrams and word tests that are not reflective of any particular context. For this reason these tests were considered to be more appropriate for the purpose of this research.

Criterion 4: Is the test reliable and valid?

Table 2 also suggests that with the possible exception of the Approaches to Studying Inventory (ASI), there is little conclusive independent evidence that supports the reliability and validity of any of the tests, although the researchers who developed the tests are usually able to provide some evidence for their test's reliability. Research exists that suggests that the Learning Styles Inventory (LSI) and the Learning Styles Questionnaire (LSQ) both have questionable reliability and validity, whilst the GEFT has been show to measure ability, rather than cognitive style.

From the analysis of the various tests described, it was decided that for the purpose of this research, Cognitive Styles Analysis (Riding 1991) was the most appropriate measure. At the time of selection, there existed little evidence suggesting that it may be any less reliable than the other tests considered and there was much research (mainly carried out by its author, and his postgraduate students) to suggest its validity in a number of circumstances (Riding 1998). Its two scales, wholist-analytic and verbaliser-imager, were derived from two significant bodies of knowledge; the work of Witkin, Paivio and their respective co-workers. Furthermore, Riding has attempted to correct some of the difficulties in measurement encountered by others on this dimension. The tests are also context free, in that they do not relate to any particular educational system or workplace setting and are therefore appropriate to use in a variety of circumstances including architecture. Riding also claims that CSA is not culture specific in its nature, which is important given the multicultural nature of the subjects used in this research. The test is available in a number of languages, although for the purpose of the research, all subjects took the English Language version.

The Cognitive Style Analysis is a computer based test that measures Riding's two dimensions of Cognitive Style, wholist-analytic and verbaliser imager. The test consists of three sub tests, the first of which measures an individual's tendency to process information in terms of words or images (the verbaliser-imager dimension). The subject is presented with a series of phrases, which ask the subject to make comparisons between two objects. Half of the phrases ask whether the objects are of the same *type* and half ask whether they are of the same *colour*. It is assumed that those with a visual cognitive style will respond faster to those questions related to colour, as they will find it easy to create a mental image of the objects in their mind before the comparison is made. Those with a verbal cognitive style will respond faster to those questions related to type, as it us assumed that they would be good at classifying objects into categories. Each question is timed and the value for cognitive style is taken as the ratio between the overall time taken to carry out the colour questions and the overall time taken to carry out the questions on type. Subjects who are quick in responding to the type questions, but slow in responding to the colour questions will be classified as 'Verbalisers', whilst those who are slow at responding to the type questions, but fast at responding to the colour questions will be classed as 'Imagers'. Those who are fast at *both* question types or those who are slow at *both* question types are classed as 'Bimodals'. The second and third sub-tests measure an individual's performance in figural tests in order to determine whether they organise information as wholes or parts. The subjects are shown two figures consisting of a number of simple shapes overlaying each other. Subjects are asked to indicate whether one shape is contained within the other. This is a disembedding task similar to those included in Witkin's embedded figures tests and it is assumed that those who find it easy to break information into parts will be quicker in their performance in this test. The remaining sub-test asks subjects to compare whether the two complex figures are the same, or different and it is assumed that those with a holistic or global cognitive style will perform quicker at this test. Again the ratio of the total time taken for the disembedding tasks and the comparison tasks is taken. Those who were fast in performing the disembedding task but were slow on the comparison tasks would be considered to be 'Analytics' whilst those who were fast on the comparison tasks and were slow on the disembedding tasks would be considered to be 'Wholists'. Those who were slow on *both* sub-tests, and those who were fast at *both* sub-tests were considered to be 'Intermediates'.

In both cases it is the timing of the subjects' response, rather than the accuracy of their response that is used to measure cognitive style. Whilst the test does provide an independent score for accuracy, this is primarily used as a mechanism for identifying subjects who failed to understand the test, or refused to take it seriously. Subjects are not made aware that their cognitive style will be based upon their response times and therefore are less likely to contrive their results.

It was also decided that the students should take the short 30 item version of Entwistle's Approaches to Studying Inventory (Entwistle 1981) as this was seen from initial research to be reasonably reliable. Its comprehension/operation learning scales also seemed to relate to the wholist-analytic super-ordinate dimension, and therefore would form a useful point of comparison. It was thought however that as this scale reflected more 'traditional' study methods than those generally used in architecture, then this test would only be suitable for those students who had recently joined the school who could reflect upon their secondary education. The test was converted into a format that students could take on a computer, immediately following the administration of the CSA.

Hypotheses Tested

The collected data from the CSA test was used to determine whether:

- There was a significant correlation between students' marks in architectural design and their score on the wholist-analytic dimension of Cognitive Style Analysis.
- A significant difference existed between the mean position within the cohort (with respect to their marks for architectural design) for students in each of the three arbitrary style groupings of wholist, intermediate and analytic .
- A significant change in the mean position in the cohort occurred between the end of the first year and the end of the third year for students in each of the three arbitrary style groupings of wholist, intermediate and analytic.
- There was a significant correlation between students' marks in architectural design and their score on the verbaliser-Imager dimension of Cognitive Styles Analysis.
- A significant difference existed between the mean position within the cohort (with respect to their marks for architectural design) for students in each of the three arbitrary style groupings of verbaliser, bimodal or imager.
- A significant change in the mean position in the cohort occurred between the end of the first year and the end of the third year for students in each of the three arbitrary style groupings of verbaliser, bimodal or imager.

The collected data from the ASI test was used to determine whether:

- There was a significant correlation between students' marks in architectural design and their score on the comprehension learning scale of the Approaches to Studying Inventory.

- There was a significant correlation between students' marks in architectural design and their score on the operations learning scale of the Approaches to Studying Inventory.
- There was a significant correlation between students' marks in architectural design and their score on the versatile learning scale of the Approaches to Studying Inventory.

Administration of the tests

Three successive cohorts of students were asked to take the learning styles tests. As a pilot the initial cohort was asked to take the Cognitive Styles Analysis and the thirty item version of the Approaches to Study Inventory. As a result of the pilot study, the subsequent cohorts, took only the CSA test, because the ASI failed to provide any positive results.

The computer based Cognitive Styles Analysis was administered to each of the cohorts within their first week of attending university. The tests were administered within the school's computing room, and for logistical reasons the students carried out the test simultaneously in groups of 10-15. In order to alleviate concern about distractions from other students taking the test on adjacent computers, the third cohort did not complete the test simultaneously, but rather took it in turns to carry out the test. This however was more difficult to administer. The author was present at all times whilst the tests were taking place to ensure that they were carried out in an appropriate manner.

5.23 A test of spatial skills

As we saw in chapter 2, Witkin suggested that cognitive style may be related to spatial skills. It is assumed that visual-spatial skills are an important element in architectural education. Therefore, in addition to the two cognitive style tests, the redrawn Vandenberg Mental Rotation Test version A (MRT-A) (Peters et al 1995) was used to determine the extent to which spatial skills, cognitive style and performance in design work were related. In this pencil and paper test, students were presented with a complex 3D shape made up of 10 cubes (Figure 8). They were asked to compare the shape to four similar shapes, two of which will have the same arrangement of cubes but rotated about its vertical axis. The remaining two shapes will have a different arrangement of cubes. Students are asked to mentally rotate the first shape in order to determine which of the two are of a similar configuration. The exercise is timed, and the score given is the number of correct answers provided within the fixed time period. The test was chosen because it was felt that the exercise related well to the kind of three dimensional exploration used by students when visualising their architectural designs.

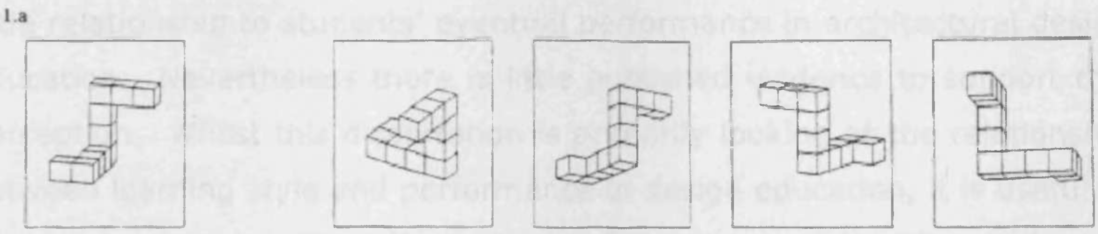


Figure 8 Sample Item from the Mental Rotation Test (Peters et al 1995)

Hypotheses tested

The collected data from the MRT test was used to determine whether:

- A significant correlation existed between students' marks in architectural design, and their score on the redrawn Vandenburg Mental Rotations test (MRT-A).
- A significant correlation existed between a student's scores on the wholist-analytic dimension of the CSA and their scores on the MRT-A test.
- A significant correlation existed between a student's scores on the verbaliser-imager dimension of the CSA and their scores on the MRT-A test.

Administration of the Test

The third cohort were asked to complete the redrawn version of the Vandenberg Mental Rotation Test. This was administered to all students simultaneously in a classroom situation. Some of the students who took the Cognitive Styles Analysis failed to attend when this test was administered.

Details of the numbers of students completing the test can be found in the following chapter.

5.24 Entry Qualifications

In Part 1 of this dissertation, it was suggested that there was a perception amongst teachers of architecture that post 16 entry qualifications, bear little relationship to students' eventual performance in architectural design education. Nevertheless there is little published evidence to support this perception. Whilst this dissertation is primarily looking at the relationship between learning style and performance in design education, it is useful to be able to compare the effectiveness of measures of learning style and measures of entry performance as predictors of a student's eventual outcomes. If, for instance, the measures of learning style provide better predictors of performance, than a student's entry qualification, then this information would be of potential interest to admissions tutors.

Qualification data for the cohorts being studied was obtained from the Cardiff University registry. In order to carry out calculations related to students' entry qualifications a standardised measure of entry qualification was required. This was derived from results in the GCE- Advanced ('A') Level, Advanced Supplementary ('AS') Level and Scottish Higher Level examinations using the system of points advocated by the UK's University Central Admissions Service (UCAS). The points system allocates a numeric score to a student's examination result, which is usually given as a letter grade in the range of A-E as shown in Table 3. Any grades below grade E, are considered to be a fail and are therefore allocated 0 points.

The student's total point score is the sum of the points achieved over all examinations sat. Where a student has re-taken an examination, perhaps in order to improve their grades, the higher of the two results is used and the lower discounted. Similarly, where a student has taken an AS level examination, and then proceeded to study the same subject at A level, the AS level results are discounted. Clearly this analysis restricts the sample to those students who have sat the GCE A level or equivalent examination. Students with overseas qualifications or those with vocationally based qualifications (i.e. BTEC) are excluded from the subsequent analysis.

Grade Letter	Equivalent points score	
	A Level	AS Level / Scottish Higher
A	10	5
B	8	4
C	6	3
D	4	2
E	2	1

Table 3: Examination point score equivalents

It may not only be the magnitude of a student's entry qualifications that predict eventual outcome of the students; it is also necessary to consider the subject areas that students covered in their post 16 studies. It is not the place of this research to carry out a detailed survey of individual qualifications and how they relate to performance in design subjects, nevertheless, it is possible to generate a figure for a student's preference between 'arts' and 'science' subjects. In order to obtain a figure for subject bias, separate points scores were calculated for both arts and science subjects. Any division of subjects into arts and sciences is bound to be to a certain extent arbitrary; for the purpose of this investigation, sciences were taken to include the natural and social sciences, whilst the arts were taken to include art, languages, humanities and design. 'General studies' as an 'A' level subject, was omitted from the study. Appendix 4 lists the allocation of subjects by arts and sciences. A ratio for bias towards arts subjects was then calculated by dividing the number of points scored for arts subjects, by the total number of 'A' level points.

Thus a bias value of 0 would be given to any student who has all science points, and a value of 1 would be given to any student who has all arts points. Intermediate values reflect the spectrum of arts and science specialisation. This value will subsequently be referred to as a student's 'subject bias' ratio. The subject bias ratio could also be used to split the cohort into three groups that could be referred to as 'artists' (those with a predominance of arts subjects), 'all-rounders' (those with a balance of arts and science subjects) and 'scientists' (who have a predominance of science subjects).

Hypotheses Tested

The collected data on entry qualifications was used to determine whether:

- A significant correlation existed between students' marks in architectural design, and their overall 'A'-Level points score.
- A significant correlation existed between students' marks in architectural design and their subject bias ratio.
- A significant difference existed between the mean position within the cohort (with respect to their marks for architectural design) for students in each of the three arbitrary style groupings of artist, All rounder and scientist.
- A significant change in the mean position in the cohort occurred between the end of their first year and the end of their third year for students in each of the three arbitrary style groupings of artist, all rounder and scientist.
- A significant correlation existed between students' scores on the wholist-analytic dimension of the CSA and their subject bias ratio.
- A significant correlation existed between students' scores on the verbaliser-imager dimension of the CSA and their Subject Bias ratio.

5.25 Student Interviews

In order to supplement the quantitative data, interviews were carried out with a group of students from the second cohort. The purpose of the interviews was to provide qualitative data that could be used to help explain phenomena gleaned from the quantitative study, rather than providing additional data for statistical analysis. The collected data has been used to generate a series of case studies.

The students were chosen as the three students with the largest increase in their rank position within the cohort and the three students with the largest decline in their rank position within the cohort between the end of their first year and the end of their third year. It was decided to exclude mature students, those who had failed or those with extenuating circumstances affecting their marks in order to ensure that the interviewees were typical of the population. The interviews were conducted following the publication of the students' degree results, but before they commenced professional employment. The students who took part in the interviews were given £10 book tokens. One student invited for interview, whose position in the cohort had declined substantially, was unable to attend on the day of the interview and therefore the interview did not take place.

The interviews were loosely focussed on a set of questions in an attempt to get an impression of the students' perceptions of their learning experiences. In particular the interviews aimed to find out what factors led to that particular improvement or decline in position within the cohort. The questions were intended as prompts to encourage the students to talk freely about their learning experience rather than as pointers from which comparative data analysis could be made. The interview questions were devised in discussion with colleagues from within the school of architecture who had also been responsible for the assessment of the students' work. The author performed all the interviews himself, and it was considered that a pilot of the questions was not necessary as it would be possible for the interviewer to make clarifications, or ask supplementary questions during the interview. The interviews were conducted along side the student's project work exhibition and lasted for approximately 15 minutes each. They were recorded onto audiotape. A transcript of each interview is included in appendix 3.

The interview was preceded by a preamble explaining about the research and that the students would remain anonymous in any report that was subsequently published. The students were not told why they were selected, and were not made aware of their marks for design work until after the interview.

The questions asked were:

- *How do you feel about your experience on the course, from year 1 to now?*
- *What was your favourite project during the whole three years? (and why?)*
- *What was your least favourite project?*
- *What did you find particularly challenging about the course?*
- *Did you find that at some point during your course you felt you really began to understand how to do architecture?*
- *How have your perceptions of architecture changed over the last three years?*
- *In your first year you took a test to find out your cognitive style. You came out as XY. Do you think that this relates to your way of thinking?*
- *In your 'A' levels you did particularly well in Arts/Sciences. How do you think this relates to your performance in design?*

5.3 Techniques for statistical analysis

The results from the quantitative data were analysed using a selection of standard statistical tests designed to determine whether the results obtained were significant. The summarised data for each student from each of the tests and the student record data was held in a single relational database with the students' university ID numbers being used as a unique identifier on which the various data sources could be related. Analysis software, SPSS was used to conduct the relevant statistical analysis of the data.

As was suggested in the previous section, assessment grades in architecture are likely to be generated through the subjective judgement of tutors and critics. Therefore it was necessary to use data that reflects the student's rank position in the cohort, rather than their absolute grades. The analysis of data of this type uses a set of tests derived from the field of 'non-parametric' statistics. Non-parametric tests are considered to be 'less powerful' than the alternative parametric tests in that they are more likely to over-estimate the significance of a relationship between two variables, however, they are useful in situations where it is not possible to obtain an accurate measurement of a particular variable (for instance where subjective judgements are used). Readers unfamiliar with techniques of statistical analysis may wish to consult Hugh Coolican's *Introduction to Research Methods and Statistics in Psychology* (Coolican 1996) .

The statistical tests used in the analysis of the data in this dissertation are designed to determine whether a relationship exists between two specific variables, and to determine whether that relationship is significant. The term significant has a specific meaning in social science statistics, and a relationship is considered to be significant only if there is less than a specified chance that it could have occurred through random error. For instance, it is common for a result to be considered significant if there is less than a 5% probability that the relationship has occurred through a random coincidence. This is described as being significant to the 0.05 level or written as $p<0.05$. Greater certainty can be achieved when relationship between two variables can be shown to have less than a 1%

probability of having occurred through random coincidence. This is described as being significant to the 0.01 level or written as $p<0.01$. Statistical significance implies that the results from a random sample of the population are on the whole representative of the population as a whole; the larger the sample, the more likely it is that a relationship between two variables will be significant.

The following tests were used in the analysis of the data:

5.31 Correlation Tests

These tests describe whether one variable increases or decreases in line with another. For instance if students' marks increased as their measurements of learning style increased, then it is said that a correlation exists. A correlation coefficient of 1 would indicate a direct relationship between the two variables, whereas a correlation coefficient of 0 would indicate no relationship exists between the two. A figure in between represents a partial relationship, which may involve other factors. It should be noted that the existence of a correlation between two variables does not indicate that one variable causes the other variable to be as it is. It is possible that there is a common influencing factor between the two. The coefficient of correlation is often referred to by the letter 'r'.

Correlations are often calculated using the parametric Pearson formula. The Spearman's-rho formula provides a non-parametric equivalent. Both tests generate a coefficient of correlation from which a value for statistical significance can be calculated.

5.32 Tests comparing two groups of subjects

It is possible to use statistical tests to determine whether two groups of subjects are significantly different. For instance it is possible that a group of female students will gain a higher average mark than a group of male students. Nevertheless, these results may be as a result of a random error, that would be less likely to occur if the sample size was larger.

Parametric statistical tests such as the independent samples t-test determine the statistical significance of the differences between two groups of subjects. The 'Mann-Whitney-U' test provides a non-parametric equivalent. An Analysis of Variance (ANOVA) provides a similar parametric test where there are more than two groups of subjects. The 'Kruskal-Wallis H' test is the non-parametric equivalent.

5.33 Tests that measure the change in a variable over time

It is possible to determine whether there is a significant change in a variable over time. For instance the average mark for a group of students may increase between their first and third years of study. Again these results may be a result of a random error, that would be less likely to occur if the sample size was larger. Parametric statistical tests such as the paired samples t-test would determine the significance of a change in a measurement that is repeated over time. The non-parametric equivalent of this test is the Wilcoxon signed ranks test.

5.34 Tests that measure the significance of numbers of subjects falling into particular categories

It is also possible to determine whether there is a statistical significance to the distribution of subjects into particular categories. For instance a cohort of 70 architecture students may consist of 30 female students and 40 male students. Given that admissions to university are roughly evenly distributed between the genders, we would expect that a cohort of 70 architecture students would consist of 35 males and 35 females. We need to know whether the difference between what we expect and what we get is statistically significant, or the result of some random error that would be less likely to occur if the sample size was larger. The chi-square (or χ^2) test can be used to determine whether such differences are significant.

CHAPTER 6: RESULTS AND ANALYSIS

This chapter explores the data collected from three cohorts of students. Data was collected by asking the students to complete three tests which may provide some indication of their individual differences, particularly with regard to their learning styles. The chapter also explores the relationship between the results and data collected from student records in terms of their qualifications upon entry into the school of architecture and their recoded marks for design project work.

The initial section of the chapter examines each of these data sources in order to address issues related to sampling, validity and reliability. The second section addresses the principal hypotheses identified in the previous chapter and uses common statistical tests to determine whether relationships exist between the various data sources and whether these relationships are statistically significant. Attempts are made to explain the nature of the relationships that emerge in the discussion chapter that follows.

6.1 Data Collection

6.11 Cognitive Styles Analysis

Continuous data

190 out of 202 students from the three cohorts took the Cognitive Styles Analysis test. The tests were taken by all students who attended a compulsory IT induction course at the beginning of their first year. However 11 students did not attend the IT sessions, either because they encountered delays in registering for the course or they had personal circumstances that prevented them from attending. One further student from the second cohort took the test, but the computer failed to record her results and she did not record the results manually. In addition 5 students from a prior cohort also took the test, although their results were not compared with design marks. As more than 90% of the students in the three cohorts took the test, it can be assumed that these students represented an accurate sample of students within the school.

Table 4 outlines the mean wholist-analytic and verbal-imager ratios captured by the CSA for each of the three cohorts of subjects tested. These are compared to statistical summaries of two standardisation samples collected by Richard Riding and his colleagues. The first sample (Riding 1999a) was based upon 999 subjects aged between 11 and 65 from a variety of backgrounds and professions. The second sample (Riding 1999b) was based upon 1448 UK secondary school pupils who were thought, by Riding[17] to be a better representation of the population as a whole.

[17] This is a suggestion that was made by Richard Riding in response to his analysis of an early selection of my data.

	N	Wholist-Analytic Dimension	Verbal-Imager Dimension
Cohort 1	51	1.32 (SD=0.53)	1.09 (SD=0.16)
Cohort 2	69	1.46 (SD=0.59)	1.08 (SD=0.19)
Cohort 3	70	1.41 (SD=0.6)	1.06 (SD=0.15)
Arch. students	190	1.4 (SD=0.57)	1.07 (SD=0.16)
Standardisation sample [a]	999	1.25 (SD=0.45)	1.06 (SD=0.20)
Standardisation sample [b]	1448	1.12 (SD=0.46)	1.1 (SD=0.27)

[a] Standardisation sample of selection of subjects from across the UK population aged 11-65. (Riding 1999a)
[b] Standardisation sample of secondary school pupils aged 14-16. (Riding 1999b)

Table 4 Mean ratios for wholist analytic and verbal imager dimensions

Regarding the wholist-analytic dimension, a direct comparison of the architecture students group and both standardisation samples suggests that the architecture students tested were on the whole more analytic (as denoted by a larger ratio) than both the standardisation samples. A statistically significant difference was observed between the mean wholist-analytic ratios for architecture students and both of the standardisation samples. This was determined using a single sample t-test, which allows a sample of students to be compared against a known mean ($t=3.717$ and 6.829 respectively, $df = 189$, $p<0.001$ for both standardisation samples). A straw poll of other researchers carrying out similar research on higher education students, suggested that on the whole their samples were also more analytic than the standardisation sample. This suggests a possible influence of secondary education filtering out wholists.

The data suggests that the first cohort was less analytic than the subsequent two, although the first cohort was approximately three quarters of the size of the subsequent cohorts which may lead to this inconsistency. An analysis of variance comparing the mean wholist-analytic ratios for each of the three cohorts showed any differences to be insignificant.

Regarding the verbal-imager dimension, the ratios obtained by the architecture students, tended to show a reasonable similarity with the 11-65 year standardisation sample. A single sample t-test showed there to be no significant difference between the architecture sample and this standardisation sample. When compared with the school pupil sample, a significant difference did emerge although this is probably too small to be of any practical significance ($t=2.02$, $df=189$, $p=0.045$).

Categorical data

It is also possible to use the ratios for the wholist-analytic and verbal imager dimensions to generate groups of students with similar cognitive styles. Whilst any division of this type is to an extent arbitrary, this reduction of the continuous data to a nominal format is useful in detecting non linear relationships and in tracking the progress of groups of students over time.

The wholist-analytic ratio can be used to categorise students into three groups namely wholists, intermediates and analytics. Riding derives these groups based upon the aforementioned standardisation samples so that a third of the subjects would fall into each division - wholists being the lower third, intermediates being the middle third and analytics being the upper third. He is then able to suggest split points that divide the range of scores into three groups.

Table 5 shows the split points for the three groups based upon Riding's school pupil standardisation sample and shows the percentage of students from the three cohorts of architecture students that fall into each group. As might be expected from the analysis of the continuous data, the highest proportion of students were analytics, a group that represented more than 50% of the students tested. A chi-square (χ^2) test showed this to be highly significant.

	Number	Wholist	Intermediate	Analytic	χ^2
W/A Ratio Range (Based upon School Pupils Standardization Sample)		<=0.91	0.92-1.18	=>1.19	
Cohort 1	51	10 (19.6%)	13 (25.5%)	28 (54.9%)	10.94** (P=0.004)
Cohort 2	69	10 (14.5%)	16(23.2%)	43 (62.3%)	26.8** (P=0.00)
Cohort 3	70	11 (15.7%)	20 (28.6%)	39 (55.7%)	17.5** (P<0.001)
Architecture Students (Three cohorts)	190	31(16.3%)	49(25.8%)	110(57.9%)	54.1**, (P=0.00)
School Pupils (Standardization Sample)	1448	33.3%	33.3%	33.3%	

**Difference is significant at the 0.01 level

Table 5 Percentage of subjects falling into the three sub-categories on the wholist-analytic dimension as defined by the school pupil standardisation sample.

	Number	Wholist	Intermediate	Analytic	χ^2
W/A Ratio Range (Based upon the architecture student's Standardization Sample)		<1.07	1.07 – 1.48	>1.48	
Cohort 1	51	19 (37.3%)	19 (37.3%)	13 (25.5%)	1.412 (p=0.494)
Cohort 2	69	21 (30.4%)	20 (29.0%)	28 (40.6%)	1.652 (p=0.438)
Cohort 3	70	24 (34.3%)	23 (32.9%)	23 (32.9%)	0.029 (p=0.986)
Architecture Students (Three cohorts)	190	64 (33.7%)	62 (32.6%)	64 (33.7%)	

Table 6 Percentage of subjects falling into the three sub-categories on the wholist-analytic dimension as defined by the sample of architecture students.

It was considered that the relatively low numbers of students in the wholist group are likely to present difficulties in conducting further statistical analysis on this dataset. The groups are however entirely arbitrary and there is no scientific reason to continue using Riding's split points, especially if no comparison is being made with other groups of subjects outside the school of architecture. For this reason and in order to aid subsequent analysis, a set of split points based upon the three cohorts of architecture students was chosen that divided the entire sample of 190 into three equal sized groups. These are shown in Table 6. Whilst using these split points there were only 25% of analytics in the first cohort and 40% of analytics in the second cohort, a chi-square test suggested that any variation in the numbers of students in each group within each of the cohorts was insignificant.

In a similar way, the Verbaliser-Imager ratio can be split into three groups namely, Verbaliser, Bimodal and Imager. Table 7 shows the split points for the three groups based upon Riding's school pupil standardisation sample and shows the percentage of students from the three cohorts of architecture students that fall into each group. The results suggest that a higher percentage of Verbalisers exist within the architecture students sample than within the standardisation sample. Again a chi-square test was carried out to investigate the significance of this and whilst the differences were not significant for the cohorts taken individually, when taken as a whole, a significant difference was highlighted.

	Number	Verbaliser	Bimodal	Imager	χ^2
V/I Ratio Range (Based upon school pupils standardization sample)		<=1.01	1.02-1.14	=>1.15	
Cohort 1	51	19 (37.3%)	13 (25.5%)	19 (37.3%)	1.412 (p=0.494)
Cohort 2	69	29 (42.0%)	17 (24.6%)	23 (33.3%)	3.13 (p=0.209)
Cohort 3	70	30 (42.9%)	19 (27.1%)	21 (30.0%)	2.9 (P=0.230)
Architecture Students (Three cohorts)	190	78 (41.1%)	49 (25.8%)	63 (33.2%)	6.64* (P<0.036)
School Pupils (Standardization Sample)	1448	33.3%	33.3%	33.3%	

* Significant at the 0.05 level

Table 7 Percentage of subjects in the three sub categories on the verbaliser - imager dimension as defined by the school pupil standardisation sample.

	Number	Verbaliser	Bimodal	Imager	χ^2
V/I Ratio Range (Based upon architecture students sample))		<0.98	0.98 – 1.15	>1.15	
Cohort 1	51	14 (27.5%)	18 (35.3%)	19 (37.3%)	0.824 (p=0.662)
Cohort 2	69	25 (36.2%)	21 (30.4%)	23 (33.3%)	.348 (p=0.371)
Cohort 3	70	25 (35.7%)	24 (34.3%)	21 (30.0%)	0.840 (p=.831)
Architecture Students (Three cohorts)	190	64 (33.7%)	63 (33.2%)	63 (33.2%)	

Table 8 Percentage of subjects in the three sub categories on the verbaliser-imager dimension as defined by the architecture students' sample.

In order to maintain consistency, a set of split points based upon the three cohorts of architecture students was chosen that divided the entire sample of 190, into three equal sized groups in a similar way to the Wholist-Analytic dimension. These are shown in Table 8

Test Accuracy

Riding (1999a) suggests that the CSA has inbuilt measures for its own reliability. As has been explained earlier, the results from the test are derived from the ratio of response times for carrying out two separate tests. The score is independent of the number of correct responses made by the subject. However the software does provide data for the number of correct responses, and for the overall test speed. As the questions are relatively simple, especially for students in higher education, it is assumed that there would be few incorrect answers. However if the number of correct responses was low (Riding suggests less than 70%) then this may suggest a suspect test result which may have to be removed from any analysis. This may be particularly true where response speed is slow, suggesting that the subject struggled to understand the questions. Conversely, where the number of correct answers is low, and response speed is high, this may suggest that the subject failed to take the test seriously.

With regards to the wholist-analytic ratio, correct scores ranged between 78% and 100% with a mean score of 97.5%. The speed index ranged between 2.12 and 11.2 with a mean value of 5.5[18].

Whilst the values for accuracy are higher than Riding's suggested 70% figure, exploration of the data using statistical tests that detect outliers[19], suggested that any subjects who achieved less than 80% accuracy could be classed as outliers and should be investigated more thoroughly; the

[18] Riding does not provide units for the speed index, or give details of how it is calculated. It appears to represent the average number of answers provided within a fixed time period so that the lower the figure, the slower the test speed.
[19] This was done using Stem and Leaf, Box and normality plots in SPSS

higher value reflecting a presumed high level of ability for university students. One student from the second cohort fell into this category with an accuracy score of 78% and a slow speed index of 2.69. It was thought that the student may have struggled to understand the test instructions; possibly a result of her first language not being English. This result has been removed from further analysis.

With regards to the verbaliser-Imager ratio, correct scores ranged between 58% and 100% with a mean score of 91.5%. The speed index ranged between 5.89 and 1.74 with a mean value of 3.06. It appears the subjects found this test to be more challenging than the wholist-analytic tests, as speeds were slower, and accuracy lower.

As with the wholist-analytic ratio, subjects whose accuracy levels with less than 80% should be investigated more thoroughly. The tests for the Verbal Imager ratio are largely text based, and therefore it is not surprising to see that the majority of subjects who achieved low accuracy scores were those for whom their first language was not English and therefore may have struggled to understand the questions. Six students' results were omitted from further analysis from the first cohort, seven from the second and three from the third.

The CSA software does not provide a full output related to students' responses to each test item and therefore it is not possible to carry out a split half reliability test. Nevertheless, a reasonable degree of consistency between the test results for each cohort, suggests a degree of reliability in terms of its ability to measure a constant personality factor.

Gender

The data was also analysed to determine whether any significant gender differences were present. Table 9 shows the mean values for the wholist-analytic and verbaliser-imager ratios for the three cohorts by gender. Whilst it is difficult to make a full judgement of the effect of gender, given that the number of females approximated only half the number of males, an independent samples t test on the two ratios, with gender as the independent variable, suggested that there were no significant differences between the genders (P=0.57 for the wholist-analytic ratio and P=0.11 for the verbaliser imager ratio). This mirrors Riding's (1999a) findings for the general standardisation sample. Riding (1999b) did detect a significant gender effect for his school pupil sample, but he suggested that this was of little practical significance. Both genders showed results that appeared to be more analytic than the standardisation samples.

	N		Wholist-Analytic Dimension		Verbal-Imager Dimension	
	Male	Female	Male	Female	Male	Female
Architecture students	123	67	1.43 (SD=0.57)	1.36 (SD=0.60)	1.09 (SD=0.18)	1.05 (SD=0.15)
Standardisation sample [a]	496	503	1.30 (SD=0.49)	1.21 (SD=0.39)	1.06 (SD=0.25)	1.07 (0.15)
Standardisation sample [b]	704	744	1.16 (SD=0.54)	1.08 (SD=0.37)	1.12 (SD=0.35)	1.10 (SD=0.18)

[a] Standardisation sample of selection of subjects from across the UK population. (Riding 1999a)
[b] Standardisation sample of secondary school pupils aged 14-16. (Riding 1999b)

Table 9 Mean cognitive style ratios by gender

6.12 Approaches to Study Inventory

51 out of 57 students from the first cohort took the computerised version of the approaches to study inventory. The tests were taken by all students who attended a compulsory IT induction course at the beginning of their first year. However 6 students did not attend the IT sessions, either because they encountered delays in registering for the course or they had personal circumstances that prevented them from attending. However the 90% response rate can be assumed to be a reasonably representative sample of that particular cohort and of students within the school as whole.

For the purpose of this study only the 3 scales related to how students process information whilst learning were used, these are the operations learning, comprehension learning and versatile learning scales. The mean scores for each of these scales is shown in Table 10. The author is not aware of any large scale standardisation samples that these figures might be compared with in the way that was possible with the Cognitive Styles Analysis, however as no attempts are to be made to categorise each scale into nominal groups, then this is less important.

Cohort 1	Mean
Comprehension	14.90 (SD=2.86)
Operation	14.55 (SD=3.51)
Versatile	37.27(SD=3.75)

Table 10 Mean scores for three scales of the approaches to studying inventory (ASI)

6.13 Mental Rotation Test

The MRT(A) test (Peters et al 1995) was administered to 56 out of 74 students from the third cohort during a second IT introduction course some weeks later than they completed the CSA test. The reasons why the 18 students did not attend the session is unknown, but not unusual for absences at such a session. However the sample represented 75% of the cohort and therefore can be assumed to be reasonably representative. Students were given six minutes to complete the tests and within that time students were able to complete between 1 and 22 items. Some students found this test much more challenging than others. The results, classified by gender are shown in Table 11 which compares the scores from the cohort tested with a sample of 636 students form the University of Guelph (Peters et al 1995). The scores from students from the sample of architecture students were significantly higher than those from Peters' sample when compared using a single sample t-test ($t=4.05$, $df=54$, $p<0.01$). Peters also suggested that a gender effect existed such that males would generally score higher than females. This was the case with the school of architecture data and an independent sample t-test, with the two groups defined by gender showed this to be significant ($t=2.79$. $df = 54$ $p<0.01$, equal variances assumed).

	Male			Female			All		
	N	Mean Score	SD	N	Mean Score	SD	N	Mean Score	SD
Cohort 3	37	14.10	3.87	19	11.00	4.08	56	13.05	4.18
University of Guelph)[a]	237	13.64		399	9.18		636	10.8	5.0

a(Sample reported in Peters et al (1995)

Table 11 Mean scores on MRT (A) test compared with those compiled by test's authors

6.14 Post 16 Entry Qualifications

Of the 202 students who formed the three cohorts of students, 169 possessed qualifications that could be easily converted into points using the UCAS system (see Chapter 5 for details on how this was determined). The remaining students were excluded from any analysis regarding entry qualification as it was difficult to make useful comparisons with the less traditional entry qualifications. The mean points scores are shown in Table 12. In order to determine whether a particular cohort's entry profile is typical for the school, the scores for both points score and subject bias are compared to a standardisation sample based upon five cohorts of architecture students who entered the school in the years from 1997 – 2001. The results suggest that the mean number of 'A'-Level points has increased marginally, whilst there is little difference in subject bias. An analysis of variance suggests that there are no significant differences between the three cohorts both in terms of the total 'A'-level points scores and in terms of the student's subject bias between arts and the science based subjects.

	N	A Level Points	Subject Bias
Cohort 1	52	23.3 (SD=6.6)	0.44 (SD=0.28)
Cohort 2	57	25.8 (SD=5.1)	0.50 (SD=0.29)
Cohort 3	58	25.8 (SD=7.3)	0.46 (SD=0.27)
3 Cohorts	167	25.0 (SD=6.48)	0.46 (SD=0.28)
Standardisation sample [a]	422	24.69 (SD=6.16)	0.42 (SD=0.29)

[a]Based upon 422 architecture students in 5 cohorts

Table 12 Mean scores for A Level points and Subject Bias

The standardisation sample was also used to split the cohort into 3 arbitrary groups with respect to subject bias in a similar way that had been done previously with the CSA dimensions. The groups were scientist, all-rounder and artist and the group boundaries were defined so that approximately one third of the subjects from the standardisation sample would fall into the each group. The numbers of students in each group are shown in Table 13 which suggests that in the first cohort, there were a higher proportion of all-rounders than in other cohorts and in the second cohort there was a higher proportion of artistic students than in other cohorts. Chi-Square tests, however suggest that these differences were not significant.

	Number	Scientist	All Rounder	Artist	χ^2
Subject bias – split points		<0.33	0.33-0.5	>0.5	
Cohort 1	52	14 (26.9%)	21 (40.4%)	17 (32.7%)	1.423 (p=0.491)
Cohort 2	57	15 (26.3%)	16 (28.1)	26 (45.6)	3.895 (p=0.143)
Cohort 3	58	18 (31%)	20 (34.5%)	20 (34.5%)	0.138 (p=0.933)
Architecture Students (Three cohorts)	167	47(28.1%)	57 (34.1%)	63 (37.7%)	2.347 (p=0.309)
Standardization Sample (Five cohorts)	422	138 (32.7)	151 (35.7)	133 (31.5)	

Table 13 Numbers of students in each Subject Bias group

Gender

	N		Subject Bias Ratio	
	Male	Female	Male	Female
3 Cohorts	108	61	0.45 (SD=0.28)	0.49 (SD=0.26)

Table 14 Subject Bias Ratio by Gender

The data was also analysed to determine whether any significant gender differences were present. Table 14 shows the mean values for the subject bias ratios for the three cohorts by gender. Whilst it is difficult to make a full judgement of the effect of gender, given that the number of females approximated only half the number of males, an independent samples t-test, with gender as the independent variable, suggested that there were no significant differences between the genders (P=0.27).

6.15 Students' Results

Assessment grades were obtained for design project work, both in terms of individual projects and an end of year aggregate mark. The end of year aggregate marks represent those that were agreed by boards of examiners for the student's design module which constitutes 80/120 credits. The mark therefore does not include any of the marks gained in lecture based modules, or any work assessed as part of those modules that might be related to design project work. In some cases the aggregate mark contains a number of small elements that are not strictly design project work, in that they do not require the students to design something. These may include group research work and essays but on the whole these represent such a small proportion of the students' work that they are unlikely to skew the results. Grades were obtained for all three years of the B.Sc degree for the first 2 cohorts and the first two years for the third cohort. The Mean marks for design work for each of the three cohorts are shown in Table 15 which shows a consistency of grading at all stages of the course with mean marks approximating 60%. Table 16 suggests that this figure applies for both genders, with neither gender performing significantly better than the other.

	End of 1st Year			End of 2nd Year			End of 3rd Year		
	Mean	SD	N	Mean	SD	N	Mean	SD	N
Cohort 1	60.19	7.6	56	58.38	10.88	53	59.31	6.1	46
Cohort 2	60.56	8.26	67	59.49	9.86	67	60.01	8.5	62
Cohort 3	59.01	12.0	70	59.24	9.67	61	N/A		

Table 15 Mean marks for design

Mean Design Mark		End of 1st Year		End of 2nd Year		End of 3rd Year	
		Male	Female	Male	Female	Male	Female
Cohort 1	Mean	59.85	61.12	57.86	59.69	59.01	60.06
	SD	7.29	8.82	11.04	10.73	6.05	6.45
	N	41	15	38	15	33	13
Cohort 2	Mean	61.7	58.9	60.22	58.41	60.57	59.63
	SD	7.33	9.30	9.74	10.14	8.43	9.22
	N	39	28	40	27	36	23
Cohort 3	Mean	58.86	59.30	59.49	58.79		
	SD	9.6	15.8	8.82	11.23		
	N	46	24	39	22		

Table 16 Mean design marks by gender

6.2 Comparisons between tests

The results shown in Table 17 show no significant correlations between subject bias and cognitive style. Neither do the results here suggest that there are any significant correlations between either of the cognitive style dimensions and the results of the Mental Rotation test. Nor do the results suggest a significant link between the information processing scales of the Approaches to Studying Inventory and the Cognitive Styles Analysis.

Pearson Correlation		Cognitive Styles Analysis		Subject Bias
		Wholist Analytic	Verbaliser Imager	
CSA Verbaliser - Imager Scale	Correlation	.075		
	Sig. (2-tailed)	.304		
	N	190		
Subject Bias	Correlation	.114	.069	
	Sig. (2-tailed)	.152	.388	
	N	159	159	
Total A-Level Point Score	Correlation	0.019	0.050	-0.057
	Sig. (2-tailed)	0.808	0.531	0.465
	N	159	159	169
ASI Comprehension Learning Scale	Correlation	-.109	.212	.214
	Sig. (2-tailed)	.447	.135	.145
	N	51	51	48
ASI Operation Learning Scale	Correlation	.003	-.205	.275
	Sig. (2-tailed)	.984	.148	.058
	N	51	51	48
ASI Versatile Learning Scale	Correlation	-.188	-.117	.075
	Sig. (2-tailed)	.186	.415	.612
	N	51	51	48
Mental Rotation Test	Correlation	-.204	-.158	-.173
	Sig. (2-tailed)	.135	.249	.249
	N	55	55	46

Table 17 Correlation coefficients between measurement scales

6.3 Relationships between measurements of individual differences and marks for design work

6.31 Cognitive Styles Analysis

Wholist-Analytic Dimension

Continuous Data

Table 18 shows the correlations between design mark and the Wholist-Analytic dimension of cognitive style and Table 19 shows the same when the cohort is split by gender. The correlation was calculated using the non-parametric Spearman's Rho method as the data for student design marks needed to be transformed into rank format for reasons described earlier. No outliers were removed from the data, except for those test results disregarded due to poor test accuracy (see chapter 5).

Results from the first cohort's first year suggested that a positive correlation existed between the students' marks in design and their cognitive style as measured by cognitive styles analysis, such that the more analytic students were, the more likely they were to gain a better mark ($r=0.442$). This was significant to the 0.01 level. By taking the square of the correlation coefficient (r) it is possible to estimate the percentage of the variance for which cognitive style is likely to account. In the first year this amounted to approximately 19%. The positive correlation was also reflected in the second year, albeit with a lower degree of significance. Here cognitive style appeared to account for a lower 11% of the variance in the students' marks. By the end of third year however, the results produced very low and insignificant correlations.

By contrast to the first cohort, there were no significant correlations between design mark and the wholist-analytic dimension for the second and third cohorts. Nevertheless, female students did show a correlation between their cognitive style and design mark in the third cohort's first year.

Spearman's rho		End of 1st Year	End of 2nd Year	End of 3rd Year
Cohort 1	Correlation Coefficient	0.442(**)	0.343(*)	0.030
	Sig. (2-tailed)	0.001	0.028	0.861
	N	50	41	37
Cohort 2	Correlation Coefficient	0.014	0.009	0.005
	Sig. (2-tailed)	0.913	0.946	0.970
	N	60	57	51
Cohort 3	Correlation Coefficient	0.123	0.173	N/A
	Sig. (2-tailed)	0.322	0.186	
	N	67	60	

** Correlation is significant at the 0.01 level (2-tailed).
* Correlation is significant at the 0.05 level (2-tailed).

Table 18 Correlation of Design mark with wholist-analytic Ratio

Spearman's rho		End of 1st Year		End of 2nd Year		End of 3rd Year	
		Male	Female	Male	Female	Male	Female
Cohort 1	Correlation Coefficient	0.355(*)	0.601	0.290	0.535	-0.230	0.553
	Sig. (2-tailed)	0.027	0.050	0.114	0.111	0.249	0.097
	N	39	11	31	10	27	10
Cohort 2	Correlation Coefficient	-0.097	0.217	-0.014	0.201	-0.127	0.144
	Sig. (2-tailed)	0.579	0.297	0.937	0.359	0.496	0.544
	N	35	25	34	23	31	20
Cohort 3	Correlation Coefficient	-0.085	0.419(*)	0.203	0.209	N/A	
	Sig. (2-tailed)	0.582	0.046	0.216	0.364		
	N	44	23	39	21		

** Correlation is significant at the 0.01 level (2-tailed).
* Correlation is significant at the 0.05 level (2-tailed).

Table 19 Correlation of design mark with wholist-analytic Ratio, split by gender

Categorical Data

Each of the cohorts was split into three arbitrary cognitive style sub groups of wholist, intermediate and analytic, using the architecture students sample of CSA ratios to provide the split points from which each group could be defined (see Table 6). The mean percentile-rank for each group was calculated and the non parametric, Kruskal Wallis H test, was used to test for a significant difference between each of the groups. This data was also used to monitor the longitudinal changes in the mean percentile-ranks for each group over time. To test the significance of this, a repeated measures t-test was used. Given the data is ranked, it would seem beneficial to use a non-parametric test for this (for instance the Wilcoxon Signed Ranks test). This however presents substantial difficulties as such tests refer to changes in rank position within the individual group, rather than with respect to the cohort as a whole. It was felt that a related samples t-test was sufficiently robust to be useful even with ranked data.

First Cohort

Table 20 shows the mean percentile ranks for the wholist, intermediate and analytic sub groups for the three years of the first cohort's undergraduate course. These are also shown in graphical form in Figure 9. In the first two years analytic students on average achieved higher rank positions than intermediates, who in turn attained higher rank positions than wholists. By the students' third year, all three groups appeared to have converged to a similar level, the analytic students having fallen by an average of 13 percentiles. A Kruskal-Wallis Test showed the differences in the mean percentile-ranks for students in the three cognitive style groups to be significant (p=0.024) in their first year and less significant (p=0.095) for their second year. There were no significant differences by the student's third year, highlighting the apparent convergence of the three groups' results. A related samples t-test comparing the students' percentile-ranks at the end of year 1 and their positions at the end of year 3 shows the fall in the position of the analytic students to be significant (P=0.033). Changes for the intermediate and wholist students did not appear to be significant. It should be noted that any improvement in the rank position of wholist students would lead to an apparent fall in the performance of analytic students as they are forced to take up lower rank positions within the cohort which may explain some of the apparent convergence of mean rank positions.

Cohort 1		Wholist Analytic Groups					
		Wholist	Intermediate	Analytic	Total	Kruskal Wallis	
Year 1	Mean	37.00	54.74	64.92	51.00	χ^2	7.428
	N	18	19	13	50	df	2
	Std. Deviation	27.78	29.16	23.99	29.15	Sig	.024 (*)
Year 2	Mean	40.24	48.32	64.92	51.22	χ^2	4.707
	N	12	16	13	41	df	2
	Std. Deviation	28.45	28.64	27.26	29.22	Sig	.095
Year 3	Mean	50.75	50.51	52.93	51.35	χ^2	.052
	N	9	16	12	37	df	2
	Std. Deviation	32.48	30.01	28.31	29.26	Sig	.974
t-Test	t	.170	1.085	2.434			
	df	8	15	11			
	p	.869	.295	.033*			

*significant at the 0.05 level (2-tailed).

Table 20 Cohort 1: Mean percentile-rank in cohort for wholist, intermediate and analytic students

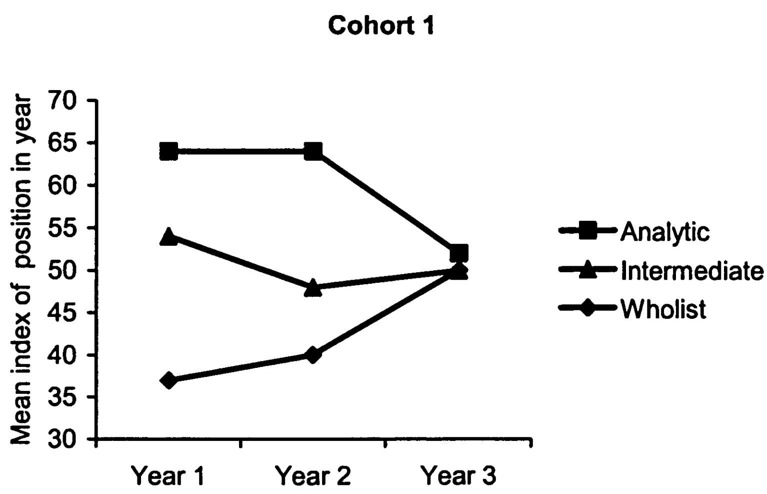


Figure 9 Mean percentile-rank in cohort for wholist, intermediate and analytic students

Table 21 illustrated in Figure 10 shows a similar analysis conducted with the sample split by gender. It suggests that female wholists generally achieved lower design marks than any other groups and that female analytics were generally better positioned in the cohort. A Kruskal-Wallis Test showed this to be significant in the students' first year (P=0.038).

Whilst the trends for males appear to mirror those for all students, the graph suggests that male wholists performed particularly well in their third year. This, was not however statistically significant. It should be noted that the sample size is low especially with regard to the numbers of females and so results with respect to gender should be regarded with some degree of caution.

Cohort 1		Wholist Analytic Groups										
		Wholist		Intermediate		Analytic		Total		Kruskal Wallis		
		M	F	M	F	M	F	M	F		M	F
Year 1	Mean	40.9	26.8	48.5	78.0	62.5	78.0	49.9	54.7	χ^2	3.32	6.54
	N	13	5	15	4	11	2	39	11	df	2	2
	SD	29.8	20.7	26.8	28.6	24.2	25.4	27.8	34.6	Sig	0.19	0.03
Year 2	Mean	40.8	39.0	43.9	61.5	62.0	80.4	49.5	56.3	χ^2	2.51	4.41
	N	8	4	12	4	11	2	31	10	df	2	2
	SD	32.7	21.5	28.7	27.6	28.5	13.8	30.2	26.5	Sig	0.28	0.11
Year 3	Mean	70.2	26.3	47.3	60.1	47.3	81.0	51.5	50.8	χ^2	2.46	5.12
	N	5	4	12	4	10	2	27	10	df	2	2
	SD	23.6	25.2	32.3	22.6	26.6	22.9	29.2	30.8	Sig	0.29	0.07

*significant at the 0.05 level (2-tailed).

Table 21 Cohort 1: Mean percentile-rank in year for wholist, intermediate and analytic students by gender

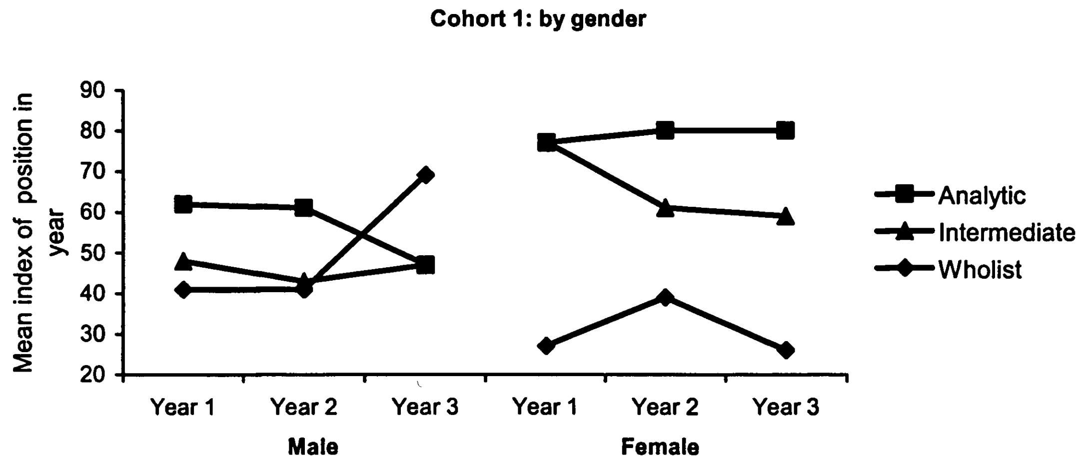


Figure 10 Mean percentile-rank in cohort for wholist, intermediate and analytic students by gender

Student drop-out

Table 22 shows that in the first cohort, 14 (27.5%) of the subjects initially given the CSA test, had left the cohort by the end of their 3rd year. It is notable that over 52% of wholists had left the cohort by this time, and a chi-square analysis suggests that this is highly significant ($p<0.01$).

Cohort 1		Wholist Analytic Group					
	Wholist	Intermediate	Analytic	Total		Sig	
Male	Count	8	3	1	12	χ^2	9.021
	Expected Count	4.0	4.6	3.4	12	df	2
	% of each group that left cohort	61.5%	20.0%	9.1%	30.8%	sig	0.011*
Female	Count	2	0	0	2	χ^2	2.400
	Expected Count	1.0	0.7	0.3	2	df	2
	% of each group that left cohort	33.3%	.0%	.0%	16.7%	sig	0.301
All Students	Count	10	3	1	14	χ^2	9.895
	Expected Count	5.2	5.2	3.6	14	df	2
	% of each group that left cohort	52.6%	15.8%	7.7%	27.5%	sig	0.007**

Table 22 Cohort 1: Number of students who left the cohort

<u>Second Cohort</u>

Table 23 shows the mean percentile-ranks for the wholist, intermediate and analytic sub groups for the three years of the second cohort's undergraduate course; these are also shown in graphical form in Figure 11. As with the first cohort, in the first two years, analytic students were on average claiming higher rank positions than the other two groups, however this time, it was the intermediates, rather than the wholists who attained the lowest positions in the cohort. By the students' third year, the wholist and analytic students had converged to similar levels whilst the intermediates appeared to show an improvement of 20 percentiles. A Kruskal-Wallis test suggested that the differences in the mean percentiles for the three cognitive style groups were not significant during any of the three years. Moreover, the apparent improvement in the position of the intermediates is not shown to be significant by a related samples t-test comparing the intermediate students' percentile-ranks at the end of year 1 with their position at the end of year 3. It is likely that this phenomenon was the result of a small number of students skewing the results. The change in the percentile-ranks for the analytic students was however significant (P<0.01), which is comparable with the first cohort's results suggesting a relative decline in the mean position of analytic students. Changes to the positions of wholist students do not appear to be significant.

Cohort 2:		Wholist Analytic Groups					
		Wholist	Intermediate	Analytic	Total	Kruskal Wallis	
Year 1	Mean	49.54	42.19	57.05	50.83	χ^2	2.634
	N	18	16	26	60	df	2
	Std. Deviation	27.38	30.45	29.05	29.11	Sig	0.268□
Year 2	Mean	48.71	46.24	55.30	50.88	χ^2	1.014
	N	19	14	24	57	df	2
	Std. Deviation	31.72	30.34	26.82	29.12	Sig	0.602□
Year 3	Mean	46.45	62.58	48.08	50.98	χ^2	2.515
	N	16	12	23	51	df	2
	Std. Deviation	34.48	25.19	26.57	29.15	Sig	0.284□
t-test	t	0.46	-1.05	3.26			
	df	14	11	22			
	p	0.650	0.313	0.004			

Table 23 Cohort 2:Mean percentile rank in cohort for wholist, intermediate and analytic students

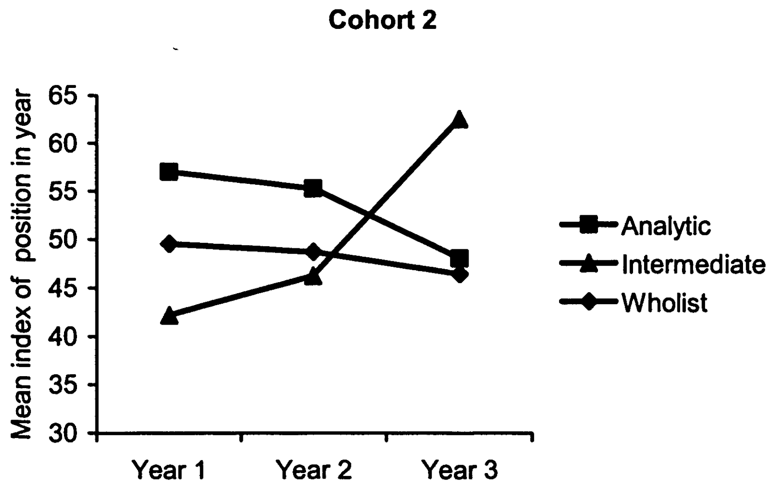


Figure 11 Cohort 2: Mean percentile-rank in cohort for wholist, intermediate and analytic students

Table 24, illustrated in Figure 12, shows a similar analysis conducted with the sample split by gender. The graph suggests that the apparent low initial position and subsequent improvement of the intermediate students shown for the whole cohort is particularly apparent amongst females. A Kruskal-Wallis Test suggested that the female intermediates achieved significantly lower positions than the wholists and analytics during their first and second years ($P<0.05$) but the apparently improved position for intermediates by third year, such that they now have a higher mean rank positions than the wholists and analytics was not shown as significant. There were no significant differences between the three groups for male students.

Cohort 2		Wholist-Analytic Group								Kruskal Wallis		
		Wholist		Intermediate		Analytic		Total				
	Gender	M	F	M	F	M	F	M	F		M	F
Year 1	Mean	53.8	40.8	58.1	21.6	57.8	56.1	56.5	42.8	χ^2	0.20	6.76
	N	12	6	9	7	14	12	35	25	df	2	2
	SD	29.9	20.8	28.1	19.7	28.1	31.3	27.9	29.3	Sig	0.90	0.03
Year 2	Mean	48.0	50.1	61.8	25.4	56.7	53.5	54.6	45.3	χ^2	0.96	6.11
	N	13	6	8	6	13	11	34	23	df	2	2
	SD	35.3	25.0	19.3	31.0	30.5	22.9	30.0	27.3	Sig	0.61	0.04
Year 3	Mean	51.1	36.0	62.0	63.7	50.9	44.9	53.8	46.4	χ^2	1.26	2.06
	N	11	5	8	4	12	11	31	20	df	2	2
	SD	35.8	32.5	22.5	33.7	21.3	32.0	27.1	32.2	Sig	0.53	0.35

Table 24 Cohort 2: Mean percentile-rank position in cohort by gender

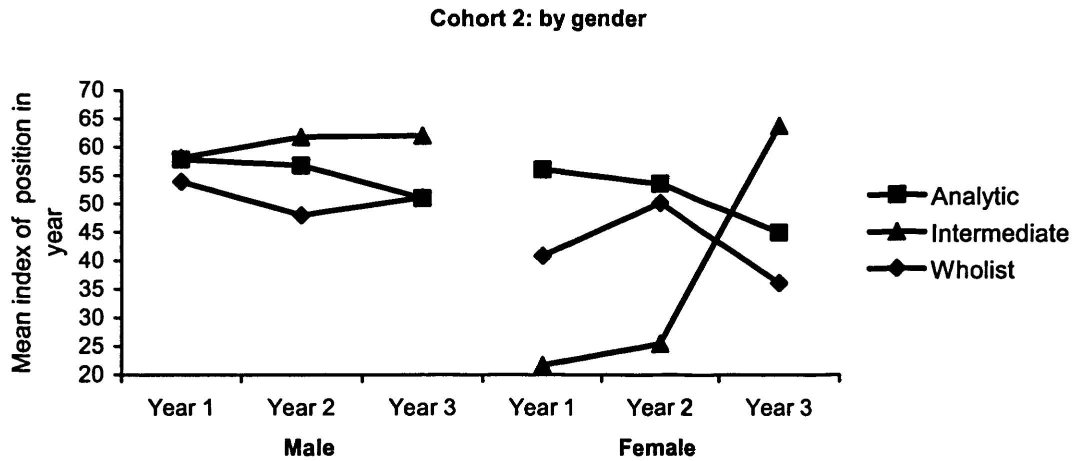


Figure 12 Cohort 2: Mean percentile-rank position in cohort by gender

Student Dropout

The percentage of students who left the cohort for what ever reason is shown in Table 25, which shows that 24.6% of the subjects initially given the CSA test had left the cohort by the end of the 3rd year. Unlike the first cohort the number of wholists who left the cohort was not excessive compared with the other groups. It did appear that rather more intermediate students had left the cohort, but this was not shown to be significant by a chi-square test.

Cohort 2 Gender		Wholist-Analytic Group			Total	χ^2	
		Wholist	Intermediate	Analytic			
Male	Count	2	2	4	8	χ^2	0.409
	Expected Count	2.7	2.1	3.2	8	df	2
	% of each group that left cohort	15.4%	20.0%	25.0%	20.5%	sig	0.815
Female	Count	3	5	1	9	χ^2	4.802
	Expected Count	2.4	2.7	3.9	9.	df	2
	% of each group that left cohort	37.5%	50.0%	8.3%	30.0%	sig	0.091
All Students	Count	5	7	5	17	χ^2	1.858
	Expected Count	5.3	4.8	7.0	17	df	2
	% of each group that left cohort	23.8%	35.0%	17.9%	24.6%	sig	0.395

Table 25 Cohort 2: Number of students who left the cohort

Third Cohort

The results for each of the three cognitive style groups is shown in Table 26 and when split by gender in Table 27. The results from the previous two cohorts suggest that there may be a decline in the relative position within the cohort of analytic students, but this is most apparent in the students' third year. At the time of writing this data was not available for the third cohort and so it is not possible to draw similar conclusions. Nevertheless, in common with the first two cohorts, the mean percentile-rank for analytic students was higher than the wholist and intermediate students in the first two years, although this was not statistically significant. In reality full conclusions on this can only be made once a student's final year examinations had been taken into account. At the time of writing, insufficient students had left the cohort to carry out a chi-square test of significance on student drop out.

Cohort 3		Wholist-Analytic Group					
		Wholist	Int	Analytic	Total	Kruskal Wallis	
Year 1	Mean	48.27	46.64	57.04	50.74	χ^2	1.675
	N	22	22	23	67	df	2
	Std. Deviation	29.27	27.68	30.37	29.08	Sig	0.433
Year 2	Mean	46.58	47.89	57.53	50.83	χ^2	1.735
	N	20	19	21	60	df	2
	Std. Deviation	33.58	25.31	27.88	29.10	Sig	0.420

Table 26 Cohort 3: Mean percentile-rank in cohort for wholist, intermediate and analytic students

Cohort 3		Wholist-Analytic Group										
		Wholist		Intermediate		Analytic		Total		Kruskal Wallis		
		M	F	M	F	M	F	M	F		M	F
Year 1	Mean	57.0	37.7	43.8	54.1	51.7	69.0	50.3	51.5	χ^2	1.56	3.54
	N	12	10	16	6	16	7	44	23	df	2	2
	SD	30.9	24.6	26.2	32.5	26.9	36.4	27.7	32.2	Sig	.456	0.17
Year 2	Mean	45.7	47.5	44.2	58.0	60.8	50.9	50.6	51.1	χ^2	2.89	0.34
	N	11	9	14	5	14	7	39	21	df	2	2
	SD	35.9	32.5	23.9	29.0	25.1	33.8	28.5	30.9	Sig	.236	0.84

Table 27 Cohort 3: Mean percentile-rank in cohort for wholist, intermediate and analytic students by gender

Project by project analysis

A project by project analysis was carried out looking at the average position in the cohort for each group of wholist, intermediate and analytic. It was noticeable from the analysis that analytics achieved higher average positions in each of the cohorts than the other two groups, for a large number of projects, particularly those in the early stages of the student's education. In the first cohort a number of these results were statistically significant. In one project, the Space and Structure project, this was significant to the 0.01 level.

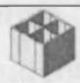
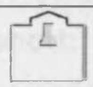
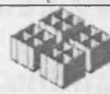
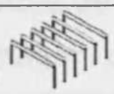
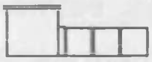
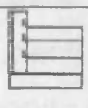
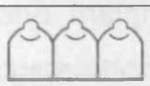
Summary of Design Projects Undertaken				
	Typical Projects	Cohort 1: 1999-2002	Cohort 2: 2000-2003	Cohort 3: 2001-2004
First Year Projects				
	**House 1.** A small scale house, using traditional construction	W=46 I=46 A=63	W=54 I=40 A=55	W=44 I=48 A=59
	**House 2** A small scale house inspired by 20th Century Precedents	W=45 I=53 A=55	W=48 I=50 A=52	W=53 I=45 A=53
	Warm Up Short Project to prepare students for major design	W=49 I=53 A=48	*Not Run in this cohort*	W=51 I=45 A=53
	**Major First year design** Small public building encompassing a sequence of spaces	**W=36 I=57 A=52**	W=44 I=45 A=59	W=47 I=45 A=56
Second Year Projects				
	**Summer Project** Short untutored project		W=47 I=48 A=55	W=53 I=49 A=50
	**Urban Housing Project.** Town study followed by design of small group of houses	**W=45 I=47 A=63**	W=49 I=51 A=52	W=48 I=50 A=55
	**Space and Structure** Design of a large span building	**W=33 I=53 A=65**	*Not Run in this cohort*	W=50 I=50 A=53
	**Major Second Year Design** Community building, combining large and small spaces	W=44 I=50 A=60	W=52 I=51 A=50	W=47 I=48 A=56
			W=52 I=35 A=59	
Third Year Projects				
	**Urban Design** Group study and urban intervention	W=46 I=55 A=49	*Not run in this cohort*	
	**Autumn Semester Project** An office or academic building , often with a number of repeating units.	W=49 I=53 A=50	W=46 I=65 A=46	*Completed after the submission of this thesis*
	**Degree Project** Major public building with complex brief	W=50 I=49 A=54	W=45 I=63 A=47	

Table 28 Mean percentile-ranks in projects undertaken by students during the research.

Key: [light grey] *Analytic dominant,*
[dark grey] *Analytic dominant, statistically significant ($p<0.05$)*

Summary

The results from the first cohort suggest that there may be a significant relationship between cognitive style and the students' performance in design project work although this became less significant as the students progressed through the school. The relative position of analytic students within the cohort appears to be higher than wholist and intermediate students at the end of the first year but then declines significantly as students progress through the school. Whilst the correlations between design performance and cognitive style were not significant in the second cohort, the rank positions of analytic students still declined significantly between the first and third year. A high proportion of wholists left the first cohort, but this did not appear to be replicated in subsequent years.

6.32 Verbal-Imager Dimension

Continuous Data

Table 29 shows the correlations between design mark and the verbaliser-imager dimension of cognitive style. Table 30 does likewise with the sample split by gender. The correlation was calculated using the Spearman's Rho method as the data for student design marks needed to be transformed into rank format for reasons described earlier. No outliers were removed from the data except for those test results disregarded due to poor test accuracy (see chapter 5)

Results from all three cohorts, suggested that correlations between a student's mark in design, and their cognitive style as measured by Cognitive Styles Analysis on the verbaliser-imager dimension were small and insignificant when the cohorts were taken as a whole. Significant correlations did appear with female students in the first year of the second cohort and the second year of the third cohort.

Spearmans-rho		End of 1st Year	End of 2nd Year	End of 3rd Year
Cohort 1	Correlation Coefficient	-.035	-.054	.132
	Sig. (2-tailed)	.823	.752	.464
	N	44	37	33
Cohort 2	Correlation Coefficient	.219	.147	.114
	Sig. (2-tailed)	.108	.300	.451
	N	55	52	46
Cohort 3	Correlation Coefficient	.147	.084	
	Sig. (2-tailed)	.247	.530	NA
	N	64	58	

** Correlation is significant at the 0.01 level (2-tailed).

Table 29 Correlation of design mark against verbaliser-imager ratio

Spearmans-rho		End of 1st Year		End of 2nd Year		End of 3rd Year	
		Male	Female	Male	Female	Male	Female
Cohort 1	Correlation Coefficient	-.022	-.073	.075	-.305	.340	-.140
	Sig. (2-tailed)	.903	.831	.711	.392	.113	.699
	N	33	11	27	10	23	10
Cohort 2	Correlation Coefficient	-.001	.417(*)	.060	.253	.113	.212
	Sig. (2-tailed)	.995	.038	.757	.245	.582	.369
	N	30	25	29	23	26	20
Cohort 3	Correlation Coefficient	.073	.195	-.087	.440(*)		
	Sig. (2-tailed)	.652	.373	.608	.046	NA	
	N	41	23	37	21		

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

Table 30 Correlation of design mark against verbaliser-imager ratio by gender

Categorical Data

A similar analysis to that carried out for the wholist-analytic dimension, based upon the three categorical groups of verbaliser, bimodal and imager was also carried out for the three cohorts. The split points between groups were calculated using the sample of architecture students as described earlier.

First Cohort

Table 31 shows the mean percentile-ranks for the verbaliser, bimodal and imager sub groups for the three years of the first cohort's undergraduate course; these are also shown in graphical form in Figure 13. In the first year, it would appear that there is little difference between mean percentile-ranks for the three groups, this was followed by a decline in the relative position of imagers in the second year. By the students' third year, imagers appear to have improved in their rank positions, whilst verbalisers appeared to decline. A Kruskal-Wallis Test suggested no significant differences existed between the mean percentile-ranks of each group for any of the years of study. A related samples t-test comparing the students' mean percentile ranks at the end of year 1 and their position at the end of year 3 suggested that any changes in rank position were not significant for either of the three style groups. However the improvement of the imagers between 2nd and 3rd year was significant ($t=2.4$, $df=13$, $p=0.028$).

Cohort 1		Verbal Imager Group					
		Verbaliser	Bimodal	Imager	Total	Kruskal Wallis	
Year 1	Mean	56.00	52.12	51.88	52.91	χ^2	.155
	N	10	17	17	44	df	2
	Std. Deviation	28.03	30.47	29.61	28.96	Sig	.925
Year 2	Mean	57.49	50.91	46.17	50.36	χ^2	.575
	N	7	16	14	37	df^2	2
	Std. Deviation	27.59	35.02	26.22	30.05	Sig	.750
Year 3	Mean	46.33	50.77	59.46	52.99	χ^2	1.010
	N	7	14	12	33	df^2	2
	Std. Deviation	26.68	30.36	29.09	28.75	Sig	.603
t-test	t	1.905	1.147	.370			
between	df	6	13	11			
years 1 & 3	p	.105	.272	.718			

Table 31 Cohort 1: Mean percentile-rank in cohort for verbaliser, bimodal and imager students

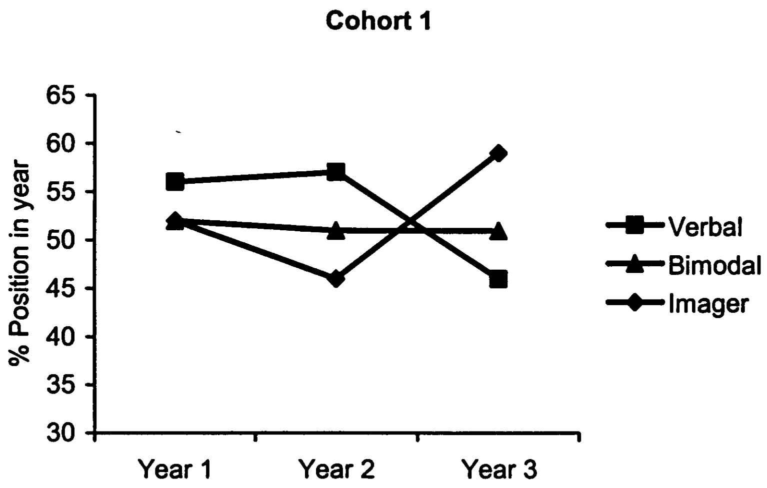


Figure 13 Mean percentile-rank in cohort for verbalisers, bimodals and imagers

Table 32 illustrated in Figure 14 shows a similar analysis conducted with the sample split by gender. The graph suggests that female bimodals generally achieve lower design marks than any other groups and that male verbalisers tend to decline in rank position as they progress through the school. A Kruskal-Wallis Test however, showed there to be no significant differences in mean percentile-rank between the three groups for any of the years of study. Furthermore, a repeated measures t-test also suggested that any change in rank position within each group was not statistically significant. As with the wholist-analytic dimension, it should be noted that the sample size is low, especially with regard to the numbers of females and so results with respect to gender should be regarded with some degree of caution.

Cohort 1		Verbal Imager Group											
		Verbaliser		Bimodal		Imager		Total		Kruskal Wallis			
		M	F	M	F	M	F	M	F		M	F
Year 1	Mean	54.2	60.0	56.6	37.5	46.9	68.0	52.3	54.7	χ^2	.603	1.30
	N	7	3	13	4	13	4	33	11	df	2	2
	Std. Deviation	27.1	36.0	26.4	42.2	29.7	26.1	27.4	34.6	Sig	.740	.521
Year 2	Mean	46.9	71.5	52.9	42.2	42.4	55.4	48.1	56.3	χ^2	.439	1.20
	N	4	3	13	3	10	4	27	10	df^2	2	2
	Std. Deviation	30.8	18.3	35.7	37.5	27.6	22.9	31.4	26.5	Sig	.803	.546
Year 3	Mean	35.1	61.2	56.0	31.5	60.4	57.4	53.9	50.8	χ^2	2.49	1.65
	N	4	3	11	3	8	4	23	10	df^2	2	2
	Std. Deviation	8.55	37.9	28.0	36.7	33.6	21.2	28.4	30.8	Sig	.288	.437
t-test	t	2.65	-.60	.810	.782	-.24	1.60					
between	df	3	2	10	2	7	3					
years 1 & 3	p	.077	.608	.437	.516	.816	.206					

Table 32 Cohort 1: Mean percentile-rank in cohort for verbaliser, bimodal and imager students by gender

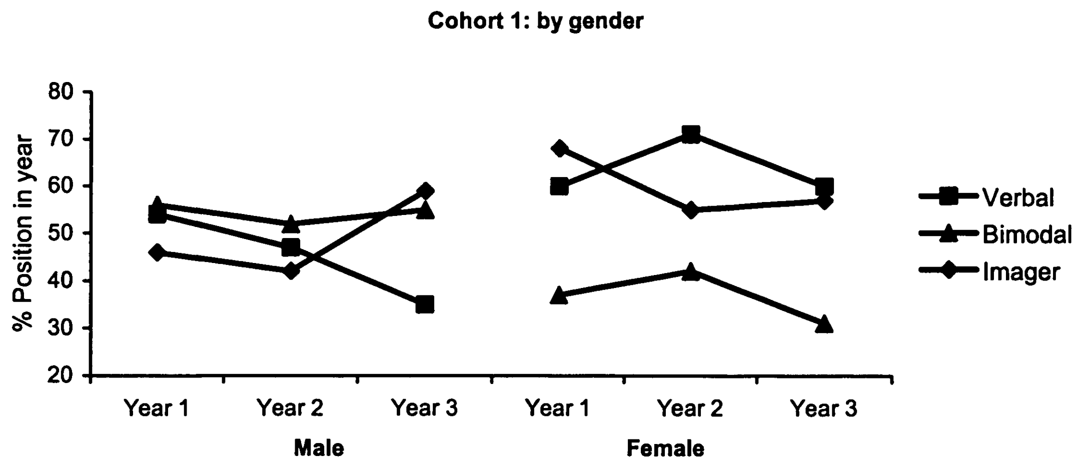


Figure 14, Mean percentile-ranks in cohort for verbalisers, bimodals and imagers by gender

Student Dropout

Table 33 suggests that unlike the wholist-Analytic scores for this cohort, there were no significant differences between each of the three groups with respect to students leaving the cohort for what ever reason.

Cohort 1	Verbaliser- Imager Group					
	Verbaliser	Bimodal	Imager	Total		
Male Count	3	2	5	10	χ^2	2.302
Expected Count	2.1	3.9	3.9	10.0	df	2
% of each group that left cohort	42.9%	15.4%	38.5%	30.3%	Sig	0.316
Female Count	1	1	0	2	χ^2	1.200
Expected Count	.7	.7	.7	2.0	df	2
% of each group that left cohort	25.0%	25.0%	.0%	16.7%	Sig	0.549
All Students Count	4	3	5	12	χ^2	1.302
Expected Count	2.9	4.5	4.5	12.0	df	2
% of each group that left cohort	36.4%	17.6%	29.4%	26.7%	Sig	0.522

Table 33 Cohort 1: Number of students who left the cohort

Cohort 2

Table 34 shows the mean percentile-rank for the verbaliser, bimodal and imager sub groups for the three years of the second cohort's undergraduate course, these are also shown in graphical form in Figure 15. The results bear little similarity to those of the first cohort, with imagers showing a higher mean percentile-rank for all three years. There is a minor improvement in the position of the bimodal students in the second year, but this disappears by the students' third year. As with the previous cohort, a Kruskal-Wallis Test suggested no significant differences between the mean percentile–ranks of each group for any of the years of study. A related samples t-test comparing the students' mean percentile position at the end of year 1 and their position at the end of year 3 suggested that any changes in rank position were not significant for either of the three style groups

Cohort 2		Verbal Imager Group					
		Verbaliser	Bimodal	Imager	Total	Kruskal Wallis	
Year 1	Mean	45.04	47.79	60.00	50.91	χ^2	2.904
	N	22	14	19	55	df	2
	Std. Deviation	32.26	25.52	26.91	29.13	Sig	.234
Year 2	Mean	42.86	52.88	57.91	50.96	χ^2	2.554
	N	19	15	18	52	df^2	2
	Std. Deviation	27.16	30.17	29.83	29.14	Sig	.279
Year 3	Mean	45.36	47.49	58.45	51.09	χ^2	1.922
	N	15	13	18	46	df^2	2
	Std. Deviation	22.62	33.70	30.57	29.18	Sig	.382
t-test	t	1.921	-.338	.630			
between	df	14	11	17			
years 1 & 3	p	.075	.742	.537			

Table 34 Cohort 2: Mean percentile-rank in cohort for verbaliser, bimodal and imager students

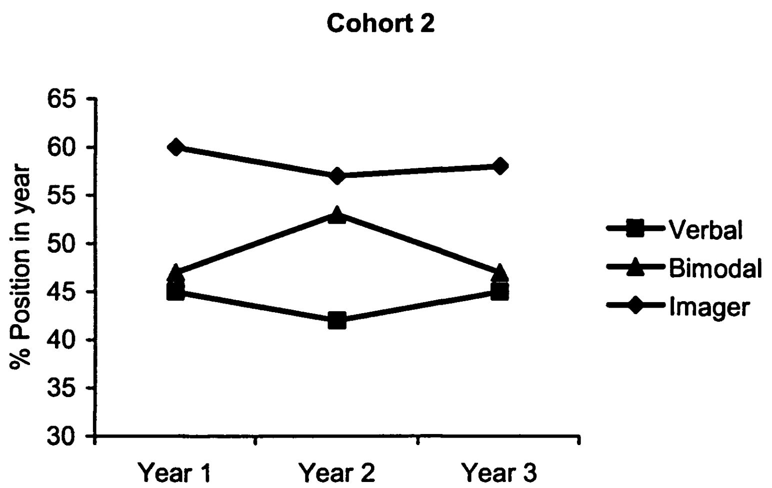


Figure 15 Cohort 2: Mean percentile-ranks in year for verbalisers, bimodals and imagers

Table 35 illustrated in Figure 16 shows a similar analysis conducted with the sample split by gender. Unlike the previous cohort, the graph suggests that female verbalisers, rather than bimodals, generally achieve lower design marks than any other groups, although the female bimodals' positions are still low compared to the male groups, except in their second year. A Kruskal-Wallis Test however, showed there to be no significant differences in mean percentile-ranks between the three groups for any of the years of study. Furthermore, a repeated measures t-test also suggested that any change in rank position within each group was not statistically significant. As with the wholist-analytic dimension, it should be noted that the sample size is low especially with regard to the numbers of females and so results with respect to gender should be regarded with some degree of caution.

Cohort 2		Verbal Imager Group										
		Verbaliser		Bimodal		Imager		Total		Kruskal Wallis		
		M	F	M	F	M	F	M	F		M	F
Year 1	Mean	53.9	34.3	56.3	39.2	60.9	58.6	57.0	43.4	χ^2	.373	3.23
	N	12	10	7	7	11	8	30	25	df	2	2
	SD	31.3	31.4	27.3	22.1	27.1	28.3	28.1	29.0	Sig	.830	.198
Year 2	Mean	50.6	32.2	52.6	53.1	64.0	50.2	55.8	44.8	χ^2	1.32	1.68
	N	11	8	8	7	10	8	29	23	df^2	2	2
	SD	28.3	23.0	32.8	29.4	30.8	28.5	29.9	27.4	Sig	.516	.431
Year 3	Mean	52.1	35.1	51.2	43.1	59.7	56.7	54.8	46.2	χ^2	.697	2.01
	N	9	6	7	6	10	8	26	20	df^2	2	2
	SD	18.7	25.7	34.3	35.5	27.7	35.6	26.2	32.6	Sig	.706	.365
t-test	t	1.10	1.70	-.27	-.17	.73	.16					
between	df	9	4	5	5	9	7					
years 1 & 3	p	.298	.164	.795	.871	.479	.872					

Table 35 Cohort 2: Mean percentile-rank in cohort for verbaliser, bimodal and imager students by gender

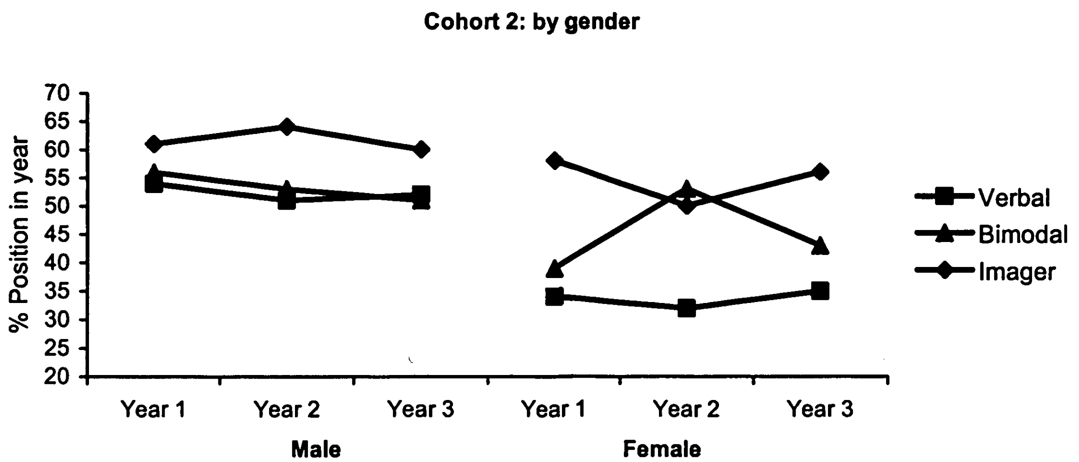


Figure 16 Cohort 2:Mean percentile-ranks in cohort for verbalisers, bimodals and imagers by gender

Student Dropout

Table 36 suggests that as with the previous cohort, there are no significant differences between each of the three groups with respect to students leaving the cohort for what ever reason.

Cohort 2	Verbaliser- Imager Group				χ^2	
	Verbaliser	Bimodal	Imager	Total		
Male Count	4	2	2	8	χ^2	0.701
Expected Count	3.1	2.1	2.8	8.0	df	2
% of each group that left cohort	30.8%	22.2%	16.7%	23.5%	Sig	0.704
Female Count	5	2	1	8	χ^2	2.931
Expected Count	3.1	2.3	2.6	8.0	df	2
% of each group that left cohort	45.5%	25.0%	11.1%	28.6%	Sig	0.231
All Students Count	9	4	3	16	χ^2	3.216
Expected Count	6.2	4.4	5.4	16.0	df	2
% of each group that left cohort	37.5%	23.5%	14.3%	25.8%	Sig	0.200

Table 36 Cohort 2 Number of students who left the cohort

Cohort 3

The results for each of the three cognitive style groups are shown in Table 37 and when split by gender in Table 38. As with the previous two cohorts there are no significant differences between the mean percentile-ranks of the three groups for either year of study. It is not possible to make full conclusions about this cohort as these can only be made once the student's final year examinations had been taken into account. At the time of writing insufficient students had left the cohort to carry out a chi-square test of significance on student drop out.

Cohort 3		Verbal Imager Group					
		Verbaliser	Bimodal	Imager	Total	Kruskal Wallis	
Year 1	Mean	46.83	48.00	60.73	51.56	χ^2	3.608
	N	23	21	20	64	df	2
	Std. Deviation	29.11	27.74	29.71	29.08	Sig	.165
Year 2	Mean	49.83	51.51	53.92	51.72	χ^2	.179
	N	20	19	19	58	df^2	2
	Std. Deviation	28.47	31.99	28.17	29.10	Sig	.914

Table 37 Cohort 3: Mean percentile-rank in cohort for verbaliser, bimodal and imager students

Cohort 3		Verbal Imager Group										
		Verbaliser		Bimodal		Imager		Total		Kruskal Wallis		
		M	F	M	F	M	F	M	F		M	F
Year 1	Mean	45.4	48.7	52.4	39.1	55.4	73.1	51.2	52.1	χ^2	0.82	4.55
	N	13	10	14	7	14	6	41	23	df	2	2
	SD	35.1	20.3	26.7	29.6	26.7	35.1	29.2	29.4	Sig	0.66	0.10
Year 2	Mean	59.1	40.4	48.5	57.9	48.3	69.5	51.3	52.3	χ^2	0.98	3.51
	N	10	10	13	6	14	5	37	21	df^2	2	2
	SD	28.7	26.3	31.4	35.3	28.7	21.9	29.2	29.5	Sig	0.61	0.17

Table 38 Cohort 3: Mean percentile-rank in cohort for verbaliser bimodal and imager students by gender

Summary

The results shown relating the verbal imager dimension to students design marks show few consistent patterns between the three cohorts. Whilst there were a few moderate correlations for female students, there is little evidence to suggest that there is a particularly strong relationship between the Verbal-Imager dimension of cognitive style and a student's performance in architectural design. Furthermore there were no significant differences between the performance of students in either of the three cognitive style groups related to this dimension.

6.33 Approaches to studying inventory

Table 39 shows the correlation coefficients for the students' marks for design and the scales for operations, comprehension and versatile learning on the Approaches to Studying Inventory. Again the correlation was calculated using Spearman's Rho. Results from the first cohort suggested that correlations between the students design mark and their learning style, according to the three ASI scales, were small and insignificant. This measure was not used with subsequent cohorts.

Cohort 1 Spearman's rho		End of 1st Year	End of 2nd Year	End of 3rd Year
Comprehension	Correlation Coefficient	-.054	-.040	.006
	Sig. (2-tailed)	.710	.804	.972
	N	50	41	37
Operation	Correlation Coefficient	.164	.131	.272
	Sig. (2-tailed)	.256	.415	.103
	N	50	41	37
Versatile	Correlation Coefficient	-.055	.233	.167
	Sig. (2-tailed)	.704	.142	.325
	N	50	41	37

** Correlation is significant at the 0.01 level (2-tailed).
* Correlation is significant at the 0.05 level (2-tailed).

Table 39 Correlation of design mark with comprehension, operation and versatile learning scales of the Approaches to studying inventory

6.34 Mental Rotation Test

Tables 40 and 41 describe the relationship between mental rotation ability and performance in design project work. A Spearman's Rho calculation was carried out to determine whether any correlation existed but the results showed that these were small and insignificant for all students and for individual genders, suggesting that mental rotation plays little part in the ability of a student to learn to become an architect.

Cohort 3 Spearman's rho		End of 1st Year	End of 2nd Year
Mental Rotation	Correlation Coefficient	-.074	.099
	Sig. (2-tailed)	.590	.497
	N	55	49

Table 40 the relationship between mental rotation and performance in design

Cohort 3 Spearman's rho		End of 1st Year		End of 2nd Year	
		Male	Female	Male	Female
Mental Rotation	Correlation Coefficient	-.024	-.091	.300	-.036
	Sig. (2-tailed)	.886	.719	.095	.892
	N	37	18	32	17

Table 41 The relationship between mental rotation and performance in design by gender.

6.35 Post 16 Entry Qualifications

A-Level Point Scores

For each of the cohorts a Spearman's Rho test was carried out to determine whether any correlation existed between a student's overall 'A' Level point score and their end of year rank position. Results are shown in Table 42 which suggests that there were no significant correlations between total A-Level points score and students' performance in design for the cohorts as a whole or when the cohort is split by gender (Table 43).

Spearman's rho		End of 1st Year	End of 2nd Year	End of 3rd Year
Cohort 1	Correlation Coefficient	-0.001	-0.108	.163
	Sig. (2-tailed)	0.995	0.511	.349
	N	47	39	35
Cohort 2	Correlation Coefficient	-0.059	-0.157	.019
	Sig. (2-tailed)	0.667	0.261	.896
	N	56	53	50
Cohort 3	Correlation Coefficient	0.071	0.134	
	Sig. (2-tailed)	0.604	0.340	N/A
	N	56	53	

Table 42 Correlation of design mark against A Level Points Score

Spearman's rho		End of 1st Year		End of 2nd Year		End of 3rd Year	
		Male	Female	Male	Female	Male	Female
Year 1	Correlation Coefficient	-.164	.281	-.234	.397	.040	.473
	Sig. (2-tailed)	.332	.431	.214	.291	.847	.199
	N	37	10	30	9	26	9
Year 2	Correlation Coefficient	-.046	.114	-.033	-.163	.359	-.177
	Sig. (2-tailed)	.801	.596	.863	.458	.061	.432
	N	32	24	30	23	28	22
Year 3	Correlation Coefficient	0.143	-0.007	0.145	0.140	N/A	
	Sig. (2-tailed)	0.406	0.977	0.422	0.556		
	N	36	20	33	20		

Table 43 Correlation of design mark against A Level points score by gender

Subject Bias

A Spearman's Rho test was then carried out to test for correlation between Subject-Bias and the end of year marks for the student's design project. The results shown in Table 44 suggest that no apparent correlations exist for the first or third cohorts. When the results of the second cohort were analysed, a significant relationship did exist, such that the higher the student's bias towards arts subjects, the more chance of gaining a higher rank position in the cohort. This was apparent in the second year for all students and in the first and second year for female students (Table 45)

Spearman's rho		End of 1st Year	End of 2nd Year	End of 3rd Year
Cohort 1	Correlation Coefficient	.041	.148	.093
	Sig. (2-tailed)	.771	.339	.580
	N	52	44	38
Cohort 2	Correlation Coefficient	.221	.278(*)	-.127
	Sig. (2-tailed)	.102	.044	.378
	N	56	53	50
Cohort 3	Correlation Coefficient	0.113	-0.124	
	Sig. (2-tailed)	0.409	0.377	
	N	56	53	

*significant to the 0.05 level

Table 44 Correlation of design mark against subject bias

Spearman's rho		End of 1st Year		End of 2nd Year		End of 3rd Year	
		Male	Female	Male	Female	Male	Female
Cohort 1	Correlation Coefficient	.156	-.126	.158	.196	.201	.055
	Sig. (2-tailed)	.341	.681	.389	.542	.306	.881
	N	39	13	32	12	28	10
Cohort 2	Correlation Coefficient	.055	.423*	.277	.441*	-.033	-.129
	Sig. (2-tailed)	.763	.039	.138	.035	.866	.567
	N	32	24	30	23	28	22
Cohort 3	Correlation Coefficient	.056	.245	-.228	.041		
	Sig. (2-tailed)	.748	.298	.203	.862		
	N	36	20	33	20		

*Significant to the 0.05 Level

Table 45 Correlation of design mark against subject bias by gender

Categorical Data

In order to investigate the possibility of a non-linear relationship between the subject-bias ratio and performance in design project work, the cohort was split into the three groups of Artist, All-rounder and Scientist.

Cohort 1

The results shown for the first cohort in Table 46 and illustrated graphically in Figure 17, suggest that all-rounders appear to have performed marginally better than the other groups in their 1st year, however the artists have steadily improved their position, whilst the scientists appear to have declined, especially between the first and second years. A Kruskal-Wallis test however did not show the differences between the groups to be significant, including when the cohort is split by gender (Table 47). Nevertheless, a related samples t-test, carried out comparing the average first and third year positions for each of the three groups suggested that the decline in the mean percentile-ranks of the scientists was significant ($p<0.05$) whilst any changes by the all-rounders and artists were not significant.

Cohort 1		Subject Bias Group					
		Scientist	All Rounder	Artist	Total	Kruskal Wallis	
Year 1	Mean	50.00	53.48	48.64	50.96	χ^2	0.280
	N	14	21	17	52	df	2
	SD	27.51	32.67	27.27	29.14	Sig	0.869
Year 2	Mean	42.99	55.08	53.18	51.14	χ^2	1.318
	N	12	17	15	44	df^2	2
	SD	30.76	28.35	29.59	29.19	Sig	0.517
Year 3	Mean	46.32	51.05	55.47	51.32	χ^2	0.555
	N	10	15	13	38	df^2	2
	SD	19.54	36.02	28.23	29.24	Sig	0.758
t-test	t	2.316	1.731	-.251			
between	df	9	14	12			
years 1 & 3	p	.046*	.105	.806			

(* significant to the 0.05 level)

Table 46 Cohort 1: Mean percentile rank in cohort for scientist, all-rounder and artist students

Cohort 1		Subject Bias Group										
		Scientist		All Rounder		Artist		Total		Kruskal Wallis		
		M	F	M	F	M	F	M	F		M	F
Year 1	Mean	45.6	66.0	51.5	61.5	51.0	44.2	49.7	54.5	χ^2	0.39	0.53
	N	11	3	17	4	11	6	39	13	df	2	2
	SD	26.44	30.55	30.96	43.54	24.83	33.33	27.51	34.57	Sig	0.822	0.764
Year 2	Mean	42.1	45.4	54.0	58.5	51.3	56.8	49.8	54.5	χ^2	0.87	1.26
	N	9	3	13	4	10	5	32	12	df^2	2	2
	SD	34.4	20.8	27.3	35.7	32.8	24.7	30.5	26.0	Sig	0.64	0.53
Year 3	Mean	50.7	35.9	45.3	88.1	63.1	43.1	51.7	50.0	χ^2	1.89	4.49
	N	7	3	13	2	8	5	28	10	df^2	2	2
	SD	20.0	16.9	35.1	13.0	25.6	30.5	29.4	30.2	Sig	0.38	0.10

Table 47 Cohort 1: Mean percentile- rank in cohort for scientist, all-rounder and artist students by gender

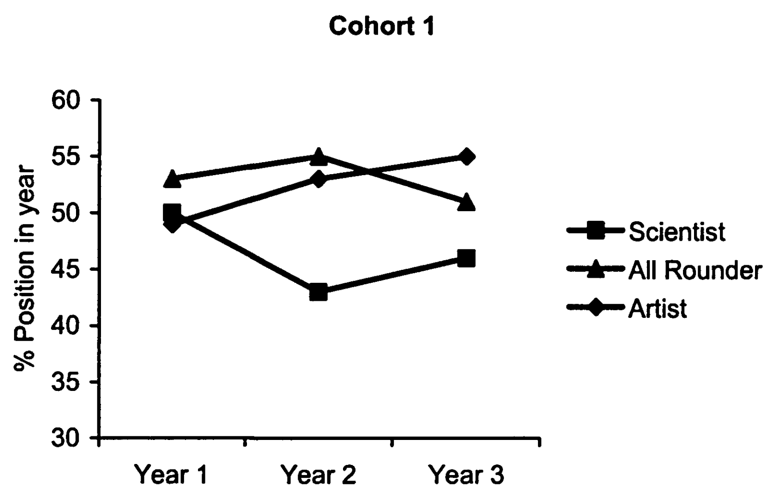


Figure 17 Mean percentile-rank in cohort for artists, scientists and all rounders

Student Dropout

Table 48 suggests that unlike the wholist-analytic scores for this cohort, there were no significant differences between each of the three groups with respect to students leaving the cohort for what ever reason.

Cohort 1		Subject Bias Group				χ^2	
		Scientist	All Rounder	Artist	Total		
Male	Count	4	4	3	11	χ^2	0.403
	Expected Count	3.3	4.8	3.0	11.0	df	2
	% of each group that left cohort	36.4%	25.0%	30.0%	29.7%	Sig	0.817
Female	Count	0	0	1	1	χ^2	0.741
	Expected Count	2	2	6	1	df	2
	% of each group that left cohort	0%	0%	16.7%	10%	Sig	0.690
All Students	Count	4	4	4	12	χ^2	0.294
	Expected Count	3.3	4.6	4.1	12.0	df	2
	% of each group that left cohort	30.8%	22.2%	25.0%	25.5%	Sig	0.863

Table 48 Cohort 1: Subject bias and students that left the cohort

Cohort 2

The results shown in Table 49 and illustrated graphically in Figure 18, contrast dramatically with those from the first cohort. Here, the artists appear to decline in position, and it is the scientists and all-rounders that appear to improve in position, the scientists having finished the first year with a particularly low mean percentile rank position. As with the previous cohort, a Kruskal-Wallis test does not show any significant differences in the mean percentile-ranks for each of the three groups, including when the cohort is split by gender (Table 50). Nevertheless, a related samples t-test, carried out comparing the average first and third year positions for each of the three groups suggested that the decline in the mean percentile position of the artists was significant ($p<0.05$) whilst any changes by the scientists and all rounders were not significant.

Cohort 2		Subject Bias Group					
		Scientist	All Rounder	Artist	Total	Kruskal Wallis	
Year 1	Mean	41.14	49.50	57.01	50.89	χ^2	2.754
	N	14	16	26	56	df	2
	SD	28.79	30.26	28.15	29.12	Sig	.252
Year 2	Mean	44.20	42.52	60.14	50.94	χ^2	4.395
	N	14	15	24	53	df²	2
	SD	31.42	29.51	25.87	29.14	Sig	.111
Year 3	Mean	57.17	51.43	47.67	51.00	χ^2	.854
	N	12	14	24	50	df²	2
	SD	24.53	35.38	28.00	29.15	Sig	.653
t-test	t	-1.950	.424	2.216			
between	df	11	13	23			
years 1 & 3	p	.077	.678	.037*			

* significant to the 0.05 level

Table 49 Cohort 2: Mean percentile-rank in cohort for scientist, all-rounder and artist students

Cohort 2		Subject Bias Group										
		Scientist		All Rounder		Artist		Total		Kruskal Wallis		
		M	F	M	F	M	F	M	F		M	F
Year 1	Mean	51.0	27.9	52.6	45.4	60.3	53.1	55.7	44.9	χ^2	0.41	3.61
	N	8	6	9	7	14	12	31	25	df	2	2
	Std. Deviation	32.2	18.2	29.2	33.3	29.2	27.5	29.3	28.2	Sig	0.81	0.16
Year 2	Mean	53.3	32.0	42.7	42.1	67.7	52.5	56.0	44.8	χ^2	3.47	3.06
	N	8	6	9	6	12	12	29	24	df²	2	2
	Std. Deviation	31.3	29.6	32.7	26.8	22.2	27.8	29.4	28.1	Sig	0.17	0.21
Year 3	Mean	63.7	48.0	46.0	58.6	56.1	39.1	55.1	46.1	χ^2	1.15	1.47
	N	7	5	8	6	12	12	27	23	df²	2	2
	Std. Deviation	23.0	26.0	32.2	41.1	26.4	27.9	27.2	31.1	Sig	0.56	0.47

Table 50 Cohort 2: Mean percentile rank in cohort for scientist, all-rounder and artist students by gender

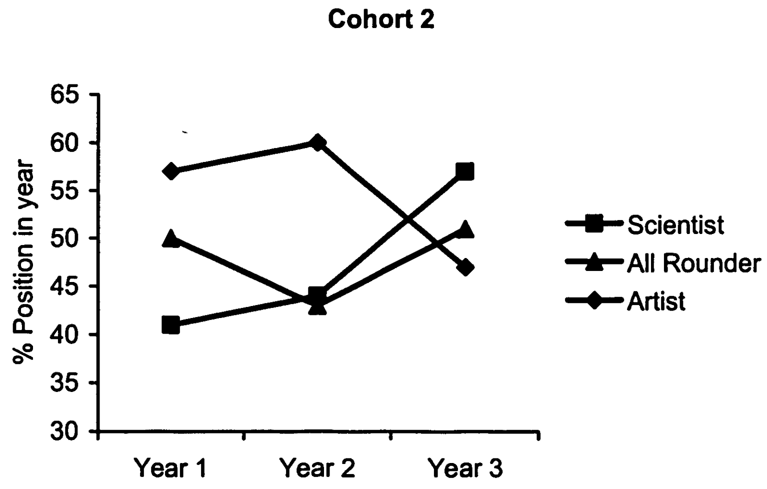


Figure 18 Mean percentile-rank in cohort for artists, scientists and all rounders

Student Dropout

Table 51 suggests that as with the previous cohort, there were no significant differences between each of the three groups with respect to students leaving the cohort for what ever reason.

Cohort 2		Subject Bias Group				
	Scientist	All Rounder	Artist	Total		
Male Count	1	1	2	4	χ^2	0.051
Expected Count	1.0	1.2	1.8	4.0	df	2
% of each group that left cohort	12.5%	11.1%	14.3%	12.9%	Sig	0.975
Female Count	1	1	0	2	χ^2	2.032
Expected Count	.5	.6	1.0	2.0	df	2
% of each group that left cohort	16.7%	14.3%	.0%	8.0%	Sig	0.362
All Students Count	2	2	2	6	χ^2	0.488
Expected Count	1.5	1.7	2.8	6.0	df	2
% of each group that left cohort	14.3%	12.5%	7.7%	10.7%	Sig	0.78

Table 51: Cohort 2: Subject bias and students that left the cohort

Cohort 3

Table 52, illustrated in Figure 19 suggests similar trends to those of the second cohort, with an apparent decline in the mean percentage rank position for Artists, and an improvement in the position of the Scientists. However a Kruskal Wallis test suggested that there were no significant differences between the means of any of the three groups in either of the two years studied. This was also the case when the cohort was split by gender (see Table 53).

Cohort 3		Subject Bias Group					
		Scientist	All Rounder	Artist	Total	Kruskal Wallis	
Year 1	Mean	47.11	54.46	50.52	50.89	χ^2	0.591
	N	17	20	19	56	df	2
	SD	30.13	30.06	28.34	29.12	Sig	0.744
Year 2	Mean	60.50	50.20	43.24	50.94	χ^2	2.990
	N	16	19	18	53	df	2
	SD	30.71	29.45	26.41	29.14	Sig	0.224

Table 52: Cohort 3: Mean percentile-rank in cohort for scientist, all-rounder and artist students

Cohort 3		Subject Bias Group										
		Scientist		All Rounder		Artist		Total		Kruskal Wallis		
		M	F	M	F	M	F	M	F		M	F
Year 1	Mean	49.1	44.2	49.8	61.3	45.9	63.2	48.1	55.8	χ^2	0.10	1.53
	N	10	7	12	8	14	5	36	20	df	2	2
	SD	31.5	30.2	26.8	35.0	28.4	26.5	28.0	31.0	Sig	0.94	0.46
Year 2	Mean	61.6	59.0	52.7	46.7	38.2	56.2	49.4	53.4	χ^2	4.02	0.21
	N	9	7	11	8	13	5	33	20	df^2	2	2
	SD	33.0	29.9	22.8	38.2	27.4	20.3	28.5	30.8	Sig	0.14	0.88

Table 53 Cohort 3: Mean percentile ranks in cohort for scientist, all-rounder and artist students by gender

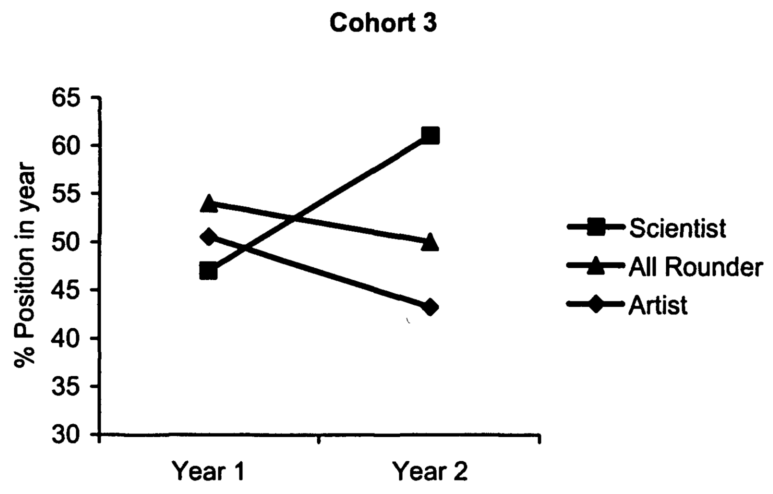


Figure 19 Mean percentile-ranks in cohort for artists, scientists and all-rounders

Summary

The results for the three cohorts suggest that there is little evidence to suggest that there is a relationship between 'A' level points score and performance in design. Furthermore the results comparing whether students had an artistic or scientific bias to their 'A' level portfolios with design performance were inconclusive and contradictory especially when the first cohort showed a significant decline in the mean rank position of the scientists, but the second cohort showed a significant decline in the mean percentile position of the artists.

Out of all the tests used, only the wholist-analytic dimension of cognitive style provided any prediction of future performance in architectural design, particularly in the early years of a course where analytic students appeared to have an advantage. Nevertheless most of the significant results occurred only with the first cohort and subsequent results were inconsistent.

The other tests produced results which were inconsistent and would be difficult to use as a predictor of future performance.

CHAPTER 7: STUDENT INTERVIEW CASE STUDIES

As explained earlier, in order to supplement the quantitative data described in the previous chapter, interviews were carried out with a group of students from the second cohort. The purpose of the interviews was to provide qualitative data that could be used to help explain phenomena gleaned from the quantitative study, rather than providing additional data for statistical analysis. The collected data has been used to generate a series of case studies. The methodology for the selection of the students is described in chapter 5.

Six students were invited for interview, however one student whose position in the cohort had declined substantially, was unable to attend on the day of the interview and therefore the interview did not take place.

The interviews were loosely focussed on a set of questions in an attempt to get an impression of the students' perceptions of their learning experiences. The questions were described in chapter 5. The interviews were conducted along side the student's project work exhibition and lasted for approximately 15 minutes each. They were recorded onto audiotape. Details of the five students interviewed are included below. A full transcript of the interviews is included in appendix 3

Case Study				Student A	
Age upon joining course:	20	**Gender:**	Female		
Post 16 Qualifications					
Subjects: Art and Design (A) General Studies (D) Modern History (D) German (B)History of Art(A)					
Points Score:	36	**Subject Bias:**	1	**Group:**	Artist
Cognitive Style					
Wholist-Analytic Ratio	1.55	**Cognitive Style Type**		Analytic	
Verbal Imager Ratio	1.40			Imager	

Performance in design project work

	Design Marks	Percentile-Rank
End of Year 1	64	66
End of Year 2	58	41
End of Year 3	52.	21.

Description

Student A entered the school with a strong background in Arts subjects, with no A-Levels in the sciences. She performed relatively well in her first year, her position bordering on the top third of the cohort. During subsequent years her rank position within the cohort declined, and her final design mark had her placed well in the bottom third. She did particularly well in arts and humanities subjects during the course, but less well in Building Technology. Overall, the student gained a lower second class honours degree.

Interview Questions

Student's general impressions of the course

The student particularly enjoyed the first year of the course, largely because of the encouragement and support that she had received from staff members. She appreciated the number and variety of courses undertaken in first year. She found it more difficult to work independently when there was less of a framework of support in the subsequent years

Student's favourite Project

3rd Year Autumn Semester Project: an office for CADW in Treforest. The student enjoyed working with real clients and visiting tutors' offices. She felt that this was particularly challenging. The student gained a mark of 50% for this project, which translates to a percentage rank position of 20 in the year.

Project that the student found most challenging

The third year final design project: a gallery. The student felt that she required a lot of help on this especially with regards to the environmental and technical issues. The confined site also made this project challenging. She gained a mark of 53% on this project which translated to a percentile-rank of 27.

Point in course where a leap of understanding was perceived The student struggled to identify a particular point
Changes in perceptions of architecture as a result of the course The student felt that her perceptions of architecture had changed from a view that it was a scientific, calculation based subject to one that had a greater emphasis upon art.
Perception of usefulness of post 16 qualifications The student felt that her artistic 'A' level qualifications were of particular benefit in the first year, but recognised that this may also hinder her abilities to express herself in situations where she would need to be more precise.
Recognition of cognitive style Student claimed to spend a lot of time thinking about the individual parts of her building and sometimes does not relate those parts to the whole during presentations - which may reflect her analytic cognitive style. She claimed that she prefers to write about something, rather than draw it if she struggles to understand something, which might suggest that she should be a verbaliser.
Other information The student commented upon how she perceived (incorrectly) that there was a tick box mentality within the school, with a list of requirements for particular projects.
Comments
The relative decline of this student's position within the cohort with respect to design reflects that found more generally for analytic students within this research. Her comments about requiring more support from tutors may well mirror Witkin's research on autonomy, uncertainty and field independence, which suggests that those with an analytic cognitive style would have difficulty imposing a framework onto a situation that is not well structured. The student's comments about the tick box requirements of the course, which may be a misperception, also suggest that the student is trying to find a framework, where as in reality this does not exist. She appeared to make an accurate self perception of herself as an analytic, although there was some doubt about her being an imager as suggested by the CSA test data.

Case Study				**Student B**			
Age upon joining course:	18			**Gender:**	Male		
Post 16 Qualifications							
Subjects: Mathematics(C) Geography(C) Design And Technology (A)							
Points Score:	**20**	**Subject Bias:**	**0.45**	**Group:**	**All Rounder**		
Cognitive Style							
Wholist-Analytic Ratio	1.38	**Cognitive Style Type**	Intermediate				
Verbal Imager Ratio	0.95		Verbaliser				

Performance in design project work

	Design Marks	**Percentile-Rank**
End of Year 1	58	38
End of Year 2	55	25
End of Year 3	66	75

Description

Student B entered the school with a mix of Arts and Science subjects. At the end of his first two years he was gaining marks for design work that were placing him well into the lower half of the cohort. However by the end of his third year his position in the year had improved dramatically. In lecture courses he tended to derive better marks in building technology than in humanities subjects. Overall the student gained an upper second class honours degree.

Interview Questions

Student's general impressions of the course

The student felt that he had been limited in the first two years of the course by a particular design tutor. He felt he improved in the third year when that tutor was not available to teach him

Student's favourite Project

Non-assessed summer project. He felt that this did not have any of the pressure associated with other projects, especially as there was no requirement to consider technical issues which allowed him to explore those issues that he enjoyed.

Student's least Favourite Project

Second Year, Spring projects - Library. The student felt that he didn't feel inspired by the project and lacked direction. He also ignored some advice that he was given by a tutor. He gained a mark of 45% for this project, which translates to a percentile-rank of 14.

Project that the student found most challenging

Third year, Autumn semester project: an office for CADW in Treforest. This was the first project that the student started to carefully consider how he was designing. He found his tutor on this project particularly helpful and tried to

understand how the tutor came up with his ideas. The student felt that he needed to generate his own ideas of an equivalent standard to his tutor. He gained a mark of 65% which translates to a percentage rank index of 80.
Point in course where a leap of understanding was perceived Following the library project, the student started to understand why his peers were getting good marks. He gained inspiration especially from those students who subsequently gained first class degrees.
Changes in perceptions of architecture as a result of the course The student felt that he had a better understanding of architecture, but did not elaborate on what this implied.
Perception of usefulness of post 16 qualifications The student felt that his design and technology A level had been of benefit, but was less sure about the relevance of the Maths and Geography. The Design and Technology helped him to understand the design process and also to develop graphic skills.
Recognition of cognitive style The student felt that the verbaliser label was inappropriate given that he has difficulty with his writing. He felt that he was better able to picture things rather than describe them in words. He felt that the intermediate label was fair.
Other information Despite gaining high marks for building technology, the student claimed to struggle to integrate technology into the design process.
Comments
Of particular interest with this student are his comments about his relationships with design tutors and his peers, in terms of gaining inspiration. In some respects his description of working with his tutor in third year is similar to Schon's (1985) description of Petra learning from Quist. The student strives to gain an understanding of how his tutor thinks, rather than to expect the tutor to generate the necessary ideas for him. This point emphasises the benefits of good design teaching and it is possible that in this case the students relative improvement between second and third year may be a reflection of external circumstances such as the nature of the design tutor, rather than some internal individual difference. The student claims that his design technology 'A' level course was helpful, yet his marks in 1st and 2nd year were low. His descriptions suggest that in order to succeed, then it was necessary to learn a more subtle version of the design process, than might have been obtained at 'A' level

Case Study				Student C	
Age upon joining course:	18		**Gender:**	Male	

Post 16 Qualifications

Subjects:
Design And Technology(A)MEI Mathematics(B)General Studies(D)Physics(C)

Points Score:	27	**Subject Bias:**	0.41	**Group:**	All Rounder

Cognitive Style

Wholist-Analytic Ratio	1.39	**Cognitive Style Type**	Intermediate
Verbal Imager Ratio	1.02		Bimodal

Performance in design project work

	Design Marks	**Percentile-Rank**
End of Year 1	54	19
End of Year 2	66	70
End of Year 3	63	61

Description
Student C entered the school with a science and technology dominated portfolio. In his first year his marks for design positioned him in the lower 20% of the cohort, but by the second year he was bordering the top 30%.

Interview Questions

Student's general impressions of the course
The student felt that he had learned a great deal, especially after the end of his first year.

Student's favourite Projects
Second Year Housing Project and Third Year Spring semester project, a gallery. The student claimed that these were designs where he has worked on a strong idea from the beginning and worked hard to refine that idea. The student claimed to often generate the concepts for his projects quite late in the timescale, but with these projects he was able to develop those concepts from an early stage. The student gained marks of 68% and 66% which translates to percentile-ranks of 73 and 74 respectively.

Student's least Favourite Project
Spring semester project in second year (library) and Autumn semester projects in third year. The student claimed that with both of these projects he had insufficient time to develop his ideas fully. The student achieved a mark of 65% and 59% with these projects which translates to percentile-ranks of 59 and 50.

Project that the student found most challenging The student found both third year projects particularly challenging although he wasn't sure of the reasons why. He suggests that he was unhappy with his work on the autumn semester project and hence it was redesigned towards the end of the project. The spring semester project was a large brief on a small site, which added particular challenges.
Point in course where a leap of understanding was perceived The student felt that this happened between his first and second year. He suggested that this may have been the result of a particularly good tutor who enabled him to get a better understanding of what he was trying to achieve. The student claims that this was a combination of being pushed more by the tutor, and having fewer distractions from the supplementary projects end exercises that accompanied first year design projects. The student felt that there was more time in second year to explore his own ideas.
Changes in perceptions of architecture as a result of the course The student felt that any changes in perceptions of architecture were as a result of working in architectural practices over the summer vacations, gaining an understanding of what real world architecture is about. He felt that this has given him a more rational design mind.
Perception of usefulness of post 16 qualifications The student regretted not taking more arts subjects at A-Level, but claimed that he went to a science based school and believed that architecture required science subjects to be followed at A-level. He could see a limited benefit of his science A-levels in that they allowed him to gain a better understanding of how a building would function but gave him no assistance in terms of presentation techniques.
Recognition of cognitive style The student saw himself as an all rounder, which may reflect the intermediate – bimodal label.
Other information The student claimed to be a late designer, who takes time to generate sound ideas.
Comments
The student suggested that his poor performance in first year may have been a response to the large number of small projects that he was required to pursue. He expressed a preference for projects where there was more time for him to develop his own ideas, perhaps a rejection of a tightly structured course. This contrasts with those students who flourished in first year, but then struggled in subsequent year, perhaps as a result of a lack of structure. Witkin's research suggests that those with a global or holistic cognitive style require more structure, and it is possible that this student was sufficiently holistic to be able to impose his own structure, albeit often quite late in a project.

Case Study			Student D		
Age upon joining course:	18		Gender:	Male	
Post 16 Qualifications					
Subjects: English Literature(A) General Studies(C) Geography(B) Design And Technology(A)					
Points Score:	34	**Subject Bias:**	0.71	**Group:**	Artist

Cognitive Style			
Wholist-Analytic Ratio	0.95	**Cognitive Style Type**	Wholist
Verbal Imager Ratio	1.11		Bimodal

Performance in design project work

	Design Marks	Percentile-Rank
End of Year 1	58	34
End of Year 2	64	63
End of Year 3	73	94

Description

Student D entered the school with a portfolio of A level qualifications that was biased towards the arts rather than the sciences. His performance in first year led him to be placed firmly in the lower half of the cohort, but by the end of his third year he attained the 4th highest rank position. He was awarded a first class honours degree.

Interview Questions

Student's general impressions of the course

The student recognised that he had learned a great deal whilst being on the course especially during his final year and claimed that it has fulfilled a great deal of what he enjoys pursuing.

Student's favourite Project

Third Year, Spring semester project - a gallery. The student claimed that the success in this project was due to his combination of the application of what he had learned in his prior studies and his dialogue with his tutor whom he regarded as particularly helpful. He felt that he had developed a cycle of development for the project that particularly suited him, concentrating upon the artistic side of design. He worked hard, repeatedly trying to improve the project. The student gained a mark of 82% which translates to a percentile-rank of 98

Student's least Favourite Project

Second year, spring semester – a library, The student was unhappy with his working technique. He felt he worked hard, but could not obtain a good outcome. The student gained a mark of 68% on this project, which translated into a percentile-rank of 68.

Project that the student found most challenging
Third year, spring semester - gallery. The student claimed that this was down to the large brief small site and the need for a considerate environment

Point in course where a leap of understanding was perceived
At the end of the autumn project in third year. The student was unhappy with the outcome from the project and used the final project to rectify those mistakes that had been made during previous projects.

Changes in perceptions of architecture as a result of the course
The student recognised that these had changed especially in terms of the way he worked but struggled to describe how. He suggested that he was able to now do things in a more intuitive manner.
He described the change as being "In the way that I would approach a problem in design, there's been a lot learned there and its hard to describe because its more unconscious - you tend to learn to do things the best way"

Perception of usefulness of post 16 qualifications
The student perceived Cardiff's course as a mix between the arts and the sciences. He felt that the design technology helped him to understand structures as well as about art and design. He felt that it may have been beneficial to have done more sciences.

Recognition of cognitive style
The student felt that bimodal represented a good description of his personality. He also tended to treat problems holistically, although he claimed to be learning to become more analytic.

Other information
The student felt that it was important that designs should not be based purely on concept and that designs should be underpinned by technology and this is what he has attempted to do in recent projects.

Comments

The student talked about doing things unconsciously, or perhaps intuitively. This may be a reflection of his wholist cognitive style, which as discussed earlier may represent a super-ordinate dimension that includes intuition. He also talks about the need to underpin design with technology (rather than to separate the two as some interviewees have suggested). Whilst this student claims to be able to think more analytically, it is possible that his studies have succeeded in developing his holistic/global side to the extent that he was able to flourish in his final design project.

Case Study		**Student E**	
Age upon joining course:	18	**Gender:**	Female

Post 16 Qualifications

Subjects: International Baccalaureate
Subjects English (Higher), Mathematics(Higher), Physics(Higher), Japanese, Geography

Points Score:	N/A	**Subject Bias:**	N/A	**Group:**	N/A

Cognitive Style

Wholist-Analytic Ratio	1.62	**Cognitive Style Type**	Analytic
Verbal Imager Ratio	0.97		Verbaliser

Performance in design project work

	Design Marks	**Percentile-Rank**
End of Year 1	67	85
End of Year 2	60	48
End of Year 3	49	17

Description
Student E entered the school with a range of IB subjects that focussed upon sciences and languages, but lacked any Art or Design qualification. She ended her first year in the top 15% of the cohort, but in subsequent years her position in the cohort steadily declined so that in the final year she was in the bottom 20% of the year. Her grades for Building Technology have tended to be higher than the humanities based subjects, especially in her second year where she gained a mark of 72% for Building Technology.

Interview Questions

Student's general impressions of the course
The student felt that she had learned a great deal during the course, especially with regards to building technology. She admitted to finding it difficult at times to generate design project work that the design tutors appreciated and would glean her the grades that she expected.

Student's favourite Project
Third year, spring semester, a gallery. The student commented upon how she was able to work steadily with her tutor on a week by week basis and in doing so her design improved. She suggested that this left time for subsequent analysis of lighting and satisfaction of building regulations. The student gained a mark of 45% for this project, which gave her a percentile-rank of 8

Student's least Favourite Project
Second Year, Spring semester, Housing project: The student struggled to improve the design during the project. She complained of having a mind-block that prevented her from having better ideas. The student gained a mark of 51% which translated to a percentile-rank of 21

Project that the student found most challenging. As above
Point in course where a leap of understanding was perceived The student claimed that in the second year, she started to understand for herself the kind of ideas that she perceived were required by the tutors. She described how she learned to use journals for inspiration, although this principally involved looking at the pictures, rather than the text. In the first year she would rely upon her peers for assurances as to what was expected of her.
Changes in perceptions of architecture as a result of the course Her initial perceptions about architecture were that it was a combination of arts and mathematics. She was unaware that she would be required to design her own buildings and work out how they would be constructed. She argued that for her architecture had moved away from being some sort of personal interest to being for the wider benefit of society, satisfying human needs. This change was derived from conversations with tutors and examiners.
Perception of usefulness of post 16 qualifications The student chose her highers based upon what she perceived was needed in architecture. However she recognised that Maths and Physics were not particularly beneficial. She regretted not doing art, but she had experience of this outside school, and used to draw plans of her house. She felt that Geography was probably her most useful subject as it helped her to understand landscape.
Recognition of cognitive style The student recognised that she tends to break things down into small parts, rather than seeing them in a broad way, which confirms her analytic style label. She suggests that this may have helped with the technical side of her work. Her tutors often asked her to take a wider perspective and be less constrained. She felt that she was more of a technical person. She found the environmental analysis and technical requisites the easiest part of the course. The student did not comment on her verbaliser characteristics
Other information Claimed to work from a pragmatic rather than philosophical standpoint when designing.
Comments
The relative decline of this student's position within the cohort with respect to design reflects that found more generally for analytic students within this research. Her comments related to her bias towards the technical side of her work, which she often appears to separate from the design process itself appear to confirm that the student does have an analytic cognitive style. She refers frequently to needing to know "what they [the tutors] want" in order for her to get a good mark. This suggests that she is seeking a framework, within which she should work - a trait which Witkin suggests analytic students require. Initially she would ask her peers, and in first year, this would be easy when projects are small and activities are well mapped but subsequently she learned to rely upon journals, but her decline in marks suggest that this may not be an appropriate strategy.

Whilst these case studies only represent a small proportion of the students who participated in the research, the interviews suggest the possible existence of two types of students. The first, in the form of students A and E who were both measured as having analytic cognitive styles who found it difficult to cope with the broad, open frameworks associated with the third year of their course. They appeared to rely upon tutors for guidance in terms of what to do next. Students B,C and D who were measured as having intermediate and wholist cognitive styles, felt that the structured first year course was a constraint, and thrived in terms of their performance in the third year. They tended to see the role of the design tutor as an inspirational mentor. The results from these interviews concur well with the results from the quantitative studies, particularly with regards to the wholist-analytic dimension. As we saw in the previous chapter, it was the analytic students who appeared to have an advantage during the early years of their course, but did less well upon completion. This was the case with the two analytic students interviewed and the interview data provides us with some possible explanations as to why this might have happened. Furthermore, the quantitative data suggests that wholist students on the whole made a relative improvement in their position within the cohort as they approached the completion of their course. This was the case with the one wholist student interviewed who demonstrated the largest improvement in position between his first and third year. Again the interview data may provide us with some possible explanations as to why this was the case. This will be explored further in the following discussion chapter.

CHAPTER 8: DISCUSSION

This chapter addresses the research questions referred to in the previous sections and uses the student interview transcripts, together with literature on learning and cognitive styles, on architectural education and on how architects think and learn, to help explain the results obtained from the data collection. The chapter subsequently outlines a model by which learning and cognitive styles can be integrated into a more general theory of learning, which could be used to explain some of the results.

8.1 The Wholist Analytic Dimension of Cognitive Style

8.11 The nature of the sample

Students in the school of architecture investigated appeared to be significantly more analytic than the standardisation sample tested by the author of the CSA. This contrasts to some extent with much of the research described in chapter 4 which might suggest that architects would have a tendency to have a holistic, intuitive and divergent cognitive style. Specifically, Riding and Rayner 1998, suggested that in their sample of professionals of varying occupations, the highest proportion of architects fell into the 'wholist' category, although a fair number were also analytic. Furthermore, Peterson and Sweitzer (1973) suggested that architecture students were on average more field dependent (holist) than the student population as a whole. Conversely, Morris and Bergum's (1978) experiment came to similar conclusions to this research, that architecture students tend to be more analytic. It is possible that the reputation of the Welsh School of Architecture, as being a practical, and practice-oriented school may affect the type of students that take up places. This may also be a reflection of the nature of the secondary education system or university admission system in the UK, which may be more suited to analytic students. A comparative study with other schools of architecture would be necessary to demonstrate whether this was the case.

8.12 Correlations with design marks

The initial hypothesis related to the wholist-analytic dimension questioned whether there was a significant correlation between students' marks in architectural design and their score on the wholist-analytic dimension of Cognitive Style Analysis. The results from the first cohort suggested that there was a significant correlation such that in the first two years of the course, the more analytic a student's cognitive style, the higher the mark that they were likely to achieve. Furthermore in the students' first year this was significant beyond the 1% level and accounted for 19% of the variance. At the level of the individual project, significant correlations were found for projects in the second semester of first year, and the first semester of second year, some of which, notably the Space and Structure project, had a particularly high correlation coefficient. Results from the second and third cohorts did not show any significant correlations, either for the overall year marks or for the projects individually.

The results from the first and second years of the first cohort suggest that we can reject the null hypothesis[20] that no significant correlations exist between students design marks and the wholist-analytic dimension of

[20] It is normal practice in social science research to test for a 'null hypothesis', that is a hypothesis that there are no relationships between two variables rather than to test for a positive relationship. A statistical test generally leads to either the rejection or the retention of the null hypotheses. If the null hypothesis is rejected then it is assumed that a relationship between the two variables does exist.

cognitive style. It was not possible to reject the null hypothesis for subsequent cohorts. This is not to say that for the population as a whole there would be no significant relationship; rather with this particular sample of students, and the circumstances of their learning, there was no significant relationship. It is possible that the first cohort had design projects that were constructed and taught in a way that particularly suited analytic students. It is also possible that the different cohorts consisted of different profiles of students, potentially derived from a particular admissions process. Nevertheless, it should be noted that the second and third cohorts were larger than the first, which may suggest that these samples would be more representative of the population as a whole.

Results from the first cohort also suggest that the effect of cognitive style may decline as students pass through the school and by the cohort's third year there were no significant correlations with design marks. Again this may be related to the changing nature of the teaching and learning activities in each of the three years. It is also possible that by their third year they had developed strategies for learning that countered their innate cognitive style and thus the correlations would no longer be present.

The project by project analysis suggests that the wholist-analytic dimension of cognitive style may have a greater influence on some projects than others. For instance, the Space and Structure project is used to introduce certain technological issues into the curriculum including building structures. It is possible that this type of project would be favoured by analytic students who might be interested in the details of how a building is put together. This project was not run for the second cohort, and although a similar project was run with the third cohort, it was shorter in duration and did not demand the level of detail required by the first cohort. It is therefore not possible to confirm whether the initial correlations would have been repeated. It should be noted that the staff responsible for the teaching of the first and second cohorts were different and it is possible that they provided a different emphasis onto the projects conducted, which suited students with particular cognitive styles better than others.

8.13 Performance of different groups

The second hypothesis questioned whether a significant difference existed between the mean position within the cohort (with respect to their marks for design work) for groups of students labelled wholist, intermediate and analytic. The mean position in the cohort for those students labelled analytic was higher than for those students labelled intermediate and wholist in the first two years of all three cohorts. This was the case with the end of year design marks and the majority of the individual projects. Furthermore, in the first cohort's first year, the differences were statistically significant. Significant differences were also found in two individual projects from their first year. The results for the first cohort also suggest an under-performance for wholists in their early years that could imply that wholist students found difficulties in completing the course. This may have been the result of particular teaching and learning activities which wholists may have found more difficult than other groups. Furthermore, it was also observed that in the first cohort, a significantly high proportion of wholists left the cohort at various stages. It is possible that the projects were structured in a way that was particularly problematic for wholists. Nevertheless this finding was not repeated in the second cohort. Differences between the groups in the Second and Third Cohorts were not statistically significant either at the project level or for the end of year mark

The results from the first year of the first cohort suggest that we can reject the null hypothesis that no significant differences exist in mean positions in the cohort between the three groups of students. It was not possible to reject the null hypothesis for subsequent cohorts which again suggests that significant differences may only be possible under certain circumstances as outlined previously.

8.14 Changes in rank positions

The third hypothesis questioned whether there was a significant change in the mean position within the cohort, with respect to design marks, for the groups of students labelled wholist, intermediate and analytic between the end of their first year and the end of their third year. In both the first and second cohorts the results suggest that there was a significant fall in the mean position held by analytic students between the end of the first and the end of the third year of study. No significant changes in the mean position of the intermediates and wholists were found.

Results from both cohorts suggest that we can reject the null hypothesis that there would be no significant change in the mean position in the cohort, between the end of the first year and the end of the third year, for students in each of the three arbitrary style groupings of wholist, intermediate and analytic.

It would appear that in both the first and second cohort any advantage that analytic students may have had in their first year was no longer apparent by the end of their third year. It may be that by this stage wholist and intermediate students had developed learning strategies that enabled them to counter any disadvantage that their innate 'wholist' cognitive style might have had. Nevertheless it should be recognised that the decline in the relative position of the analytic students may be a result of a relative improvement by the other groups or visa-versa, or it may suggest that analytic students find the third year more difficult.

8.15 General discussion

A further insight into the apparent decline of the analytic students can be derived from the interview data that was collected. In the first year, students' project work is divided into a number of short exercises, each of which was designed to allow the students to develop particular abilities. In subsequent years, projects get progressively longer and students are expected to integrate knowledge and skills from a variety of sources, without a framework for doing so being provided. The two analytic students interviewed, both of whom showed significant declines in their position within the cohort talked about a need for a framework. Student A described having enjoyed the first year particularly because of the variety of small projects. She found the subsequent years more difficult because she was forced to work more independently, without the framework provided in the first year. Student E referred frequently to needing to know "what they [the tutors] want" in order for her to get a good mark. Yet they were encouraging her to become less constrained. Again this suggests that she was seeking a framework, within which she should work. In contrast, student C, one of the two intermediate students interviewed, whose marks had considerably improved between the end of the first and third year suggested that he found the rigid nature of first year a constraint, and preferred the freedom of subsequent projects where there was a greater opportunity to think independently.

In some respects this corresponds to Witkin's research that suggested that Field Independent (analytic) students tend to find working in situations of uncertainty more challenging and tend to require a framework in which they can work. The tutor's comments that student E needs to be less constrained may suggest a strong 'Interrupt Function' held by field dependents (Pascual Leone et al 1978) which limits the production of non-rational ideas leading towards a tendency for convergent thinking (Hudson 1966).

As we saw in chapter 3, a number of authors have argued that architectural education is about the development of intellectual frameworks within which the process of designing can take place. The results from this study have suggested that some students do indeed show a preference for working within a predefined intellectual framework and struggle when that framework is not present. Other students may be able to apply their own intellectual frameworks to an ill defined situation.

We also saw in chapter 4 that designers often approach design using a number of 'parallel lines of thought' in a simultaneous, rather than sequential manner. Not only does this enable designers to gain a holistic overview of the design whilst examining it at the detailed level, but it also enables them to understand the inter-relationships between individual aspects of their schemes. Rowe (1987) argued that in architecture, one can only understand the meaning of the whole if we have a simultaneous understanding of the parts, but in isolation our understanding of the parts will be difficult if there is no understanding of the whole. As students progress through their architectural education, the scale and often the complexity of their design projects will increase. Students may need to approach design using an increasing number of parallel lines of thought (Lawson 1997). Those who have a tendency to process information in holistically (wholists) may find it easier to cope with this increased demand, whereas those who prefer to process information in parts (analytics) may try to treat each line of thought independently and sequentially thus miss the important connections between them. This again may explain the relative decline in the position of analytic students as the course progresses.

In Chapter 2 it was suggested that the wholist-analytic dimension of cognitive style was a super-ordinate dimension that incorporated other aspects beyond whether an individual tended to process information in wholes or a series of parts. It was argued that 'wholist' thinking occupied the same pole of the dimension as intuitive, divergent thinking, whilst 'analytic' thinking was at the same pole as sequential, rational and convergent thinking. Hudson (1966: 71-72) also suggested that those who appear to have a preference for convergent thinking, are more likely to be technically minded and tend to analyse objects in specific rather than general terms. The reverse is so for those who appear to have a preference for divergent thinking.

In chapter 3, this rational-intuitive distinction was discussed with respect to architectural education. Rational people were regarded by many of the authors as being intolerant of uncertainty and unwilling to experiment in design without constraint. They were seen as having a need to justify their decisions, which are made through the application of theory, rather than through some spontaneous, heuristic judgement. Intuitive people were seen as free thinkers, who could make creative decisions, without being constrained by predetermined processes and theories. We saw in chapter 4, from Mackinnon's (1962) research that this intuitive way of thinking was common amongst architects, especially those who were regarded as being highly creative.

The distinction between rational and intuitive thinking was reflected in the student interviews, and may go some way to explaining why the relative positions of analytic students tend to decline. Analytic Student E, whose position in the cohort had declined over time, claimed to have a preference towards the technical, analytic side of her design work, whereas, Student D, who was a wholist and whose mark improved dramatically by the third year, found it difficult to describe what his major learning moment was. He claimed that it was something "unconscious... [a tendency to] learn to do things the best way". This suggests that the student has developed a more intuitive approach to designing. Nevertheless, this student did not reject the technical, rational side but rather saw it as something that is needed to underpin his design work in a rather more integrated manner than was suggested by student E. The complex nature of the projects in third year would have provided an opportunity for the Wholist student to flourish in this respect, whereas in the students' earlier years, where projects were smaller, a rational approach may have been advantageous.

The previous arguments have been based upon the premise that wholist students would adopt an intuitive approach and analytic students would adopt a rational approach. Indeed the student data suggests, to a limited extent, that this may be the case. Nevertheless, there is often little empirical evidence suggesting clear relationships between the various style labels to suggest the existence of an overarching, super-ordinate dimension of cognitive style. Often the relationship between two dimensions is through subjective judgement at the conceptual level and it is difficult to do more than speculate about whether an individual with a cognitive style defined under one particular model, is more likely to exhibit characteristics of a cognitive style as defined by a different model. Furthermore, researchers have failed to find relationships between some of the component dimensions. For instance Sadler-Smith et al (2000) found no relationship between the analytic-intuitive dimension of Allinson and Hays' Cognitive Styles Index and the wholist-analytic dimension of the Cognitive Styles Analysis.

Since the selection of CSA as a test for cognitive style, Peterson et al (2003a) have published research questioning its reliability. By creating what they regarded as an identical copy of the CSA, from which it was easier to examine responses to individual items, they claimed that the tests for the wholist-analytic dimension had a low split half reliability, but by introducing a second parallel test, in effect doubling the number of test items, then split half reliability becomes acceptable. Riding (2003) disputes this argument by saying that extending the number of items would make the test overly long, especially for younger participants and that it is possible that the answers to the early questions could be more valid whilst the test is still novel. He also doubted whether the recreated CSA tests calculated scores using the same algorithms as the original test.

8.2 The Verbal Imager Dimension of Cognitive Styles

8.21 Correlations with design marks

The first hypothesis related to this dimension, questioned whether there was a significant correlation between students' marks in architectural design and their score on the Verbaliser - Imager dimension of Cognitive Styles Analysis. The results suggested that there were no significant correlations when the cohorts were taken as a whole. Nevertheless significant correlations did exist for female students in the first year of the second cohort and the second year of the third cohort such that the greater an individual's tendency to represent information through images the higher the likely student mark.

The results suggest that the null hypothesis that there is no correlation between design mark and the verbal imager dimension of cognitive style must be retained with respect to the cohort as a whole. This suggests that a student's verbaliser-imager cognitive style, as measured by CSA is unlikely to influence students' performance in learning to design. Nevertheless, the results also suggest that females may be more susceptible to their cognitive style than males, but it is unclear as to why this might be. It should be noted however, that the sample sizes for females are small and therefore further research, with a larger sample of female students would be required to gain a fuller understanding of this phenomenon.

8.22 Performance of different groups

The second hypothesis questioned whether a significant difference existed between the mean positions within the cohort for students labelled verbaliser, bimodal or imager. No significant differences were found even when the cohort was split with respect by gender and the results do not corroborate the findings related to gender for corelational studies on this dimension. Thus we must retain the null hypothesis that no significant differences exist between each of the three groups.

8.23 Changes in rank positions

The third hypothesis questioned whether there was a significant change in the mean position within the cohort, with respect to design marks, for the groups of students labelled verbaliser, imager and bimodal between the end of their first year and the end of their third year. No significant changes were found and therefore we must retain the null hypothesis that there will be no significant changes in the mean position of each group over time and that students marks improve or decline, in a way that is unrelated to the verbaliser-imager dimension of Cognitive Style.

8.24 General discussion

One might presume that in a subject with a visual nature such as architecture, that a tendency to represent information visually during thinking would be of benefit. The results suggest that it is possible that the verbaliser-imager dimension is not important in determining marks in architectural design. It is possible that if a student is a strong verbaliser, then other mechanisms might be used to compensate for a tendency not to represent information through images. One of these mechanisms may be the use of drawings and models as a design tool. As we saw in chapter 4, drawings play an important role in architectural design. Lawson (1997) suggested that the drawing is a means of holding an idea in place, whilst another is considered; a means of enhancing parallel lines of thinking. Robbins (1994) suggested that drawing was a means to encourage experimentation without constraint. This might suggest that drawings are actually a means to assist intuitive thinking as well as compensating for difficulty in drawing. Furthermore, Douglas and Riding (1993) argued that a fluid mental picture held by imagers could interfere with an ability to draw, suggesting that it might be an advantage for an architect not to be an imager.

Since the selection of CSA as a test for cognitive style, Peterson et al (2003a) have published research questioning its reliability particularly with respect to the verbalise-imager dimension.

Peterson et al argue that the verbaliser-imager dimension is particularly unstable, even if the test length is doubled. They suggest that this may be because the test items are more subjective than those for the wholist-analytic dimension. For instance one test item asks students to respond to the following question with the answer true or false.

"Are Paper and Chalk the same colour?"

Whilst a young child would probably respond to this answer positively and rapidly, older subjects, including those who took part in this particular study may question whether this is a trick question, related to coloured chalk and coloured paper and therefore dwell on the question rather more than necessary and thus skew the results. This is not to say that the construct is invalid. Given a more robust measurement tool, then the results might have been different.

8.3 The approaches to study inventory

The hypotheses related to this measure questioned whether there were significant correlations between students' marks in architectural design and their scores on the operations, comprehension and versatile learning scales of the Approaches to Studying Inventory. The results from this study suggest that we cannot reject the null hypotheses that there are no significant relationships between the three aforementioned dimensions and student's marks in architectural design.

This inventory was chosen for the study because it appeared to measure a dimension similar to Pask's holist-serialist dimension which Riding and Cheema (1991) have argued was part of the wholist-analytic super-ordinate dimension of cognitive style. Nevertheless, the research suggests that neither of the scales correlate significantly with either dimension of the Cognitive Styles Analysis.

The Approaches to Study Inventory is a self report test based upon approaches to study adopted previously by the subjects which has been shown to be robust (Duff 2000b). It was assumed when the test was selected that the approaches taken would be mediated by an underlying innate cognitive style. If this had been the case then the scales may have correlated with the wholist-analytic dimension of CSA. In reality this does not appear to be the case. Furthermore the ASI dimensions do not appear to bear any significant relationships with performance in architectural design. It is possible that during secondary education, the students developed approaches and strategies that would counteract their cognitive styles in order to achieve high marks and it is these strategies that are reported when completing the ASI rather than the student's innate cognitive style.

8.4 Mental Rotation

8.41 Spatial skills and design performance

The hypothesis questioned whether there was a significant correlation between students' marks in architectural design, and their score on the redrawn Vandenburg Mental Rotations test (MRT-A). The results suggested that there were no significant correlations. The null hypothesis that there is no correlation between design mark and Mental Rotation must be retained and suggests that a student's spatial skills, as measured by the MRT are unlikely to influence their performance in learning to design.

The test results showed that whilst on the whole, the cohort of students tested performed significantly better at the MRT than the standardisation sample, some students found this test considerably more difficult than others. Furthermore male students produced significantly higher results on this test than female students. Recent research carried out looking into reasons why a higher proportion of women leave architecture compared to men (Manley et al 2003) suggests that one of the reasons for this is a perception that women have poor spatial skills. The present research supports the assertion that the spatial skills of women may be poorer than males (at least when measured using a test of mental rotation) but there is no evidence that this weakness in spatial skills impacts upon performance in architectural design.

As we saw in chapter 4, it is often assumed that the work of an architect would demand high spatial skills. MacFarlane-Smith (1964), referred to a number of world-renowned architects who he felt had high spatial skills. We also saw that Peterson and Lansky (1980) showed that in an exercise with architecture students, those students who drew visually correct cubes tended to achieve higher marks and were less inclined to leave the course than those who drew 'cognitive' cubes. Peterson and Lansky suggested that the cognitive cube may have been drawn according to a rational set of rules; where as the visual cube was drawn intuitively. This may suggest that there is a link between visual-spatial skills and the rational-intuitive dimension previously mentioned. In the present research, there was no apparent relationship between spatial ability and design performance as measured by the mental rotation test. It is possible that the spatial skills investigated by Peterson and Lansky fell into a different category, compared to the present research.

MacFarlane-Smith has attempted to classify the different categories or factors that contribute to what is referred to as 'spatial skills'. He identified 4 key factors:

1) Spatial relations and orientation (SR-O): those abilities concerned with the understanding of patterns, the elements contained within those patterns and their relationship to an external frame of reference such as ones own body. It may be this factor of spatial ability that embedded

figures tests such as those used to measure field dependence may measure.

2) Visualisation (V_Z): that is concerned with the holding and mental manipulation of an image of an object, through its rotation, twisting or inversion within the mind. MacFarlane-Smith argued that this factor was distinguishable from SR-O in that it must depend upon an ability to manipulate the object as whole with in the imagination, and to distinguish it from other objects that differ in shape or form. He also argued that this factor was important in being able to produce an image of a physical object through drawing. It is possible that it is this factor that the mental rotation test would be testing.

3) Perceptual speed (P): which may be specifically relevant to situations where comparisons between two objects are made, but no mental manipulations are required.

4) Kinaesthetic Imagery (K): a tentative factor connected with kinaesthetic sensations of left and right with respect to the human body.

Whilst the Mental Rotation Test may appear to measure the V_Z factor, MacFarlane-Smith's assertions that this factor is important in drawing, also suggest that those students who drew visual cubes in Peterson and Lansky's experiment may have had high V_Z abilities. Those lacking visualisation ability would have constructed the cognitive cube, using a series of rules to counteract this deficiency. Peterson and Lansky do not describe the educational background of the students prior to studying architecture and it is possible that the drawing of visual cube may not be a reflection of spatial ability at all, but rather a reflection of whether a student has previously developed a facility to draw.

As we have already seen, architects use drawings as a means for holding and externalising their thoughts. This mechanism may counter any weakness in mental manipulation of space. Furthermore in the school of architecture involved in the present research, emphasis is placed on the making of physical models to support design thinking. If a student struggles to manipulate space mentally then the creation of a model may counter that difficulty. Further research could be carried out relating mental rotation to performance in design situations where students are not permitted to make models to support their thinking.

It is also possible that the items in the mental rotation test are substantially more complex and abstract than those that an architecture student would need to carry out. The test involves the manipulation of combinations of cubes, whereas mental tasks carried out by an architect would be likely to consist of many different forms, thus making it easier for the subject to find reference points.

8.42 Spatial skills and cognitive style

The subsidiary hypotheses questioned whether there was a significant correlation between a students' score on the wholist-analytic and verbal imager dimensions of the CSA and their scores on the MRT-A test. The results suggested that there were no significant correlations on either dimension. The null hypotheses that there is no correlation between and Mental Rotation and either CSA dimension must be retained and suggests that a student's spatial skills, as measured by the MRT are unrelated to cognitive style.

In Chapter 2, a possible link between spatial skills and cognitive style was identified based upon the work of Witkin. Witkin and Goodenough (1981) cited a number of reports that suggest that cognitive style (as measured by their tests) was related to two and three dimensional spatial abilities. Thus field independents (analytics), as measured by the Embedded Figures Test (EFT) were seen to have greater spatial abilities. We also saw that many figural tests including Witkin's embedded figures tests may measure what Lynn and Kyllonen describe as measures of cognitive restructuring ability which could be considered to be a spatial skill, similar to the SR-O factor described by MacFarlane Smith. In contrast to Witkin's research on spatial skills, Macfarlane-Smith claimed that there existed a tendency for those with a high spatial ability (relative to verbal ability) to see things as wholes, rather than as a series of parts. Riding and Pearson (1994) showed that there was no relationship between cognitive style as measured by the CSA and spatial ability, using tests that might particularly measure the SR-O factor. The present research suggests that there is no relationship between cognitive style and the V_Z factor.

One might assume that a heavy preference towards representing information in images might be a result of a strong spatial-visualisation ability, but this research suggests this not to be the case. It is possible that the cognitive style test and the mental rotation test are measuring different factors of spatial-visualisation abilities and that the Vz used in mental rotation aspect is not used in the tests for cognitive style which demand the mental picturing of an object without its manipulation. A more detailed factor analysis with a necessarily large sample would be required in order to investigate this further. Douglas and Riding (1993) looked at the relationship between drawing ability and cognitive style. They found that the quality of drawings produced by 11 year old school pupils were significantly better when drawn by a pupil with a Verbaliser cognitive style than those with an imagery style. Riding (1998) suggests that this is because the fluid mental images produced within the mind of an imager interferes with the ability to represent an image externally. It may also be that students with relatively strong verbal capabilities may have to rely on drawing to a greater extent than Visualisers in order to counteract a weakness in their visual faculties, and therefore may be more practised at drawing. The present research provides us with no real indication that this is the case, as no separate assessment of the students' ability to draw was made during the studies. Nevertheless, this may be an opportunity for future research.

Riding's Cognitive Style's Analysis claims to factor out any bias towards particular abilities and so it would not be expected that there would be any relationship between cognitive style as measured by his test, and spatial abilities. Certainly the results from this study suggest that there is no relationship between cognitive style and spatial ability, but whether this is a result of Riding's algorithms factoring out this bias is less clear.

8.5 A-Level Entry

The initial hypothesis questioned whether there was a significant correlation between students' marks in architectural design, and the overall 'A'-Level points score that they had when entering the school of architecture. The null hypotheses that there is no correlation between A-Level points score and performance in design learning must be retained. It is clear from these results that within the school of architecture being investigated 'A' level points scores provide little prediction as to how well students will perform in their architectural design work.

This result is unsurprising given that the methods of architectural education differ from the educational experience students receive in secondary education. This statistic would be difficult to apply to the population as a whole, because the Welsh School of Architecture only accepts students from within a narrow band of high A level grades. Further research could be carried out in schools of architecture that accept students from wider range of A level point scores. The numbers of 'A' levels held by students also varies, and a student with more A levels will no doubt possess more points but this is not necessarily a reflection of ability.

A second hypothesis questioned whether there was a significant correlation between students' marks in architectural design and their subject bias ratio as defined in Chapter 5. A significant correlation was found between students' marks and their subject bias ratio for the second cohort. This was primarily found in the second year, although female students also showed a significant relationship in the first year. The relationship was such that the higher a student's bias towards arts subjects; the more likely they were to achieve a better mark. The correlation did not appear for the first and third cohorts.

The results from second year of the second cohort suggest that the null hypothesis that no significant correlations exist between students design marks and the subject bias ratio can be rejected. It was not possible to reject the null hypothesis for the other cohorts. This is not to say that for the population as a whole there would be no significant relationship; rather with this particular sample of students, and the circumstances of their learning, there was no significant relationship. It is possible that the second cohort had design projects that were constructed and taught in a way that particularly suited students with a bias towards artistic subjects. To determine if this was the case would require the development of some system for analysing the teaching and content of individual projects. This will be discussed further in the opportunities for further research section below.

A third hypothesis questioned whether there was a significant difference between the mean position within the cohort (with respect to marks for architectural design) for students in each of the three arbitrary style groupings of Artist, All rounder and Scientist. When the cohort was split into these groups the results do not support the significant correlations found for the second cohort previously and we must retain the null hypothesis that there is no significant difference in the mean positions in the cohort for the three groups. This was also the case when the cohort was split by Gender. This suggests that it is likely that the significant correlations found for the second cohort are of little practical significance and may be a result of random chance.

The data from student interviews suggests that some students took science based subjects, because of some perception that they were necessary in order to study architecture. In reality this is not necessarily the case and overall the results from this study suggest that there is little advantage in having either an arts or science bias to an 'A' level portfolio.

A fourth hypothesis questioned whether there was a significant change in the mean position in the cohort between the end of their first year and the end of their third year for students in each of the three arbitrary style groupings of artist, all rounder and scientist. In the first cohort there was a significant decline in the mean rank position for scientists. By contrast in the second cohort there was a significant decline in the mean percentage rank position for Artists. Thus, whilst it is possible to reject the null hypothesis that there will be no significant changes in the mean positions of each of the groups, those changes appear to be inconsistent.

It is unclear why each cohort appeared to behave so differently and the nature of the projects carried out during the students' third year was similar for both cohorts. Given the contradictory nature of this finding, it is unlikely to be of any practical significance.

The final hypothesis questioned whether there were significant correlations between students' scores on the two dimensions of cognitive style as measured by the CSA and their subject bias ratio. The results suggested that there were no significant correlations. The null hypotheses that there is no correlation between subject bias and either dimension of cognitive style must be retained and suggests that a student's cognitive style does not appear to influence the student's bias between arts and science subjects.

From the descriptions given in the literature review, particularly regarding the work of Hudson, one might expect those with an analytic, sequential cognitive style to have a preference toward the sciences, whilst those with a holistic, global or intuitive cognitive style might have a preference towards the arts. Furthermore one might easily assume that a student with a preference for thinking in images may perform better in arts subjects, whilst one who has a preference for thinking verbally, may perform better in science subjects.

The results from this study suggested that this was not the case. It would seem that even if cognitive style does mediate in subject choice as was suggested by Hudson, it cannot be assumed that subject choice is a good indicator of cognitive style. Further investigations, with a wider selection of students, would however be required to show whether this is the case.

8.6 The Presage, Process and Product Model

Despite some significant relationships, many of the results of the study were inconclusive and inconsistent, for instance significant relationships between the students' performance and the wholist-analytic dimension, only occurred for the first cohort. This may be a result of the methods of measurement, but it may also reflect the fact that learning style represents only a proportion of the many factors that contribute towards learning, with other influences being the nature of the projects and the style of teaching taking place.

As was shown in Chapter 2, educational researchers including Biggs (1999), Ramsden (1992) and Prosser and Trigwell (1999) subscribe to a model of learning which argues that the influences on student learning are derived from a wider variety of sources than simply their learning styles. The model concentrates upon three phases of the educational process as shown in Figure 20. The initial presage stage represents the learning context, in terms of the course design, teaching methods and assessments (B). In architecture, this would represent the design projects, their relationship to each other and to other elements of the course and the methods of assessment. Further contextual elements might include some of the sociological factors identified in Chapter 3 by Cuff and Stevens. Along with the learning context the presage stage also considers what the student brings to the learning situation (A). This would include prior experience, current understanding and abilities, their learning and cognitive styles and their social background. During the process stage, the individual characteristics of the student, will lead to different students having different perceptions of the learning context (C) and these perceptions will govern how the students approach their learning (D). The individual approaches will lead to the generation of a learning outcome (E).

As we saw earlier, Prosser and Trigwell (1999) argued that the perceptions that students form are crucial in determining the eventual outcome. These perceptions can be managed by ensuring that the aims and objectives of the teaching are clearly communicated to the student and by ensuring that the assessment methods are closely aligned to the learning objectives (Biggs 1999). Whilst these perceptions might be influenced by the student's learning style, there will be many other factors that shape the perceptions, some of which are out of the control of the student and connected with the learning context.

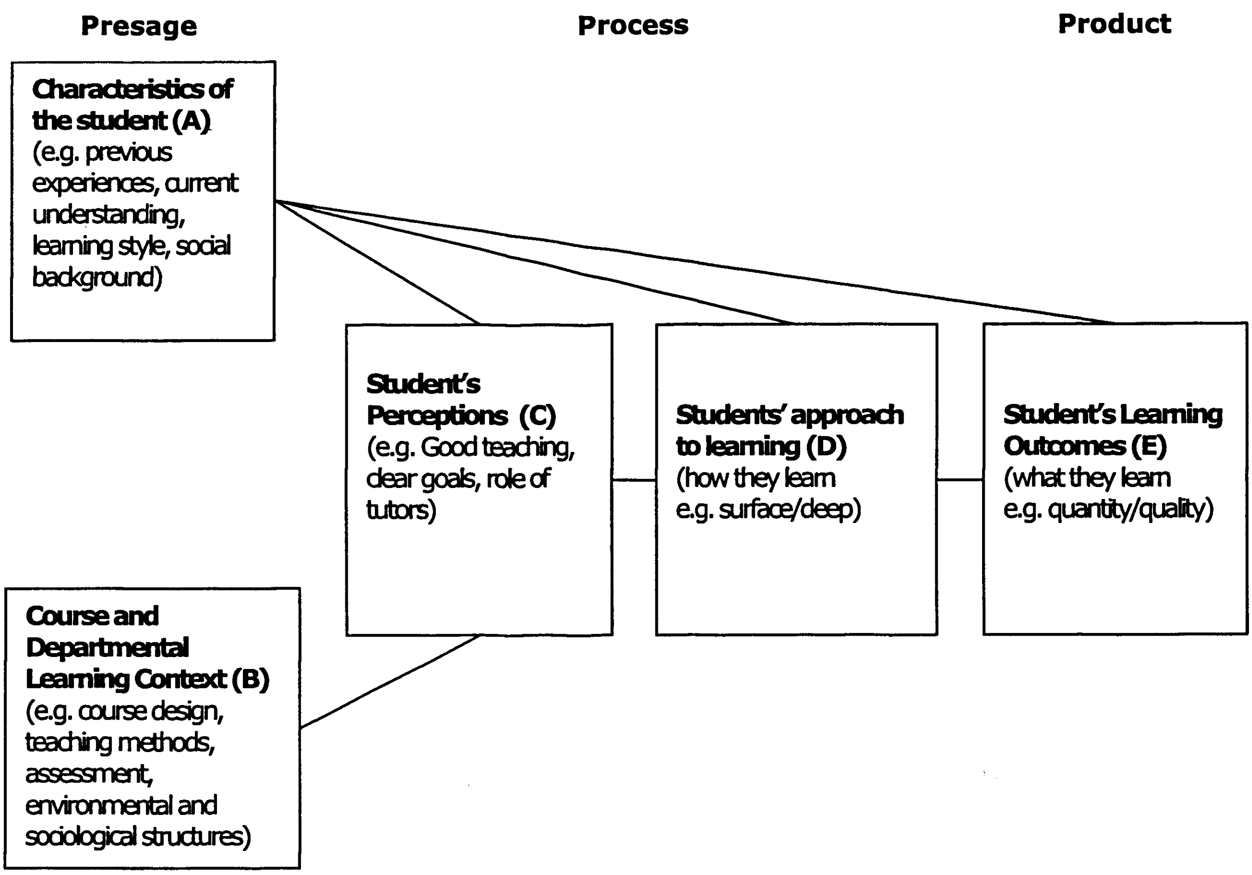


Figure 20 The Presage-Process-Product model (Biggs 1999)

One key factor outlined in this research, was the importance of the relationship between tutor and student. During the interviews with students, some described how they worked with their tutors, and some expressed the value of having a particularly good tutor. A contrast arises between the strong and the weak students in terms of this relationship. Student E talked about tutors in terms of how she was trying to satisfy their requirements. This description shows similarity to Schön's (1985) description of the relationship between Lauda and his design tutor where more emphasis was placed upon technical rationality than developing an intuitive form of reflection in action. The descriptions from the strong students could be considered similar to the relationship described by Schon between the design tutor and student, where Petra was learning about the processes of reflection in action and reflection on action, through an active dialogue with Quist.

Whilst the interview data suggests that a tutor may have a heavy influence upon how a student performs, it is still possible that a student's particular cognitive style may also impact on how successful that relationship is. The Presage, Process, Product model may help to explain this.

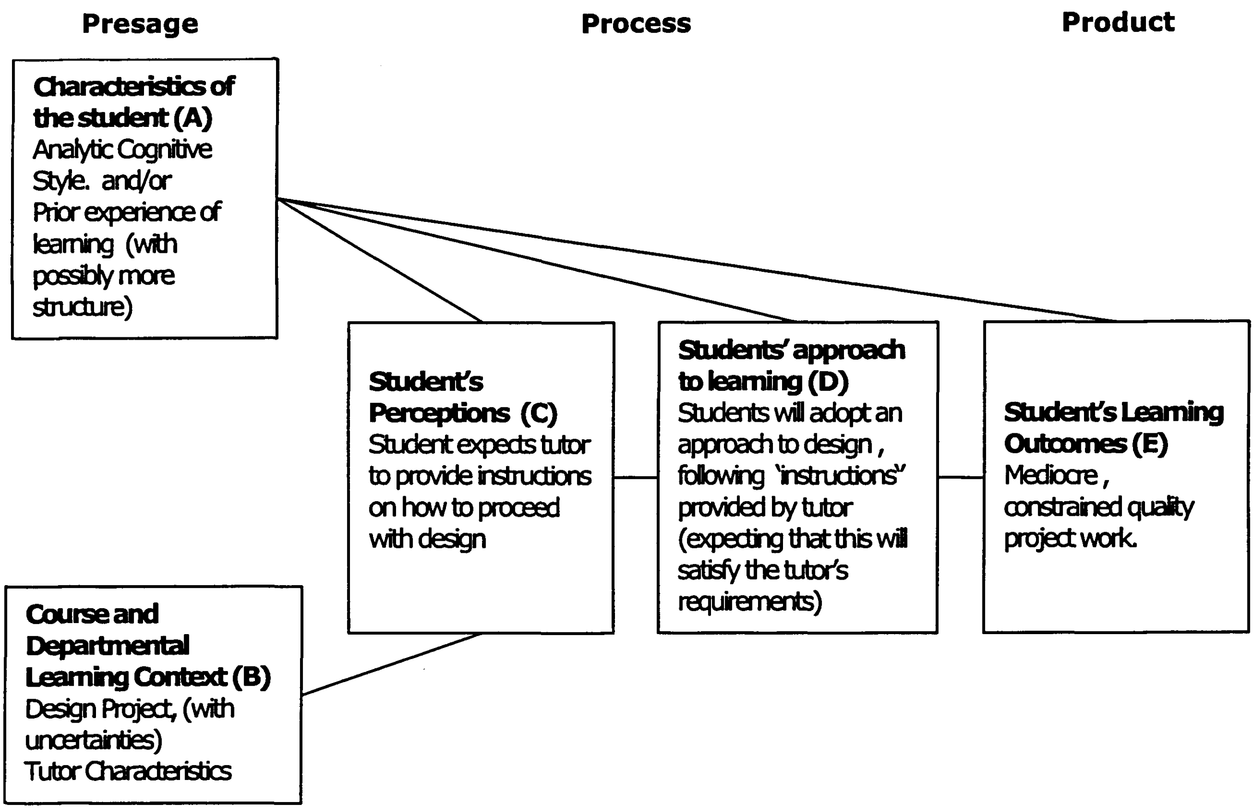


Figure 21 The PPP model applied to an analytic student carrying out a project with many uncertainties.

It has already been suggested that analytic students might struggle to create a framework when working within uncertain circumstances such as those found in architectural design projects. The PPP model, shown in Figure 21 suggests that this characteristic, together with any memories of how they may have studied previously will lead to the generation of particular perceptions of the learning context (A). These perceptions will also be influenced by the context within which the learning takes place, including the nature of the projects, how the projects are structured, how they will be assessed, what information is provided to the student and also the characteristics of the tutor (B).

In the case of the analytic student, where the context contains a degree of uncertainty, as is common in projects later in the course, this may lead to a perception that the design tutor can provide the necessary framework that the student is seeking (C). For instance student E said that she was trying to find out "what they [the tutors] want" in order for her to be successful. This leads to an approach whereby the student tries to satisfy what she perceives to be the requirements of the tutor (D). The outcome of this may be the generation of mediocre or constrained project work (E). Student E for instance commented that she was often being told to 'think wider' and be less constrained.

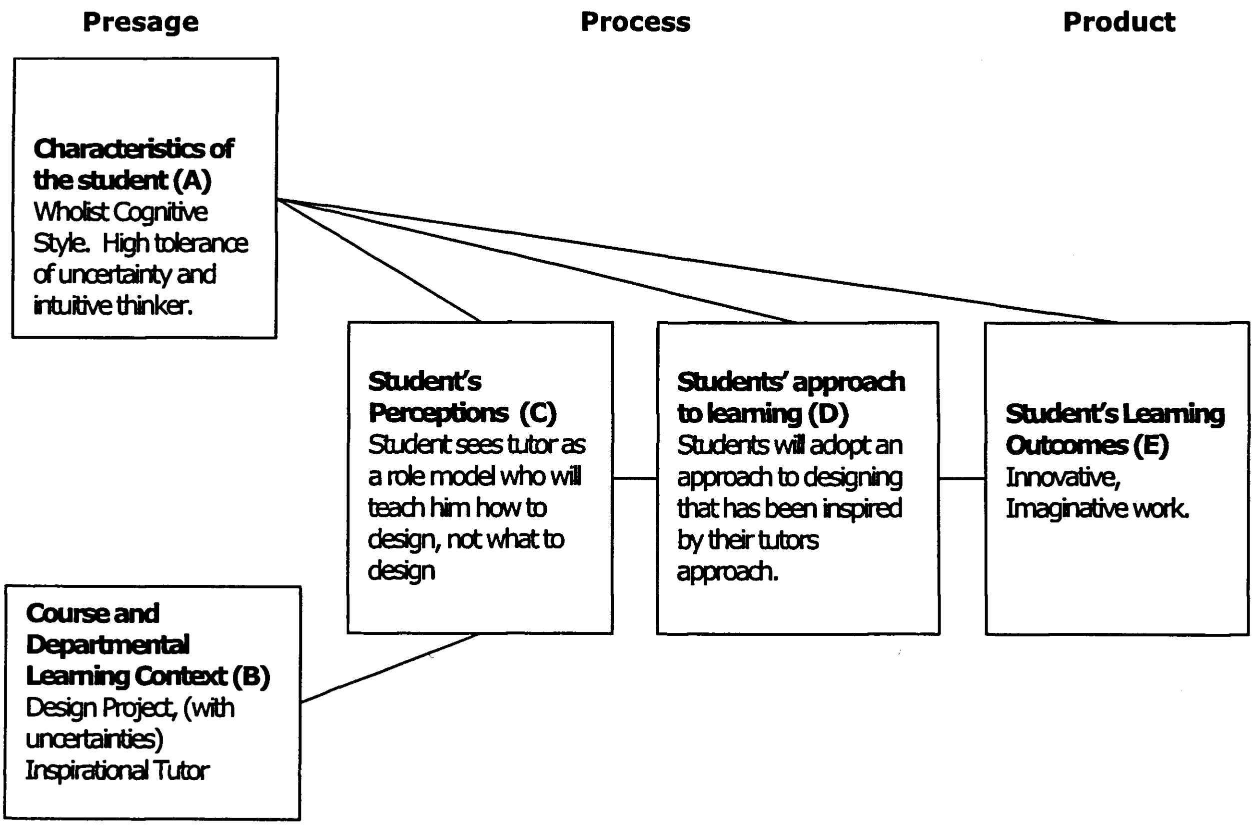


Figure 22 PPP Model applied to a 'wholist' student

It has also been suggested that wholist students may be better able to cope with uncertain circumstances. The PPP model, shown in Figure 22 suggests that this characteristic (A) may lead to a different perception of the learning situation to that suggested by the analytic student. This perception may be assisted, as was suggested in the interviews, by the student working with a particularly inspiring tutor. The student may worry less about what is required of him and would perceive the role of the design tutor to have more of an inspirational role (C).

In the interviews, the students who improved most during the course talked about their relationships with their tutors as a dialogue. One student talked about the tutor as having "opened my eyes to what I was trying to achieve...and since then I improved more and more so". Another talked about his tutor in terms of

> "It was just trying to understand where his ideas came from and how he thought about them which I was trying to suss out, but I found it quite hard... I suppose with [Tutor] giving ideas, you've got to come up with your own of an equivalent standard - I found that quite a challenge, but that was really beneficial I think."

Both these descriptions suggest that students were using their tutor as a role model, attempting to use them as a means for understanding design thinking, rather than as sources for dictating rules and constraints. Their subsequent approach, rather than being one of trying to satisfy requirements, was one of trying to change the way that they generated and thought about ideas in order to satisfy their own goals (D). The outcome of the students taking this approach was designs that were considered by their assessors to be innovative and imaginative (E).

The models suggest that whilst cognitive style might have an influence upon design performance, other factors connected with the perceptions that students generate may also have a particular influence. It would be useful to conduct further studies looking at how these perceptions are generated and how they can be influenced by teachers.

CHAPTER 9: CONCLUSIONS, IMPLICATIONS OF THE RESEARCH AND OPPORTUNITIES FOR FURTHER RESEARCH

9.1 Conclusions

The parameters of this research were necessarily drawn tightly in recognition that there are many complex variables that might affect a student's performance in architectural design education. For this reason, the research specifically considered whether learning styles, as measured by established tests could be used as predictors of success in architectural design education. The findings of the present research suggest that this is not the case, although this may be a reflection of an inappropriateness of the specific tests used, rather than the constructs of learning and cognitive styles themselves.

The rationale behind this research was to determine whether learning styles might be a useful mechanism in selecting students for admission onto courses in architecture. The findings suggest that one may tentatively draw a link with the wholist-analytic dimension as measured by Richard Riding's Cognitive Styles Analysis such that students who are labelled as having analytic cognitive styles, that is those students who tend to organise information in parts rather than wholes, tend to gain higher marks for design than other students in the early years of their architectural education within the school studied. Nevertheless by the time they reach the third year of their course, they tend to perform less well by comparison with their peers. Whilst this dimension of cognitive style may have had an initial effect upon the performance of students in their early years, by the completion of their studies, it seems to have had little effect on their performance. It is possible that in the projects at an early stage, there were fewer aspects for students to consider simultaneously than in the later stages and that frameworks are provided to assist their understanding. As the breadth of factors that students need to consider increase, and as students were required to construct their own mental frameworks, analytic students may have found the projects increasingly difficult. This research suggested that analytic students tended to perform better in the early phases of their course, where frameworks for understanding were provided. They performed less well in the later stages of their course, where there was a greater degree of uncertainty. Interview results suggest that wholists might have found the frameworks provided in first year, a constraint.

The findings of the present research also suggest that an alternative measure of this dimension, the Approaches to Studying Inventory was not suitable for predicting success in architecture students.

The results also suggest that there is little difference in the performance of those students who prefer to represent information in images (imagers) and those who prefer to represent information in words (verbalisers), There are recognised concerns about the reliability of measurement of this dimension, which have arisen since the selection of the Cognitive Styles Analysis tool for this research (Peterson et al 2003; Coffield 2004 and Redmond et al 2002).

Two related but subsidiary questions were also posed. The first looked at the extent to which students' performance in architectural design education was related to their ability to manipulate three dimensional objects and space within the mind. The findings suggest that there was no clear evidence that spatial ability as measured by one's ability to rotate a complex shape within the mind bears any relationship to performance in architectural design. Some students clearly find this more difficult than others and female students attained significantly lower scores on these tests than male students.

The second subsidiary question looked at the extent to which students' performance in architectural design was related to their entry qualifications, particularly with respect to GCE 'A' level performance. The research suggests that 'A' level points form a poor predictor of performance, and the bias of subject choice between the arts and sciences is little better.

9.2 Implications of the research

Although some of the results do suggest that the wholist-analytic dimension of cognitive style, might be a better predictor of a student's performance than 'A'-level grades, or a student's possession of spatial skills, the inconsistent results between the three cohorts, suggest that Cognitive Styles Analysis, in its current form, may not be an ideal tool for the selection of students. It is not clear from the results whether their inconclusive nature suggests that the measurement tool is particularly unreliable, or whether the results are a reflection of the complex challenges of design projects that may rely upon different mental faculties at different times and circumstances. Nevertheless, the research does suggest that there are individual differences between students, in terms of their perceptions and the ways in which they organise and represent information, that may require further consideration by teachers and researchers.

The research has been based upon an assumption, provided by a number of authors (Schmeck 1998; Riding and Cheema 1991; Allinson and Hayes 1996) that there exists a super-ordinate series of cognitive styles. These provide convenient models for initial analysis of individual differences but are likely to understate the complexity of the human mind. These dimensions therefore, should be treated with a degree of caution given the broad assumptions upon which they are based and the lack of empirical data that link each model to the super-ordinate dimension. One can easily question whether analytic thinking necessitates serialist processing, or whether 'wholist' thinking, refers to seeing something as a whole, or being able to think at multiple levels simultaneously. Riding prefixes the word holist with the letter 'w', which may suggest that this is different to Pask's 'holist' dimension. Whilst certain style labels may show a degree of similarity, it would be unwise to suggest that they are either synonymous, or are generated from the same mental process or cognitive control (Sadler-Smith et al 2000). For instance viewing something holistically may not be the same as behaving intuitively. Nevertheless, a super-ordinate dimension of cognitive style, may usefully reflect a commonly observed, but not necessarily universal tendency, for an individual to behave in a particular set of ways.

As suspected amongst teachers of architecture, there was no correlation between 'A'-level grades and performance in architectural design. In the school studied, it also appeared to make little difference to design marks whether a student had studied predominately arts subjects or science subjects. These may be specific to the school studied, but the results do suggest that admissions tutors may need to look beyond 'A' level subject choice as a mechanism for selection. The research also suggested that in the school investigated, students had predominantly analytic cognitive styles, compared to the general population. This may be a result of the 'A'-level system favouring analytic students and given that the research also suggested analytic students performed less well in the later stages of their courses, this may be of further concern to admissions tutors. These findings suggest a need for the development of alternative mechanisms by which student applications can be filtered.

The results from this study suggest that the Cognitive Styles Analysis test is not an appropriate tool for selection. After three years of study, under the circumstances presented to students, in the school of architecture studied, an individual's cognitive style appears to have little significant effect upon their performance in architectural design. Furthermore, doubts have been expressed about the reliability of the CSA by Peterson et al (2003), Coffield (2004) and Redmond et al (2002). As it stands, the CSA appears not to be a good predictor of future performance in architectural design education. Nevertheless, this is not to discount the possibility that an understanding of cognitive styles may be useful in the selection of students, particularly with regards to whether an individual has a preference for thinking in a global, holistic or intuitive manner, or whether they have a preference for thinking in a sequential, analytic manner. The interview data described in chapter 7 of this research, albeit from a limited sample, did suggest that individuals who performed well in their third year, showed signs that they were thinking intuitively. Those who did less well suggested through their interviews, that they might be constrained by an overly analytic mode of thinking. There may be other mechanisms that admissions tutors could use to determine an individual's cognitive style. This might be through a modified cognitive style test; through the careful questioning of students in interviews; or by asking candidates to participate in some exercise which is designed to reveal cognitive style, in a similar way that Pask determined the cognitive style of his subjects. These represent opportunities for further research that will be discussed later.

The results of the mental rotation test similarly bear little relationship to students' performance in architectural design education and again this is not a suitable test for admissions. As we saw in chapter 4, Peterson and Lansky found that how students draw cubes formed a good predictor of future performance in architectural design, although further research would be needed in other schools of architecture to determine if this really is a useful admissions tool.

There is no evidence in the research to suggest that significant differences in performance in design work occur between the genders. Neither does gender appear to be related to cognitive styles. Whilst differences between the genders with respect to design marks do occur in some of the cognitive style groupings, these results are inconclusive and are possibly a response to a small number of females in some of the groups. Nevertheless the results do suggest that the mental rotation skills of males are significantly better than those of females, but this appears to have no impact upon the students' final performance. The implication of this for the profession of architecture is that despite possible differences in spatial abilities, gender cannot be considered as grounds for the selection of architects.

The majority of research into learning and cognitive styles has been carried out on school children, or students of psychology and business studies. This research has been a useful exercise in expanding that research into a wider area of study, particularly one that uses the teaching and learning methods associated with designing. Entwistle's Approaches to Studying Inventory (ASI) is considered to be one of the most reliable of the learning style indexes (Coffield 2004) and yet this provided a very poor predictor of performance in architectural education, primarily because it questions areas of study that are less common in architectural education, than in other areas of study. Results from using Cognitive Styles Analysis showed some correlations with performance, although even these were limited. Nevertheless, there is some evidence to support the predictive validity of a learning style test that does not rely upon self report questionnaires.

The research has not attempted to investigate the reliability and validity of the tests used; this has been covered elsewhere, and it is clear that there are some concerns, particularly with the Verbaliser-Imager scale on Cognitive Styles Analysis. A more reliable test may have provided different results. Neither does the research tell us whether cognitive style remains stable over time. Riding (1998) suggests that it is stable, but admits that there is a need for a fuller study investigating this claim. Nevertheless, it is difficult to distinguish a measure of cognitive style stability, from a more general measure of test-retest reliability as both require the repeated administration of the test over a period of time,

9.3 Opportunities for Further Research

The majority of the data used in this research were collected through the application of particular quantitative tests. This is useful in identifying underlying relationships and trends. Nevertheless, the quantitative results have on the whole tended to be inconsistent and any trends that emerged were generally unclear. For this reason, the qualitative interview responses were particularly useful in helping to explain the inconsistent and unclear results. Unfortunately, the number of interviews was limited, and a further study interviewing a larger number of students, at various stages of progression throughout their studies would be a useful investigation. This research could take the format of the phenomonographical studies carried out by Marton and co-workers (Marton 1988) and may even lead to the development of a new instrument for measurement.

It has been suggested that at present Riding's Cognitive Style Analysis tool may not be an ideal tool for the selection of students to enter schools of architecture, even if the concept of cognitive style may be a useful discriminator in itself. Nevertheless, it is possible that admissions staff may be able to gain an impression of a student's cognitive style (or other personality aspects) by conducting interviews with prospective students. Pressures on admissions staff time however, make the possibility of interviewing all applicants increasingly difficult, and therefore some form of tool that can quickly and easily discriminate between students may be advantageous. One possibility is that the Cognitive Styles Analysis tool, which at the time of writing is over a decade old, should be revised and updated in order to address some of the validity and reliability issues alluded to previously. Concerns have been raised that some of the items in the existing tool may not be sufficiently challenging for higher education students and it may also be necessary to create a version that is particularly suitable for this group, rather than relying upon a single test that is designed for all subject groups. This research could be further extended to investigate the possibility of a test that is particularly tailored for architecture students. At present the Cognitive Styles Analysis addresses what its authors regard as two super-ordinate dimensions of cognitive style and this research suggests that one of those dimensions, the wholist-analytic dimension might be a useful predictor of performance in architectural design education, were a better tool for measurement available. Nevertheless, the complexity of architectural design education may dictate an instrument that is able to measure a wider range of dimensions, so that a more detailed profile of the student could be derived that is appropriate to the subject area. These dimensions may be derived from the models reviewed in chapter 2 of this thesis, but there may be other dimensions that have yet to feature in learning styles research that might emerge through further investigation.

Time and resources did not permit this research to use more than a small collection of learning style tests. It would also be useful to repeat the exercise with a wider selection to determine if any were particularly appropriate. This would particularly apply to the Myers Briggs Type indicator, which had to be excluded from this research because the author was not qualified to administer it.

The sample selection in this research comprised students from one particular school of architecture, who generally had achieved high grades in their 'A'-Levels. A similar study in a selection of other schools, accounting for students with a wide range of 'A' level grades would be necessary to confirm the lack of a relationship between 'A' level points and subject choice and eventual performance in design project work.

This research has also suggested that the three cohorts were more analytic than Riding's standardisation sample, and it is possible that this is common for other higher education subjects; a consequence of current secondary education system favouring analytic students. A comparative study with other schools of architecture may also help to determine whether this is a common phenomenon.

As was suggested in chapter 5, students in the school of architecture under consideration are on the whole also considered to be from middle class backgrounds. It is not clear whether this is the case in other schools of architecture and the author is not aware of any studies relating cognitive style and social background. There may be a need for further research into this area.

When considering comparative studies between schools of architecture, it should be remembered that the teaching and learning activities, design projects and the profile of the student body in other schools may differ considerably, and the relationships between design mark and 'A'-Level performance may differ, making such comparisons difficult.

The results from this study suggest that in the school of architecture studied, those people, who preferred to process information in a series of parts, did better in the early years of their course, compared to their peers who did less well. By the end of the course, this distinction was less prevalent. It was not the intention of the research to determine the factors that are likely to encourage those with particular cognitive styles to do particularly well in particular projects, or stages of their education. Nevertheless, doing so would provide valuable data for the future development of design projects. In order to do this it would be necessary to carry out a detailed analysis of every single project that students pursue. This would require the generation of a framework by which projects could be analysed, that would need to take into account a wide selection of factors including, the intended learning outcomes, the scale and type of building being designed and the level of resolution of detail, style of tuition, length of project and assessment techniques. Indeed, it is likely that this type of analysis would be almost impossible to carry out, given the complex nature of all but the most rudimentary of design projects especially when design projects are created to satisfy the educational needs, rather than the needs of a researcher. As has been previously hinted at, it may be this complexity that has led to the rather inconsistent results. An alternative would be to stage a number of deliberately focussed design projects, as a research exercise in the way that Demirbas and Demirkan (2003) did with regards to Kolb's Cycle of Experiential Learning.

Further research could also tell us whether learning and cognitive styles lead to differences in the ways in which students approach project work. Van-Bakel's (1995) study could form the basis for further investigation of this. It was clear from the research that some students had greater spatial abilities than others, although this appeared to have little impact upon performance in design project work. It is possible that students with different spatial abilities are adopting different strategies, particularly with regards to 3D modelling and drawing, in order to counter this difference. Further research would be necessary to explore these different strategies.

The lack of conclusive validity and reliability data on particular learning style models continues to shape the discourse on learning styles and represents a possible reason why there is no universally accepted instrument for their measurement. The wide variety of models may reflect the fact that particular tests are more suited to particular subject groups than others. Nevertheless, it may be that simply having an understanding of learning styles, could lead to recognition of individual differences by teachers. This recognition may assist in the selection of students onto specific courses and lead to more inclusive methods of teaching without necessarily having to administer a test to measure learning style. Moreover, teachers who plan to take account of learning styles should recognise that an individual's learning style will only be a starting point within their educational processes, and as students progress, they will develop particular strategies, and ways of working that would counteract any weaknesses in those styles where appropriate. It may be a role of tutors to assist in the development of these strategies.

The learning style tests used in this research have generated somewhat inconclusive results, and it is unlikely that they could be used as a predictor of future performance in architectural design education in their present form. Nevertheless, there remains within higher education, the need for the development of tests that can assess the potential of future students in a variety of subjects. It is possible that a re-developed learning style test might be a mechanism for achieving this.

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Appendix 1:

The student Experience in the Welsh School of Architecture

Document produced by Professor Simon Unwin and the staff of the Welsh School of Architecture as part of the school's submission to the Quality Assurance Agency (QAA) 2002

WELSH SCHOOL OF ARCHITECTURE, BSc AND BArch DEGREE SCHEMES – ANALYSIS OF STUDENT EXPERIENCE (SESSIONS 2000-2002)

This matrix describes the student experience of architectural education in the Welsh School of Architecture, through the BSc in Architectural Studies and the BArch. The courses provided change in their details session by session, though the pedagogic thrust, pattern and relationship of projects and courses remains broadly the same. The situation described is hypothetical, in that it records the state of each year of the two degree schemes as they stand in the session 2001-2002, as if a student could attend all years simultaneously. The intention of the matrix is to illustrate the complex linkages and interrelationships between different components of the schemes in a way that might not be apparent in the standard module descriptions. The matrix represents a timeline running down the pages. The columns running across the pages describe roughly concurrent activities.

Overall Aim of the BSc and BArch Degree Schemes

The overall aim of architectural education in the School is to help students become well-rounded and capable architectural designers, who possess: the creative skills and disciplines or architectural design; a broad understanding of the historical and cultural context of architecture; the foundations of technological competence relating to the construction of buildings and environmental design, including issues of sustainability; an understanding of the professional responsibilities and duties of architects to clients and to society; and good habits of enquiry as a basis for lifelong learning.

The BSc Degree Scheme

BSc Module Structure.	The Design module is the core of students' experience as they go through the BSc. It consists of a number of projects in each semester, many of which are to design a building according to a set brief, but some are related exercises intended to deepen students' understanding of their design tasks, or broaden their understanding of architecture or one of its aspects. The projects tend to increase in complexity, size, and challenge through the three years of the scheme. Management of the curriculum content is overseen by the School's BSc Scheme Review Committee, a sub-committee of the Board of Studies. Each year of the scheme is led by two permanent design tutors, who inflect the project briefs with their own interests and research expertise. One of these is Year Chair and has overall responsibility for the year. Each year also has a Teaching Assistant, usually a recent graduate of the School (employed on a 1-year contract whilst also studying for a Masters degree), who helps with tutoring and with the administration of the year group. Design teaching is supplemented in all years by part time tutors, usually from local or nationally known architectural practices. Alongside the Design module, BSc student generally take two Lecture modules, organised and delivered by permanent staff, with some contributions from staff of other University departments and invited visitors. All modules are obligatory, there are no elective modules in the two degree schemes. The QAA 'Benchmarking Document' for Architecture identifies five threads in architectural education: architectural design; studies related to the cultural context of architecture; building technology; professional studies; and communication studies. Architectural design may be said to be more a 'backbone' to architectural education than merely one of five threads, but generally it will be recognised that these five threads intertwine in a complex multi-dimensional way through the BSc and BArch degree schemes described below. In each year of the course there are twelve modules. The Design modules bundle together eight of these in each year, leaving four. Two of these are allocated to the Building Technology 'double' Lecture module, which runs through both semesters in Years 1, 2 and 3. The remaining two modules in each year are allocated to single semester Lecture modules dedicated to subjects related to the cultural context of architecture. The only exception is the Autumn semester Lecture module in Year 3, which is allocated to Practice Management and Economics. Generally speaking, the content of the BSc and BArch degree schemes is dynamic and responsive. The general syllabus of the lecture modules is outlined in the module descriptions. The module descriptions for the Design modules state the general themes that will be covered during each part of the degree scheme, and the specific projects that will be run are presented to and agreed at Scheme Review Committees before each semester begins, but if opportunities for enhancing the student experience arise during the session, year teams are encouraged to take advantage of them, and if beneficial modifications to projects as outlined at Scheme Review Committee meetings are needed, then year teams are encouraged to make them. Proposals to change the themes of the Design modules in response to changing aspirations, and to feedback and performance in previous sessions, are presented at the Scheme Review Committee, which is charged with maintaining the progression of challenges with which students are faced through the degree scheme. Students are informed about the aims and intentions of design projects through project briefs, which are generally distributed and discussed at project introductions at the beginning of each project. With regard to admissions, one of the BSc tutors is responsible for the overall selection of students, coordinating colleagues in selecting suitable candidates from UCAS forms. Applicants are not generally interviewed, but all those offered a place are invited to an open day at the School, during which the structure and broad content of the schemes are explained. They (with their parents) may meet the staff and students, and can view the facilities and accommodation. Some applicants, for example mature applicants with interesting backgrounds but poor qualifications, may be invited for interview during these open days. The standard offer at 'A' level is ABB.

SEMESTER	DESIGN MODULES (3 d+/w)	OTHER ACTIVITIES	LECTURE MODULE 1 (.5 d/w)	LECTURE MODULE 2 (.5 d/w)	COMMENTS
pre-BSc scheme	At 'open-days', and by letter in September, incoming students are asked to read two books: Michael Pollan – *A Place of My Own*, and Simon Unwin – *Analysing Architecture*. The first is a useful introduction to architecture – its conception, realisation, and professional interrelationships – focusing on a small building; students must prepare one A4 sheet commenting on the book, which they discuss with their design tutors early in the Autumn semester. The second book is read as preparation for the Autumn Semester taught module - Analysing Architecture. [3-4 weeks; 'design' tutors; not assessed.]	At Registration, in the week before the Autumn semester starts, students are given a handbook for the BSc Degree Scheme along with 'Essential Information for Students', which gives information on scheme regulations and module timetables. They are also sent a list of equipment they will need, and introductory advice on studying at university. [Well before they are due to arrive, the University sends incoming students information on halls of residence and general university matters. Overseas students are sent a video of student life in Cardiff, and also, on their arrival, met at the airport and brought to their residences. The students' union also arranges events introducing students to activities available, and organises orientation trips around Cardiff.]			By asking them, at the outset of their architectural education, to read a suitably accessible text and write a short statement on their response, students are made to think about what they are expecting from their architectural education. Course information tells students about the structure of what they will encounter. University and student union information tells students about accommodation and life in Cardiff.
BSc Year 1 - Autumn	ARCHITECTURAL DESIGN 1 [AR0001] - [See next column for preparatory exercises, which are held before the Design module proper starts.]	The first three short activities operate as a 'round robin', and happen in week 1 of the Autumn semester: Architect Friends – In pairs, students draw a full-size elevation, section, and plan of their partner. This introduces the concept of orthographic drawing for display, and helps students get to know each other. The drawings line the corridors, 'introducing' the 'first years' to the rest of the school. [1 day; 'design' tutors; not assessed.] Introduction to Computing – in groups, students are introduced to computer facilities in the school, including e-mail and the Internet. [1 day; 'computer' tutors] Introduction to the Library – Students are given a general	BUILDING TECHNOLOGY 1 [AR0021] – This double module runs through both the Autumn and Spring semesters. The Building Technology module has three strands: Structures; Construction and Materials; and Environmental Design. Each strand occupies a portion of a module morning each week. The assessment for the Autumn semester is based on coursework integrated with the Design module. The assessment for the Spring semester is by written examination. Thus the double module as a whole is assessed 50% by coursework, and 50% by written examination. All three strands are assessed through both coursework and examination. Structures is taught through a	ANALYSING ARCHITECTURE [AR0006] – This single module runs through the Autumn semester only. The intention of this module is to give students the beginnings of a framework for analysing architecture, which will help them start the process of learning how to design. The core text is *Analysing Architecture*, written by the module tutor. The module offers a definition of architecture as 'intellectual structuring', concerned (at the rudimentary level) with 'identification of place'. This definition enables students to build a bridge from their own experience into architectural design. The analytical framework consists of themes presented through short	Students are helped to 'feel at home' in the school of architecture, and to get to know their colleagues and the staff, by giving them exercises in relaxed situations, and which involve them with others. Students are encouraged to see that one of the best ways to learn about design and how to do it is to look carefully and analytically at how it has been done by other architects. Students are given supplementary exercises that help them develop: their skills in architectural drawing and model making; their ability to use computers for word-processing and design related work; and the intellectual skills needed for architectural design. For the Design module, students

SEMESTER	DESIGN MODULES (3 d+/w)	OTHER ACTIVITIES	LECTURE MODULE 1 (.5 d/w)	LECTURE MODULE 2 (.5 d/w)	COMMENTS
	Exercise Workbook – students are given a workbook for their first semester in architectural education. It combines three design projects with a number of related exercises for developing skills in analysis and technique (e.g. architectural drawing and model making), and an understanding of architecture as place-making. It includes: Design Project 1 – 'Land-Art'. Students are taken to a beach where, using only found materials, they make a 'place'. Then they draw the made 'places' they feel are most effective. This project helps students get to know each other and the tutors they will be working with through their first year; it also introduces most of them to the countryside of Wales. The project challenges them to think in terms of place-making, develops an understanding of rudimentary materials and construction, and gives practise in sketch drawing and evaluating of the work of others. [1 day; 'design' tutors; assessed] Design Project 2 – 'Place to Live 1'. Each student designs a small place to live, selecting a site in the grounds of the folk museum at St Fagans. Students are encouraged to take advantage of existing topology and features, and think in terms of 'place-making' rather than 'designing a building', and using 'inside', 'outside', and 'in-between' spaces. They prepare orthodox architectural drawings, 3d sketches, a model, and a construction section for their design. [5 weeks; 'design' tutors; assessed at Final Crit (see 'Comments' column); written feedback.] While doing this students are also engaged in a series of exercises focusing on the reconstructed houses at St Fagans. Generally done in groups, these include: measured drawings; structural models; construction drawings, including full-size sections; analysis of spatial organisation; coloured drawings and verbal descriptions of aesthetic qualities.... The exercises help students understand buildings, their architectural organisation in context, their structure, their construction and use of materials, their experiential and aesthetic qualities... and give practice in the skills of orthographic representation and sketching.	introduction to the Architecture Resource Centre backed up by tours in groups of the architecture library. They are given an exercise in study skills, and required to summarise in their own words a representative article from a current architectural journal. This demonstrates their ability to grasp and express the main ideas and arguments in the article. These summaries are read, comments made, and then discussed in tutorials later. They are good indicators of students who may have difficulty with expressing themselves in English. Adopting an Architect – Each student chooses a twentieth century architect and house to research as the subject of an essay. The exercise teaches the first steps in the skills of finding, organising, referencing and presenting information. This is gathered mainly from the architecture library's collection of books and journals and increasingly from web-based sources available in the library. Students are encouraged to apply to their written presentations skills developed in other parts of the course, e.g. 'Analysing Architecture' drawing skills, word processing, and computer skills. [Autumn semester; 'library' tutors; assessed.]	series of weekly lectures presented by staff from the University's Department of Architectural Engineering. The lecturer also joins studio crits on an exercise to analyse the structure of the houses in the Folk Museum in St Fagans (see the Design module). Construction and Materials is taught by a part-time member of staff, experienced in practice. The lecturer also sets and marks some exercises asking students to draw and analyse the construction of the houses in St Fagans, and the twentieth century houses studied in the Design module. (In the Spring semester the Construction and Materials lecturer also offers construction 'surgeries' associated with the Design project.) Environmental Design is taught by a member of the School's research centre for environmental design. Exercises are set in connection with both the St Fagans houses, and the twentieth century houses studied in the Design module. The module begins with a joint session, led by lecturers from each of the three component strands. The structure of the course is explained, and the students are given a quiz to establish what they might know about the technology of architecture, and what they feel they should know. Thereafter, different permutations of two or three of the strands occupy each of the module mornings. Students are asked to prepare Technical Requisite documents (see 'Comments' column), which combine the exercises they have done in connection with the Design module. These constitute the	lectures, illustrated by examples from many periods of history and parts of the world. The module discusses various attitudinal approaches architects may take towards those for whom they design, and the conditions with which they must deal. It also explores the many ways geometry plays a part in architecture, and introduces some common strategies for spatial organisation found in architecture. The module mornings follow broadly the structure of chapters in the book. Students are required to keep an 'architecture notebook' in which they do exercises, set weekly. They are encouraged to use this notebook also for their own analytical and design investigations. The intention is to establish the notebook as part of the students' learning throughout the degree schemes, and into their professional careers. Because the module tutor for Analysing Architecture is also part of the year team for BSc 1 it is possible to integrate the module quite closely with the Design module. (See also the Twentieth Century House analysis project, under Design module column.) The module assessment has three parts: 50% is awarded to the 20th century house exercise; 25% to the 'architecture notebook'; and 25% to a 2-hour class test held at the end of the Autumn semester. The principal dimension for assessment is the extent to which students show, through the coursework, notebook and class test, an ability to look at architecture analytically, and present their findings clearly in annotated drawings. It is also hoped that students will transfer	are placed in tutorial groups, approximately twelve in each, tutored by permanent and part-time staff, all of which are working in architectural practice. Student groups change tutors at periodic intervals during projects. Additional external critics are invited to crits. The Lecture modules are integrated, as far as possible, with the Design module projects. It is important that student architects do not see design as being separate from the technology subjects, nor from history and other cultural context subjects. *(Interim and Final) Crits:* Design projects throughout the School are normally assessed at a Final Crit. Longer projects may also have Interim Crits, at which interim assessments may be made. At a crit students pin-up their work and explain it to a panel of critics, which will include design tutors and co-students, but may also include visitors from outside the School. On a typical project a crit will last approximately 30 minutes, including time for questions and discussion. Co-students are actively encouraged to participate in critting their colleagues. During a typical academic session a student will undergo half-a-dozen to a dozen crits (Interim and Final). These experiences help a student hone their skills in succinct verbal presentation, and in listening, as well as helping them become used to being criticized in front of others. But the principal purpose of a crit is as a culmination to a design project, where threads are drawn together, and an overall assessment made of work done. Generally, students will be given some written feedback on their work after the crit.

SEMESTER	DESIGN MODULES (3 d+/w)	OTHER ACTIVITIES	LECTURE MODULE 1 (.5 d/w)	LECTURE MODULE 2 (.5 d/w)	COMMENTS
	Students are encouraged to apply the understanding gained by studying the existing buildings in their design work. (See also the exercises associated with the concurrent Building Technology 1 taught module.) [5 weeks; 'design' tutors; some assessed.] Design Project 3 – 'Place to Live 2'. This time students design a small place to live for a chosen, eminent, living, creative person, allowing that person's creative activity to influence the design. The site is selected from within the Castle Grounds in Cardiff. The students prepare a similar submission to that for 'Place to Live 1', thus reinforcing their learning about orthographic representation and skills in drawing and model-making. [5 weeks; 'design' tutors; assessed at crit; written feedback.] While doing this design project, students are (as in the previous project) also engaged in a series of exercises, intended to inform their design work, this time focusing on seminal twentieth century houses. Because they cannot visit and measure these houses, they make detailed models of them instead, using information from published sources, and, in groups, prepare analyses for presentation to the whole year. Thus students research one house in depth, and see presentations on some nineteen others. In this project students learn about the workings of architecture by looking at how it has been done by other architects. They also 'learn by teaching' their fellow students about the houses they have studied. [5 weeks; 'design' tutors; assessed as part of the concurrent Analysing Architecture module.] (See also the exercises associated with the concurrent Building Technology 1 taught module.) At the end of the Autumn Semester (in January) students pin up all their work for review. Every student is interviewed, briefly, in front of their work, and given indication of their performance during the semester.	Computer Block Week – in preparation for the Spring semester project, students are instructed on the use of computer software packages for 3d visualisations, focusing on the twentieth century houses studied in Project Work. [1 week; 'Computer' staff.]	coursework that accounts for 50% of the assessment for the module. All handouts for the module are kept available in the Library. In addition, a visit to a construction site is organised. This takes place sometime in the Spring semester. The lectures deal with construction and performance issues that relate to the domestic scale of building that students meet in their studio projects. All three strands follow a thematically structured progression beginning in this semester with the performance of the building as a whole, in its site, and the external envelope… moving on in the next semester to internal subdivision and services.	the understanding of the workings of architecture gained in this module, into the design studio. Encouragement and persuasion are necessary in this regard. *[This module is also offered to other departments in the University. Students from Architectural Engineering (in the Engineering department), and from Urban Design (in the Planning department) , have attended this course.]*	*Technical Requisite Documents:* Much student learning with regard to building technology aspects of architecture is presented in the form of Technical Requisite documents. Students normally prepare these in connection with their design projects. The intention is to integrate building technology aspects of design into studio design work. A typical Technical Requisite document will contain exploration of and proposals for structural strategies, uses of materials and construction strategies, environmental strategies… all related to the particular design project in hand. Technical Requisite documents are assessed as coursework for the Building Technology modules, but they are also available to be seen by design tutors and critics.
BSc Year 1 - Spring	Framing – The Spring semester project work continues the BSc 1 emphasis on architecture as 'place-making'. On a 'simple' flat, almost rectangular (deep and narrow) site in an inner city part of Cardiff, adjacent to a well established arts centre, students are asked to 'frame' seven		The Building Technology double module continues in the Spring semester. As the main design project is one in which lighting plays an important	ARCHITECTURAL HISTORY 1 [AR0003] – This single module runs through the Spring semester only. It consists of ten module mornings, each containing two lectures. The lectures give an	During the semester part time design tutors are asked to contribute a lunchtime talk on their own design work.

SEMESTER	DESIGN MODULES (3 d+/w)	OTHER ACTIVITIES	LECTURE MODULE 1 (.5 d/w)	LECTURE MODULE 2 (.5 d/w)	COMMENTS
	specified items: an apple; a Egyptian statue; a Renaissance portrait; a romantic piece of music; a 'sky box' by James Turrell; Tracy Emin's bed; and a Magnolia tree. They must also provide: a studio for an artist in residence; a small cafeteria; some galleries for temporary exhibitions; as well as the usual facilities. Students are encouraged to think metaphorically, and in terms of architectural narrative, by asking them to make 'memory boxes' and compose 'storyboards' of their schemes before attempting to design 'buildings'. They are also required to make computer slide shows or animations of journeys through their schemes, and make lighting and presentation models. Finally, they are asked to write an 'apologia' of their scheme, using drawings and words to describe how their designs came to be the way they were. [9 weeks + Easter vacation; 'design' tutors; assessed] The Design module as a whole is reviewed and examined at End of Session Reviews, by a panel of examiners comprising staff of the School involved in the BSc scheme, and including BSc 2 tutors. The reviews include interviews with each student. Students who have failed are offered counselling on their options for retrieval.	Study Visit Abroad – After the Easter vacation students are taken on a study visit, for five days, to Paris. The visit is linked to the design module and to the module 'Introduction to Architectural History'. As well as having the opportunity to visit important buildings of the present and past, students are asked to prepare a notebook on a specific theme, e.g.: transitions between inside and out; changes in level.... [3 weeks; 'history' and 'design' tutors]	part, studio guidance is given in using models to design with light. This and other technological aspects of this project are assessed as part of the studio assessment, and members of the technology team attend crits. The Construction and Materials lecturer offers construction 'surgeries' associated with the Design module project. In preparation for the written examination, the three strands are brought together in a collection of case studies presented by each lecturer as a revision overview.	overview of architectural history from Ancient Greece through to the end of the eighteenth century. The lecture mornings cover the following themes: Greek Antiquity; Roman Antiquity; Antique Heritage in East and West (Byzantine and Romanesque); Medieval (Gothic); Early Renaissance; Palladio; Classicism in England; Baroque; From Monarchy to Aristocracy (Hawksmoor); Enlightenment and Industrialisation (Adam, Neoclassicism, Romanticism). The module is examined solely by written examination at the end of the semester, but students are also given weekly exercises to do in their notebooks. There is also an exercise connected to the overseas study visit to Paris. [The second part of the Architectural History teaching – covering the period from the beginning of the nineteenth century, through the Victorian and Modern eras, to the 1970s – takes place in BSc 2.]	*Team teaching:* Many different tutors contribute to a student's experience and learning in the School. Tutors are generally aware of what their colleagues are doing with the students through discussion at the Scheme Review Committee meetings that are held at the beginning and end of each semester, and generally make efforts to coordinate efforts and input. Often tutors will collaborate within projects and at crits; building technology lecturers, for example, sometimes participate in crit panels. Part-time tutors are involved in discussion, about the pedagogic content and intent of the courses to which they contribute, at year team meetings that are often held during the lunchtimes when they are in the School. Part-timers are always people who are experienced in architectural practice or teaching. Part-time tutors that are new to the School are reviewed to assess their ability to contribute appropriately and effectively to student learning. *Retrieval of failed examinations:* Students may attempt to retrieve failed Lecture module examinations at Summer resits, up to a maximum of 30 credits.
BSc 1: Statement of Achievem't	*The learning outcomes for each module are stated in the module descriptions. Generally, students who present for examination at the end of BSc 1 are expected to demonstrate:* • *skill in architectural design applied to projects of rudimentary to moderate complexity;* • *a developing skill in the clear, informative, and considerate presentation of architectural design using architectural drawing conventions, and verbal explanation;* • *the beginnings of a sensitivity to the aesthetic and poetic dimensions of architecture, and their exploration in architectural design;* • *skill in structuring and writing a short report on a research topic;* • *knowledge and understanding of a rudimentary conceptual framework for analysing architecture;* • *knowledge and understanding of architectural history to the beginning of the nineteenth century;* • *knowledge and understanding of the rudiments of structure, construction, materials, and environmental design, applied to domestic scale buildings;* • *skill in use of simple CAD software for design visualisations.*				

SEMESTER	DESIGN MODULES (3 d+/w)	OTHER ACTIVITIES	LECTURE MODULE 1 (.5 d/w)	LECTURE MODULE 2 (.5 d/w)	COMMENTS
pre-BSc Year 2	Seeking Inspirational Patterns - During the summer vacation between BSc 1 and BSc 2 students are asked to do a study of a place they happen to be visiting. The place should display architectural 'quality' and design 'integrity' at different scales of the built environment. They are encouraged to use Christopher Alexander's *Pattern Language* as a basis for the study. The work is submitted on return to the School in late September, and assessed by peer review. The best work is exhibited in the School.				*Vacation projects:* In each of the long recesses between years the School sets students exercises, to help prevent them from becoming 'stale'. These exercise always act a useful introduction of the students to the staff of the following year.
BSc Year 2 - Autumn	ARCHITECTURAL DESIGN 2 [AR0004] - Town study – The first studio project in BSc 2 is a town study. Students are taken to an accessible town (e.g. Ludlow) and asked to prepare an analysis using Gordon Cullen's *Townscape* as a basis. The work is done in groups. The groups also prepare a presentation to the whole year group using the town to focus on an issue related to sustainability, such as: mobility, resources, meeting places, human activities.... [2.5 weeks; assessed by presentation] The town studied then becomes the setting for the two design projects in the remaining part of the Autumn semester... Housing – The brief for the housing project is given a strong social environmental slant. Students are asked to design a group of between four and eight houses on an inner town site. These tend to be three storeys. [5.5 weeks; assessed by crit] And... Space and Structure – Students are asked to design a medium span building, using steel as the principal structural material. They adopt one of two briefs: a Performance Space (temporary), or a Market Hall (permanent). The project is divided into three phases: 1 precedent and thematic study (themes might include: dishonesty in structure; tensile structures; demountable structures...); 2 learning about structures by building and testing experimental models (the findings of which are demonstrated to the whole year group); and 3 design. Final	Occasionally during the session the year team set 'architectural knowledge' tests, without warning, to encourage students to read the architectural journals. Students receive an optional introduction to the uses of digital mapping, and the generation of three dimensional computer models of the town study area. Short 'block courses' in Building Technology supplement both the Housing and the Space and Structure design projects.	BUILDING TECHNOLOGY 2 [AR0022] - This double module runs through both the Autumn and Spring semesters. It is assessed by formal written examination and by coursework, equally weighted. The examination takes place at the end of the session. The coursework is spread through the session. Following on from BSc 1, the three strands of Building Technology are continued: Construction and Materials, Structures, and Environmental Design. Structures is taught through a series of weekly lectures presented by staff from the University's Department of Architectural Engineering. In the first semester there are two block courses (see 'Comments' column) that concentrate on construction and materials, and on space and structures. The first of these takes place in week 5 of the semester, the second in week 9. Lectures on all three strands take place in both block courses. The construction and materials block course is related to the housing design running in parallel in the design module. The testing of the students' knowledge from this course is via an individual technical requisite dealing with about ten technical aspects to do	CITY, LANDSCAPE AND SPATIAL MORPHOLOGY [AR0025] – This single module runs through the Autumn semester only. In this module students are introduced to the historical development of cities (from Classical Greece up until the Second World War), and of designed landscapes. They are encouraged to explore issues of space and form, and their relationship to aspects of use and cultural meaning. The course also examines the morphological dimensions of architecture and urban space, beyond the symbolic and stylistic. And students are asked to discuss factors contributing to spatial performance and identity. Two lecturers contribute the bulk of the lectures. One concentrating on city form and landscape design. The other on issues of spatial morphology. To some extent the content of the module informs concurrent design projects in the design module. 50% of the assessment for the module is by a 2 hour class test, and 50% by coursework.	The themes in Year 2 can be identified as: analysing and working with context; social agenda; sustainability. Year 2 exploits opportunities to associate design project briefs with current architectural competitions, e.g. the Eric Lyons Memorial Trust Housing competition and the Corus Steel competition. As in BSc 1, students are tutored in groups by part time and permanent staff. The part time staff in BSc 2 two are usually people with interests in community architecture, sustainability, participation in architecture, etc. *The two 'culture related' lecture modules: 'City, Landscape and Spatial Morphology' (Autumn semester) and 'Architectural History 2' (Spring semester) will be introduced in session 2001-2002. These replace two previous modules 'Landscape and Urban Design' and 'Social Aspects of Architecture'. The reason for the change is, briefly, to improve and coalesce coverage of architectural history from the beginning of the 19th and into the late 20th centuries, which had previously been spread through various other modules in all three BSc years. The change represents a rationalisation, and also an improvement of coverage.*

SEMESTER	DESIGN MODULES (3 d+/w)	OTHER ACTIVITIES	LECTURE MODULE 1 (.5 d/w)	LECTURE MODULE 2 (.5 d/w)	COMMENTS
	submission of the design scheme is after the Christmas recess, with crits taking place in January.		with their housing scheme. The structures block course is integrated with the architectural design module project. The students undertake a study of various structural precedents in small groups, and following this, produce physical models of various structural types, which are then tested to destruction in front of the entire year.		*Block courses:* Much building technology teaching takes place in block courses related to specific design projects. These occupy a block of time, usually a week, during which students put their design proposals through various analytical exercises, related to structural analysis, construction and materials, and environmental design.
BSc Year 2 - Spring	Major Project - The Spring semester in Year 2 is occupied by one major design project, which incorporates a study visit to a city in Europe (e.g. Amsterdam). The project is divided into a series of phases: Design Period One (weeks 1-3): includes site visits, building visits, client meetings, site analysis, initial scheme design. This is followed by the preparation for the Study Visit, and the visit itself (weeks 4-5). Design Period Two (weeks 6-9): scheme development, detailed design inculding environmental and visual performance assessment block course. Design Period Three (weeks 10-11): after the Easter recess, design refinement, presentation, and final crits.	In the week before the study visit students engage in a critical awareness workshop. These include exercises in interpreting texts and photographs as media for the polemic representation of architecture. Before the study visit students prepare a series of web pages related to particular buildings to be visited. Students are asked to pose five questions for others to answer when visiting the building. A further web page is produced following the visit, related to a student's chosen study building. The study visit itself, usually to the Netherlands, is organised by staff, but students have opportunities to set up their own visits to buildings they particularly want to see. They prepare a critical building appraisal essay, and an 'experiential' notebook of their architectural explorations in the city.	The Spring semester again contains a block course focusing on environmental issues. A week is given to this study, which includes two of the nine course lectures. This block course is in week 7. All other lectures are delivered over five Tuesday afternoons prior to the block course. The block course is again integrated with the project in the Design module. The assessment of the students' understanding of their studies during the block course is again via preparation of a technical requisite document. This technical requisite integrates physical modelling and hand calculations as well as computer design tools. The students are required to compare the physical modelling techniques with those on the computer. Every attempt is made to keep the students up to date with the latest developments in computer prediction techniques and design tools through both semesters. Students are expected to take the material produced during block courses to their design tutorials so that it integrates with their design thinking. Students are asked to explore and attempt to explain, via sketches and annotated diagrams, during	ARCHITECTURAL HISTORY 2 [AR0024] – This single module runs through the Spring semester only. (See also note regarding this module and the module 'City, Landscape and Spatial Morphology' in the 'Comments' column above.) This module follows on from the Architectural History module in BSc 1. Through it students develop their knowledge of the architectural history of Europe and North America from the early nineteenth century up to the late twentieth. Students are also asked to consider relationships between architecture and ideology, looking in particular at the ideological standpoints of some of the principal chroniclers of the Modern Movement in architecture. The module also includes discussion of the methodologies of historiography. The periods and movements covered include: Soane and the Regency period; Pugin and Ruskin; The Battle of the Styles; Morris and the Arts and Crafts; Wright and American Modernism; De Stijl; The Bauhaus and the beginnings of European Modernism; Early Le Corbusier; Scandinavian Modernism;	Opportunities are taken to work with outside bodies in the Spring semester project in BSc 2. For example, the DFEE might be involved in the community school project, or a practice such as Archetype in the project for a visitor interpretation centre.

SEMESTER	DESIGN MODULES (3 d+/w)	OTHER ACTIVITIES	LECTURE MODULE 1 (.5 d/w)	LECTURE MODULE 2 (.5 d/w)	COMMENTS
	The Design module as a whole is reviewed and examined at End of Session Reviews, by a panel of examiners comprising staff of the School involved in the BSc scheme, and including BSc 3 tutors. The reviews include interviews with each student. Students who have failed are offered counselling on their options for retrieval.		their study visit how the buildings they are visiting are constructed, and how they work from a structural and environmental viewpoint. This is assessed.	Modernism in Britain; Late Le Corbusier; Modernism questioned. This module combines contributions from a number of lecturers, exploiting special interests and expertise amongst the staff of the School. The module is assessed 50% for a 2-hour class test and 50% by coursework.	Students may attempt to retrieve failed Lecture module examinations at Summer resits, up to a maximum of 30 credits. The overall assessment for BSc 2 contributes 20% of the assessment for the BSc degree.
BSc 2: Statement of Achievem't	*The learning outcomes for each module are stated in the module descriptions. Generally, students who present for examination at the end of BSc 2 are expected to demonstrate:* • *skill in architectural design applied to projects of moderate complexity, with particular regard to context;* • *secure skill in the clear, informative, and considerate presentation of architectural design using architectural drawing conventions, and verbal explanation;* • *a developing sensitivity to the aesthetic and poetic dimensions of architecture, and their exploration in architectural design;* • *an understanding of the social and ecological agendas of architecture;* • *knowledge and understanding of urban design, landscape design, and the spatial morphology of buildings and cities;* • *knowledge and understanding of architectural history through the nineteenth and twentieth centuries;* • *knowledge and understanding of the rudiments of structure, construction, materials, and environmental design, applied to buildings of moderate complexity;* • *skill in use of CAD software for conventional architectural drawings.*				
pre- BSc Year 3	During the Summer recess, students are encouraged to travel with some intention of stimulating ideas for exploration in BSc 3. They are also set a project in the field of urban design, typically to describe in drawings and notes a public space, and to propose an intervention. This project is reviewed at the beginning of the session, and used diagnostically by design tutors.				*There is an intention is to introduce a CAD week as an introduction to BSc 3.*
BSc Year 3 - Autumn	ARCHITECTURAL DESIGN 3 [AR0007] - Urban Study and Urban Design – This project runs in two phases: an analytical phase; and a design phase. Students, in small groups, are given two weeks to observe and prepare an analysis of the urban character and form of a part of one of two given towns or cities. In the following two weeks each student, individually, prepares a design for a public space in that city. [4 weeks; 'design' tutors; assessed] Autumn Semester Design – This project focuses on the design of a medium rise, frame building (concrete or steel), and on the nature of	Students are interviewed individually at the outset of the session, to ask them to consider where they are in terms of their architectural design development, and where they want to go during their final year in the BSc and beyond.	BUILDING TECHNOLOGY 3 [AR0023] - This double module runs through both the Autumn and Spring semesters. Students are introduced to the application of building technology to the design of medium rise skeletal complex buildings, and complex internal systems. The intention is to maintain the connections between design creativity and imagination, and the technological considerations in architectural design. The course	PRACTICE MANAGEMENT AND ECONOMICS [AR0015] – This single module runs through the Autumn semester only. It covers the economics and legal aspects of architectural design, in two related strands, delivered by two lecturers. There are eight sessions, each of which is divided into two: one half dealing with economics, the other with law and related aspects. The thrust of the economics	Broadly speaking, the Practice Management and Economics lecture module in BSc 3 deals with issues pertaining to the *design* of buildings. The equivalent module in BArch 2 deals with the *delivery* of buildings. The Autumn Semester Design is seen as an opportunity to integrate the themes of urban design,

SEMESTER	DESIGN MODULES (3 d+/w)	OTHER ACTIVITIES	LECTURE MODULE 1 (.5 d/w)	LECTURE MODULE 2 (.5 d/w)	COMMENTS
	the workplace. It is related to the 'Urban Study and Urban Design' in that the proposed building will be adjacent to the public space designed in the earlier project. The new building may incorporate some facilities, such as retail or refreshment, associated with that urban space, as well as the primary function of, for examples, offices, hotel accommodation, or archives. Some emphasis is put on the achievement of a well-integrated building, showing competence in structure, construction, adaptability, and the integration of services. Students prepare a 'Technical Requisites' document in association with this project, which is assessed as coursework for the Building Technology 3 module. They also have to build a presentation model over the Christmas recess. The Final Crits are held in the assessment period at the end of the Autumn semester (i.e. late January).	Students have group seminars on writing skills on Wednesday mornings during the Autumn semester, in preparation for the essay they must write over the Christmas recess. Students also do a computer 'fit out' exercise, related to the 'Domino' project.	includes some discussion of estate and resource management. The module also covers the technology involved in the refurbishment, care and maintenance of existing buildings. The opportunity is also taken to discuss research issues and initiatives in building technology and environmental design. A visit is organised for students to office buildings under construction. Student led seminars provide the basis for debate and discussion about the connections between technique and form.	teaching is to provide students with an understanding of the economic consequences (including the themes of 'sustainability' and life-cycle costs) of design decisions, and of the structure and operation of the construction industry. The legal strand deals with the basics of English law, land law, building regulations, and professional negligence. Both strands set exercises each week for students to do in their own time. The module is assessed by written examination at the end of the semester. It is an open-book, pre-release paper.	technology, and quite closely-defined accommodation requirements. As in BSc 1 and 2, students are tutored in groups by permanent and part time staff. In BSc 3 part time staff tend to be drawn from London practices, including from the part time Professor's practice.
BSc Year 3 - Spring	At the beginning of the Spring semester students are briefed on their study visits abroad. In small groups students must make a case for a visit they will undertake. Usually they are away for approximately one week, and have to prepare a short critical evaluation of a major building they have visited. In recent years students have been to places as varied as New York, Chicago, San Francisco, Barcelona, Frankfurt, Copenhagen, India.... They return to begin the... Spring Semester Design – This project is considered by the School to be the culmination of the Design thread of the BSc degree. The briefs set are for complex public buildings, either in a dense urban location or in a sensitive landscape. Some briefs are for creative reuse of industrial buildings and others might involve an estate strategy. Students are given a choice of one of several options. They are taken to the sites; and the landscape option group usually stays nearby for a few days for study purposes. This project takes the student, by stages, through to the end of the session. This twelve week programme is carefully managed to ensure student progress, and to provide students with interim advice and feedback. Interim Crits and feedback take place at approximately four week intervals, and at	Students are interviewed individually in the Spring semester, and all are briefed about preparing for the 'Year of Education in Practice'. BArch 2 students tell them about their own experiences of working in practice, and BArch tutors tell them about the BArch degree scheme. Later in the semester students are given advice about preparing their	Building Technology 3 continues in the Spring semester. Objectives for Building Technology 3 course include coverage of: construction of medium rise skeletal buildings; occupant comfort and health; integration of building services; building use patterns for flexibility and adaptability; the impact of design decisions on sustainability; technical parameters for the design of interiors in complex buildings; design office processes and means of communication; basic techniques for working with existing buildings; research in action. The module is assessed 50% for a class test held towards the end of the Spring semester, and 50% for coursework in the form of Technical Requisite documents submitted in conjunction with the design projects.	ISSUES IN MODERN ARCHITECTURE [AR0009] – This single module runs through the Spring semester only. The intention of this module is to involve students in a critical analysis of built and theoretical works by significant modern and contemporary architects, taking account both of their own social and cultural contexts and of the theoretical antecedents on which they draw. This module consists of a series of thematic mornings combining lectures and discussion. In each a debate is based on an argument regarding a particular architect or movement in the past and how this has affected the work of a current architect or architectural movement. The lectures are given by individuals who have been directly involved with particular movements in architecture, or by members of staff with research specialism in a particular area. Another member of staff responds to the argument and helps to	The study trip abroad is intended to inform and inspire the students in preparation for their final project in the BSc. Students must research and set their own agenda for the trip, and make all organisations themselves. The Spring Semester Design is seen as an opportunity to gain experience in responding to a rather more loosely-defined brief than hitherto in the BSc. It tests their ability to produce a design which is well thought through in pragmatic and in poetic terms.

SEMESTER	DESIGN MODULES (3 d+/w)	OTHER ACTIVITIES	LECTURE MODULE 1 (.5 d/w)	LECTURE MODULE 2 (.5 d/w)	COMMENTS
	which focus is on place, idea, organisation, detail design, etc.. At the end of session, students' Design module work is examined as a whole. Students display their work for review by a panel of internal examiners, consisting of a member of the year design team, and two other members of staff. Students are interviewed in front of their work for 20-25 minutes. The internal examination panel review all the provisional assessments made during the session and agree a marksheet to be presented to an internal Board of Examiners, at which the marksheet to be submitted to the external examiners is agreed. The external examiners also interview all students individually, privately, and, after moderation between themselves, present their observations to the external Board of Examiners, at which all staff are present. Students who have failed are offered counselling on their options for retrieval.	cvs and portfolios of work for interview.		initiate debate with the students. The module is assessed by a 1-hour written examination, and a short essay, in which the work of a current practicing architect is analysed in relation to historical influence.	BSc 3 work contributes 80% of the total assessment for the BSc degree. The other 20% comes from BSc 2.
BSc 3: Statement of Achievem't	*The learning outcomes for each module are stated in the module descriptions. Generally, students who present for examination at the end of BSc 3 are expected to demonstrate:* • *developed skill in architectural design applied to projects of moderate+ complexity;* • *secure skill in the clear, informative, and considerate presentation of architectural design using architectural drawing conventions, and verbal explanation;* • *a developed sensitivity to the aesthetic and poetic dimensions of architecture, and their exploration in architectural design;* • *skill in structuring and writing a medium length report on a research topic;* • *knowledge and understanding of contemporary issues in architecture;* • *knowledge and understanding of economic and legal aspects of architectural design;* • *a developed knowledge and understanding of the rudiments of structure, construction, materials, and environmental design, applied to buildings of moderate+ complexity;* • *skill in use of CAD software for conventional architectural drawings and design visualisation.*				

The BArch Degree Scheme

BArch Module structure	The BArch is a two year scheme of study. In general, students who have completed the BSc in the Welsh School of Architecture with an honours degree are eligible to continue into the BArch, and most do so. The scheme is also open to applicants from first degrees in other schools. Graduates of the BSc who have poor honours degrees are interviewed by the Head of School and the BArch convenor before they are accepted into the BArch, in order to advise and direct their career direction. BArch 1 is the 'Year of Education in Practice', which combines a modular course with employment in an architectural practice. Students find their own placements in architectural practices, mainly in the UK, but some go abroad. Help in finding a placement is available from the School, and many practices that have employed Welsh School graduates seek replacements year after year. The School attempts to visit all students in their place of employment at least once during the year. And students return to the School for three short courses in September, April, and June (see below). The modular structure for BArch 1 'Year of Education in Practice' does not quite fit the columns established in this matrix for the BSc degree scheme. The core activity during the year is the experience of practice (described here under the 'Practice/Lecture module' column), rather than the Design module.

SEMESTER	DESIGN MODULES	OTHER ACTIVITIES	PRACTICE/LECTURE MODULES	SPECIAL SUBJECT MODULES	COMMENTS
Pre BArch Year 1		The School provides an optional CAD summer school, just after the end of BSc 3, for the development of professional skills prior to going to work in architects' offices.			
BArch Year 1 ('4th Year')	The DESIGN PORTFOLIO module [AR0032] attracts 20 credits out of 120 for the year as a whole; (as compared with 80 credits out of 120 in each of the 'in house' years. The School is concerned that students' commitment to personal design work is continued through their 'Year of Education in Practice'. They are asked to prepare a design to a given brief, and given tutorials and crits at the short courses held in the School during the year (see next column). Experience in practice is also a good opportunity for a case study focusing on an aspect of building technology. In the TECHNOLOGY IN PRACTICE module [AR0031], which attracts 10 credits of the 120 available, students are asked to do a detailed case study of a building project currently under construction, designed by their practice. They are encouraged to use the *AJ Building Studies* of the 1970s and 1980s as models. It is a way of students preparing for their BArch Year 2 Final Design Project by using resources available in their practice to broaden and deepen their understanding of building technology.	There are three 'short courses' during the Year of Education in Practice. These are held in the School. They deal mainly with economic and legal aspects of architectural practice, but they also provide opportunities for tutorials on the Special Subject Dissertation, submitted in BArch 2, and on the design project for BArch1. [See Design Portfolio, under Design module column] **September Short Course** – This short course contains the Management and Communication module (see next column). **April Short Course** – This course has two main objectives: to introduce the module on Research Methods in relation to the Special Subject (see Special Subject column) to introduce the project that is the focus of the Design Portfolio. In addition students meet tutors for initial tutorial discussions on the Special Subject.	There are four modules associated directly with the students' experience in practice. Each of these attracts 20 of the 120 credits for the year as a whole. MANAGEMENT AND COMMUNICATION [AR0026] deals with the structure and organisation of architectural and multidisciplinary practice. It provides an understanding of project documentation and of managing flow of information within the design team. It deals too with specification writing and the use of information technology. [Assessed by coursework]	The RESEARCH METHODS module [AR0028] concerns work that students do in preparation for the 'Special Subject' dissertation in BArch 2 (see below). It attracts 10 of the 120 credits for the year. Students are provided with a two-day course (part of the April short course) introducing research methods, and conventions of	The BArch Year 1 'Year of Education in Practice' is to be divided into these component modules in session 2001-2002, in response to comments by the ARB/RIBA visiting panel in session 2000. The module structure has emerged from discussion in the School as part of the Periodic Review leading to the Academic Review by the Q.A.A. Previously the 'Year of Education in Practice' had operated as one large module, attracting 120 credits, subject to 'satisfactory pursuance'. The School will be assessing how the new modular structure works in practice, and will consider amendments and alterations in due course, through the BArch Scheme Review Committee, and the Board of Studies.

SEMESTER	DESIGN MODULES	OTHER ACTIVITIES	PRACTICE/LECTURE MODULES	SPECIAL SUBJECT MODULES	COMMENTS
		June Short Course – This short course contains the Project Initiation module (see next column). Students are told about the course by correspondence a few weeks in advance. While back in the School they engage in a three-day exercise in role-play, dealing with the inception of a hypothetical project. They work in groups of four or five to produce a feasibility study and outline design. The three days are intensive, involving day and evening sessions. Students also have opportunities during the short course for tutorials with their tutors for the Special Subject Dissertation, which is submitted in BArch 2. [See also Research Methods module, in Lecture Module 2 column]	PROJECT INITIATION [AR0027] deals with understand and formulating a brief, techniques for feasibility studies, group decision making, and strategies relating to construction and material cost planning. This module is delivered mainly at short course 3 back in the School. [Assessed by coursework] Students also have to prepare a PRACTICE PORTFOLIO [AR0029]. This consists of a series of assignments designed to increase students' awareness and understanding of the processes involved in practice, especially those to do with the administration of a construction project. These cover architects' appointment, local authority permissions and approvals, production information preparation, and site inspection and the running of site meetings. [Assessed by coursework assignments] The PRACTICE EVALUATION module [AR0030] involves recording and evaluating students' work experience in practice. Students must submit record sheets at three monthly intervals. They are visited, at least once, by a member of staff of the School, for discussion about the breadth and appropriateness of the experience being provided. This visit also involves discussion with the students' supervisors within the practice, and can lead to changes in the students' experience. [Assessed by coursework – practice experience record sheets plus a critical evaluation and summary of experience.]	presentation. There are also various submission stages through the year, e.g.: research plan; literature review; initial findings; draft structure; etc. The subjects covered fall into a number of broad thematic groupings offered by the School: environmental design; architectural history and theory; professional practice. Each student has a tutor for their dissertation, with whom they correspond (often by e-mail) while they are away from the School, and with whom they have tutorials during the short courses back at the School.	

SEMESTER	DESIGN MODULES	OTHER ACTIVITIES	PRACTICE/LECTURE MODULES	SPECIAL SUBJECT MODULES	COMMENTS
BArch 1: Statement of Achievem't	*The learning outcomes for each module are stated in the module descriptions. Generally, students who present for examination at the end of BArch1 are expected to demonstrate:* • *a suitably broad experience of architectural practice;* • *an understanding of the organisation of an architectural practice;* • *an understanding of the stages of an architectural project from inception to completion;* • *skill in research towards a substantial dissertation* • *an understanding of building technology through a case study of a real project;* • *continued skill in architectural design and its presentation..*				
The second year of the BArch is in residence, and culminates with the preparation of a major piece of design, the Final Design Project. As in the BSc, the Design module accounts for 80 of the 120 credits available. 30 of the remainder are awarded for the Special Subject dissertation. And the other 10 credits belong to the Practice Management and Economics Lecture module.					
pre-BArch Year 2	Students are asked to submit their initial proposal for their Final Design Project before returning to the School. They are expected to do some preparatory work, including collection of site information, background research, and contacting client and advice bodies etc. In parallel with the preparatory work for the Final Design Project students are given a Summer Design Project, e.g. for a country house in Lancashire, or for an exhibition pavilion attached to a museum of modern art. They are encouraged to read a number of books and analyse seminal twentieth century houses including contemporary examples of domestic buildings. The aim of this project is to initiate conversation about architectural design, which is the central theme of the final year of the BArch course. It also provides students with an opportunity at the beginning of the year to define where they stand as architects. This project is reviewed at the beginning of the semester and is used diagnostically by design tutors.			Under the Research Methods module in BArch 1 students will have done preparatory work for their Special Subject dissertation.	
BArch Year 2 ('5th Year') - Autumn	ARCHITECTURAL DESIGN 4 [AR0017] - The first major design project in BArch 2 is the Urban Study and Urban Design and lasts five weeks including a Study Visit abroad. The aim in this project is twofold: first to understand, through analytical studies, the physical, social and political context of buildings and urban spaces and second to produce, through design work, proposals that are capable of improving them. The project consists of three phases. The first one involves a study visit to a city in Europe – e.g. Berlin, or Paris... - where students analyse a part of the city in groups leading to	Students are interviewed at the beginning of the session on two occasions. The purpose of these interviews is to discuss their intentions in terms of the Final Design Project and to guide them with their selection of site and programme. The discussion also focuses on the work they have done during BSc 3, as well as the office work produced during BArch 1.		SPECIAL SUBJECT [AR0018] – For this module students must prepare a 10,000 dissertation on a topic of their own choosing. There are various topic groupings available: Environmental Design; Architectural History and Theory; Professional Practice and Methods. Most of the academic staff of the department tutor students for their Special Subject, each having between three and five students. Tuition, as has been	Some students choose topics for their Special Subject dissertations that will also inform their Final Design Projects. Through BArch 2 students are placed in tutorial groups for the various projects. These groups are typically twelve to fifteen in number. Some groups are tutored by the BArch team, and others by dedicated part-time tutors who are experienced tutors who have

SEMESTER	DESIGN MODULES	OTHER ACTIVITIES	PRACTICE/LECTURE MODULES	SPECIAL SUBJECT MODULES	COMMENTS
	presentation to the rest of the year group. The second phase focuses on an analysis of the urban character of Cardiff and a group proposal for an urban design strategy in a selected area of the city. The third phase concerns an individual design proposal for a part of the group project. This exercise prepares students in addressing complex urban design issues involved in their Final Design Projects. For those who choose to locate their project in Cardiff, it offers an opportunity for a deeper contextual understanding of their site. After the completion of the Urban Design project students focus for a short period of time on the completion of their Special Subject dissertation. Then they move into the Final Design Project. This begins in the last week of November and occupies the entire Spring semester. It forms the culmination of the architectural education in the school and is self directed through free but guided selection of site and programme and is characterised by the absence of didactic structure and content. The aim is to develop knowledge, understanding and practice of skill in design through the design of a complex project. Students are asked to demonstrate evidence of a design intention over and above the immediate pragmatic concerns of site and brief. The project consists of five phases involving a review at the end of each phase for feedback and monitoring of progress. These are as follows: 1. Architectural Intention, Context and Programme (three weeks) 2. Design Process and Exploration (five weeks) 3. Volume, Space and Experience (five weeks) 4. Structure, Tectonics and Environment (five weeks) 5. Refinement and presentation (6 weeks) In the first phase students focus on defining their architectural intentions and understanding the physical and urban character of their site and programme. At the end of this phase they produce a report and receive feedback from their tutors. This part ends before Christmas leading to phase two.	Design Theory Symposium – The aim of the symposium, which takes place every week through the Autumn semester and continues into the Spring semester, is to establish the theoretical background to the work of the BArch 2 studio. The aim is to address themes in current theory and practice, in a sequence that relates to the work proceeding in the studio. At each meeting 'keynote' presentations by members of the School and visitors establish a basis for debate. Students are encouraged to make formal and informal contributions to the discussions. Specialist consultancies, in structures, and in environmental design and building services, are available for students through their Final Design Project. These are provided by consultants from leading structural engineering and building services design practices.		indicated above, begins in the 'Year of Education in Practice', with students communicating with their tutors usually by e-mail. Extra concentration is placed on the finalisation of the dissertation when students return to the school for the Autumn semester of BArch 2. The dissertations are examined by oral examination, which include external advisers, at the end of the Autumn semester, i.e. in late January.	worked at a number of schools of architecture. Students have the same tutor throughout their Final Design Project. The Design Theory Symposia, held each week, stimulate ideas and offer opportunities for students to explore and discuss issues that may arise in their design work. The Final Design Project is phased, with appropriately timed Interim Crits, to help students pace their work through the long project.

SEMESTER	DESIGN MODULES	OTHER ACTIVITIES	PRACTICE/LECTURE MODULES	SPECIAL SUBJECT MODULES	COMMENTS
BArch Year 2 ('5th Year') - Spring	During phase two of the Final Design Project, students are asked to depart into an analytical and exploratory study that will form the basis of the first ideas for their projects. This takes them through analysing seminal examples of buildings and projects; acquiring generative ideas from wherever seems appropriate – film, painting, poetry, literature...; and engaging in explorative exercises in composing space, form, light, structure.... Phase three takes students into making their first firm proposals for a building design. It should lead out of phases one and two. Students are asked to prepare orthodox architectural drawings, and material that illustrates their intentions with regard to the experiential qualities of the buildings they are designing. In phase four students are ask to consider in more detail the tectonic aspects of their design: the structural strategy; the environmental strategy; the strategy with regard to materials and their construction. They are asked to think carefully about the relationship between their tectonic strategy and the generative ideas for the design as a whole. And phase five covers the period when students will prepare the final exhibition of their propositions, for examination. There are various components to the assessment of the Final Design Project. There is a Technical Assessment, prepared by a member of the technical teaching staff of the School. There are also Internal Design Examinations, by a panel of four people, including: the students own design tutor, a member of the permanent BArch team (as chair of the panel); the technical assessor; and a member of the staff of the School who has not been part of the BArch team. Each member of this panel gives his or her own assessment, and this is computed to give an average, which goes forward, with the other assessments, to the External Examiners. The assessment for the Design module as a whole comprises the Urban Study and Urban Design, and the Final Design Project, together with assessments for supplementary exercises.	Parallel to their development of the Final Design Project, students are required to keep a 'Design File'. This collects together a range of material related to the design project, including: notes and thoughts on design ideas and intentions; research into the brief, site and context; analysis of examples pertinent to the brief and context; notes on influential texts and theories; illustrations of strategic ideas and spatial organisation ideas.... Students may keep the design file in any form they wish. Towards the end of the session they are ask to organise their collection of material into a form that can be sent to the external examiners as an introduction to their schemes before they come to the School for the formal examinations.	PRACTICE MANAGEMENT AND ECONOMICS [AR0020] – As in BSc 3 this lecture module has two strands: economics; and the legal and practice aspects of architecture. The economics strand concentrates on roles of the architect and procedures followed in an architectural project. Invited lecturers contribute to the course. The lectures deal with issues such as project management, value engineering, cost planning, negotiation, and design management. There is also a link to the Final Design Project through a consultancy by a part time member of staff. Students are required to consider the economic implications of their design, through three exercises set through the session. This part of the module is examined by individual interview once the Final Design Projects have been pinned up for examination at the end of the session, and contributes 25% of the overall assessment for the module. The other 75% comes from a written examination at the end of session.		Whereas the Practice Management and Economics lecture module in BSc 3 has dealt with issues pertaining to the *design* of buildings. The equivalent module in BArch 2 deals with the *delivery* of buildings. In relation to their Final Design Projects, students have the opportunity to use the CAD facilities, and the IT expertise in the School, as they see fit. The Design File is intended as a place where student will reflect on their design work and its relation to the work of other architects, to design theories and philosophy, and to the their own aspirations. It is examined as a contribution to the presentation and exhibition of the Final Design Project. Towards the end of BArch 2 the students' focus is more and more exclusively on the Final Design Project.

SEMESTER	DESIGN MODULES	OTHER ACTIVITIES	PRACTICE/LECTURE MODULES	SPECIAL SUBJECT MODULES	COMMENTS
	Both the Internal and External examinations consist of interviews with the students. The Internal lasts 40 minutes; the External 20-25 minutes per student. In the Internal examination students are asked to present a twenty-minute introduction to and explanation of their scheme to the examination panel. The External examination consists of private interviews between the External Examiners and the students individually. Students who have failed are offered counselling on their options for retrieval.				
BArch 2: Statement of Achievem't	*The learning outcomes for each module are stated in the module descriptions. Generally, students who present for examination at the end of BArch2 are expected to demonstrate:* • *the ability to conceive of an research a brief for a project of substantial complexity;* • *developed skill in architectural design applied to projects of substantial complexity;* • *professional skill in the visual and verbal presentation of architectural design;* • *a detailed understanding of the tectonic aspects of architectural design, and of environmental design;* • *skill in urban design;* • *a reflective attitude to design, in which influences from elsewhere are explored and acknowledged;* • *skill in preparing and presenting a substantial dissertation.*				

Appendix 2:

Welsh School of Architecture
Assessment Strategy

Document produced by Professor Simon Unwin and the staff of the Welsh School of Architecture as part of the school's submission to the Quality Assurance Agency (QAA) 2002

ASSESSMENT POLICY (BSc and BArch Degree Schemes)

(Nothing in this Assessment Policy supersedes or overrides the Departmental or Senate Regulations applying to schemes of study in the Welsh School of Architecture. In questions of interpretation, the Regulations hold authority.)

Introduction

The aim of assessing student work is to provide a convenient and accurate measure of achievement, on dimensions applied fairly and consistently, in order to distinguish success, at its various levels, from failure. Though the most valuable and interesting part of learning lies in the production of the work (together with the rich mix of associated and contributory experiences), assessment is a necessary, significant, and consequential part of the educative process.

Assessment is a formal requirement, an instrument for making decisions about student progression operationally vested in the teaching body, to be exercised accountably and responsibly in a way that balances a desire to reward and encourage students, with a public expectation that standards will be upheld. As such, assessment should be: as objective as possible; subject to checks and balances (moderation); recorded and published in a consistent understandable form; and, though sometimes involving ineffable criteria, explicable as far as possible, whilst also recognising that it relies on the professional judgement of experienced assessors.

Percentage Marks, Learning Outcomes, and Statements of Achievement

Assessment is often expressed in terms of percentage marks or their simplification into broad grades identified by letters (e.g. A, B+, B, B- for pass grades C for borderline pass/fail, and F for failure). The award of percentage marks to pieces of work is a useful expedient, which allows easy transport of fine grade assessments from one time and venue to others (for example, from a project assessment in November, or a written examination in January, to a Board of Examiners in June), and constitutes an economical medium for calculating aggregate assessments, keeping records, and compiling statistics. But percentage marking is also an exercise in extreme abstraction that obscures complex processes of judgement in many, sometimes conflicting, dimensions. In some circumstances it can be more appropriate to assess work according to learning outcomes and statements of achievement rather than by numbers. And almost always an explanation of the process of judgement will provide a student with more useful feedback than a bare percentage mark.

Assessment as a Mode of Communication

Assessment has other roles too. As well as being a measure of student achievement, it is also a mode of communication. Within the diverse transactions between tutor and student, assessment occurs at many levels and in many forms. At the informal level assessment is an ever-present part of the dialogue between tutor and student, and works both ways; it is in the encouraging comment with which a tutor responds to a student's fertile idea; it is also in the attention a student pays to a tutor's criticism. At this level, assessment is 'two-way', immediate and mercurial, an essential part of a creative relationship and as such part of a discursive dialogue, which would stultify if it became too self-conscious and subject to record. But, within those assessment processes which are more formal (see below), it is important to recognise the need for record, clarity, consistency, and supplementary explanation to students of how they should interpret the assessments awarded.

Assessment as an Indicator of the Appropriateness and Effectiveness of Methods of Teaching and Learning

Assessment may also be an indicator of the appropriateness and effectiveness of methods of teaching and of the learning opportunities and resources offered to students. High failure rates may indicate that a course is pitched inappropriately for its place in a degree scheme, or that the method or application of assessment is too severe; whereas generally high assessments may suggest a course is too easy, or that assessment is not applied with sufficient rigour. There is no suggestion, however, that, in any situation, a system of quotas for 'fails', or high grades, should be applied (although results are compared with 'normal distribution' curves, consistency between cohorts, etc.).

Types of Student Work

The work that students are asked to produce in a school of architecture may be categorised, for purposes of assessment, into five types:

- design projects;
- studio exercises that inform or supplement design projects;
- essays and dissertations;
- coursework that supplements lecture-based modules;
- lecture-based module class tests and examinations.

Different methods of assessment, moderation, and feedback are appropriate to each, as outlined below.

Assessing Design Projects

Architectural design modules, in blocks of eight, account for two thirds (80 out of 120 credits) of the aggregate assessment in each year of the BSc and BArch degree schemes; this reflects the centrality of architectural design as the core skill to be acquired through architectural education.

Careful assessment of design work is an important challenge for a school of architecture. Although quality in design is impossible to explain fully, it is possible to identify the major dimensions on which judgements tend to be made (see below). Nevertheless, assessment of design work depends most importantly on the involvement of experienced, respected and discriminating assessors, and upon moderation processes that ensure consistency and prevent unfairness. Complex judgements are involved, which cannot be reduced completely to prescribed criteria for success.

Dimensions of Assessment for Design Projects

Generally, (but not exclusively) the dimensions on which judgements of quality in design work are made, seem to be as follows. These may be considered implicit in all design projects set in the School, and their repeated restatement in every project brief is unnecessary, except where stress is placed on one or two of them, over the others, for pedagogic reasons.

Through their attitude, work, and in its presentation, students are assessed on the extent to which they demonstrate:

Imagination, creativity, innovation, adventure, and intellectual rigour in design... including:

- the ability (in various ways) to generate (exciting, engaging, intriguing, stimulating...) ideas for architectural design (propositions), and to advocate and employ sensible bases for evaluating their aptness to the brief in hand;
- the ability to develop architectural ideas rigorously (through divergent exploration and the convergent processes of clarification and refinement) into a resolved state, in terms of intellectual

intention, contextual relationships, spatial organisation, and tectonic realisation... all in relation to the explicit, implicit, and interpreted requirements of the brief;

- the ability to present the underlying ideas and the resolved state of the work in clear, informative, accurate, appropriate and attractive ways, visually and verbally, including the ability to 'sell' a design proposition to critical others;
- the ability to reflect thoughtfully on the process of design and the influences impinging on its development, and to structure and present lucid rationales.

Competence and a professional attitude to design... including:

- the ability to research and interpret a brief and analyse its conditions (including: the cultural and social context and aspirations of the client; the proposed site and its physical context; available resources; contemporary issues such as sustainability; the regulatory and planning frameworks...);
- the ability to gather and apply the knowledge and information needed to progress a design;
- the ability through design to generate and apply tectonic principles, and employ appropriate structural organisation, environmental strategies, constructional systems involving detail design and the choice of materials;
- professional discipline and self-criticism in progressing a piece of work, and confidence and accuracy in presenting it visually and verbally.

Conceptually, these dimensions are not necessarily either parallel or contiguous, and all may not apply equally in every design project. Some may tend in different or even opposing directions. It is rare that a student will achieve highly on all dimensions (the dimensions on which students achieve highly can relate to a student's own personality and innate intellectual skills), and assessors of design work will normally trade high achievement on some against lesser achievement on others, usually to the advantage of the student. For example, one piece of work might be rewarded for its poetic imagination or aesthetic sensibility, where another might receive a high assessment for its competence in construction or its professional presentation. Nevertheless the ability to generate and develop architectural ideas (bullet points 1 and 2 under 'imagination' above) is usually considered to be the core contribution of an architect, and therefore is of pre-eminent importance when considering student work. During the degree scheme as a whole, and in each of its parts (especially in the major final projects in BSc 3 and BArch 2), students are expected to achieve a reasonable level on most (if not all) dimensions.

A Caveat Regarding Criteria for Assessment

In most situations there are significant advantages to being as explicit as possible at the outset about the criteria by which work will be assessed, making the 'rules of the game' known and enabling students to focus clearly on what is expected of them. But in some situations there may be a pedagogic purpose in withholding or remaining vague about such criteria in the interests of encouraging students to establish and justify their own criteria for success, or to think hard about the criteria that may or may not be applied by others.

Processes of Moderation and Feedback in Assessing Design Projects

With the multidimensional complexity partly outlined above, and the desire to respond to students' own personalities, skills, and the agendas they set for themselves, it is not possible to apply prescribed marking schemes when assessing design projects. In their absence, the processes for involving appropriately experienced assessors, for ensuring fairness and consistency, and for providing students with informative feedback on their performance, become especially important.

Processes of assessment, moderation, and feedback occur at many levels. Normally, during a design project, there will be: *design tutorials* (usually weekly); *interim crits* (usually at the mid-point of a project, or, in longer projects, every few weeks); and *final crits* (as a culmination to a project). Formal assessment and feedback occurs at interim and final crits. At the end of the autumn semester there is also an *end-of-semester review* of all student design work for that semester (see below). And at the end of the session there is an *end-of-session design module examination* (see below).

Design tutorials are part of a dynamic and fluid process, in which student progress may be unpredictable. Although design tutorials will necessarily involve the sorts of informal assessments mentioned in the introduction above, their role in the interactions between tutor and student is mainly exploratory and advisory. It would be counterproductive to 'set a seal' of approval or disapproval by assessment at design tutorials, but tutors are advised to keep notes and sketches of ideas discussed with students, with comments on progress and application to the task in hand. Tutors are also advised to inform the Year Chair of any non-attendance at tutorials, for record.

At *interim crits* formal assessment and feedback of student progress and achievement is necessary. Interim crits normally consist of students displaying their work and explaining it to panels of critics - including permanent and part-time staff, co-students and, sometimes, experienced designers or teachers from outside the school. (A number of panels operate during a typical crit day.) Feedback to a student comes in three forms: verbal comment and discussion amongst the panel of critics and co-students; written feedback from the student's design tutor or one of the critics (students may also ask colleagues to keep notes of their crits); and an interim assessment (for guidance only) in the form of a letter grade (see below). General observations on the crits may also be shared between students and staff at a year meeting, held after the interim crits have been completed, which set the agenda for subsequent parts of the project, and maybe draw attention to common problems being encountered. Interim crits, as well as design tutorials, are also opportunities for identifying students with particular difficulties which might be affecting their progress, such as personal extenuating circumstances or medical problems.

Similar arrangements for assessment and feedback occur at *final crits*, but with all panel critics meeting, after the crits have been completed, to tour the students' work and moderate the assessments. These moderated assessments are those that are: recorded in the form of percentage marks; published to students as letter grades (see below); and taken to the end-of-semester design review (where applicable) and end-of-session design module examination (see below). And, as at interim crits, general observations about the project and student work may also be shared between students and staff at a year meeting held after the final crits have been completed.

Letter grades

Throughout the School, letter grades applied to design work conform to a consistently applied formula:

- A = 70% and above, 'excellent';
- B+ = 61-69%, 'good';
- B = 53-60%
- B- = 45-52%;
- C = 35%-49%, 'borderline';
- F = 34% and below, 'clear fail'.

The pass mark for all projects is 40%. Students are advised that assessments at interim crits are for guidance only, and that those at final crits are provisional, and subject to review at the end-of-session design module examination (see below), where they will be interviewed with their complete portfolios of design work, and assessments finalised for submission to the Board of Examiners.

Student Involvement in Tutorials, Interim Crits, and Final Crits

The skill of assessing (informally) the work of others is an essential part of the professional intellectual equipment of an architect. Students are generally encouraged to participate actively in group tutorials, interim crits, and final crits, in making evaluative comments about the work of their colleagues. Normally students are not involved in the formal assessment of work, but on occasion there may be pedagogic purpose in asking students to make a formal assessment of their own work, or of that of colleagues. The value of this to the students lies more in the process of assessment than in the actual assessments produced. And in no circumstances should assessments by co-students be allowed to have a significant effect on the overall assessment of an individual.

Assessing Group Work

Architecture is a collaborative activity. It is important in a school of architecture to give students experience of working creatively in groups. Group working is a valuable experience for students, yet poses some problems in assessment, particularly with regard to the relative contributions of individual group members, and the possible effect of group assessments in distorting the apparent performance of an individual student (either a generally low-achieving student whose overall assessment is flattered by having been a member of an effective group, or a generally high-achieving student who has had the misfortune of being a member of a group that has not gelled or worked effectively together). With this in mind it is important to be wary about the extent to which group assessments contribute to the overall individual assessments of students for a particular part of the scheme.

End-of-semester Design Reviews and End-of session Design Module Examinations

End-of-semester design reviews take place at the end of the autumn semester in each year. Their purpose is to review the progress of all students through the first half of the teaching session. At a typical end-of-semester review students will have pinned up their portfolio of work for review by the permanent year staff, who will consider the provisional project assessments awarded to date. The staff will either see all students (over one or two days), giving them a verbal indication of their progress to date; or they will interview a selection, focusing on congratulating those who have done particularly well and on consulting those who have not done well about any problems they might be encountering. Students will normally be given an indicative aggregate letter grade (which is recorded, but which has no weight on the final marksheet for the session) indicating their general progress to date.

End-of-session design module examinations are the formal examinations for the design modules in each year, at which project assessments are finalised.

Dealing with the 'non-degree' years first…

In *BSc 1* and *BSc 2*, end-of-session design module examination panels consist of permanent staff of the year under review, together with a senior member of staff (usually the Head of Department) and representative permanent staff of the subsequent year of the degree scheme. As in the end-of-semester reviews (see above), the panels review all the students' portfolios of work for the session, and interview the students to assess attitude and to enquire about students' own perceptions about their performance, but also, in cases of doubtful performance, giving students a further chance to explain their work. Marks for individual pieces of work are confirmed or amended within the context of the student's total portfolio.

Students' aggregate assessments in BSc 2 contribute 20% of the overall assessment in BSc 3 (for the degree). Because of this, BSc student design portfolios are also reviewed subsequently by the BSc external examiners (see below).

All *BArch 1* modules are (in university terms) 'S' level modules (effectively 'sandwich' modules); none are lecture-based; all are assessed by coursework (sometimes supported by record sheets) or by the submission of design projects. All modules attract either 10 or 20 credits out of the 120 credits available for the year. Coursework and project work is assessed, at crits where appropriate, by staff. Students may, where appropriate and under supervision and moderation by staff, be involved in the assessment of their own work or that of others.
In BArch 1 the design module consists of one project, which is assessed by interim and final crits, as outlined above.

In the degree years – BSc 3 and BArch 2, the end-of-session design module examinations take a more protracted form, involving teams of internal examiners, and then external examiners.

BSc 3: ***For the end-of session reviews in BSc 3 all students are allocated equal amounts of pin-up space in studios that are locked to prevent changes to displays after the deadline for pin-up. Two or three days are allocated for the 'internal' examinations, during which every student is seen by one of***

two or three panels of internal examiners – i.e. staff of the School. Each panel has a similar constitution, consisting of: a chairman – a senior member of the permanent staff of the School, who has not be directly involved in teaching the year in studio; a member of the permanent year staff; and one further member of the staff of the School. Each student is interviewed in front of their work for 20 minutes, with time included for the panel to discuss the assessments without the student present. The interview is a formal examination, and not a crit, and feedback is not given to the student. The panels consider the all the provisional assessments given through the session, accepting or amending them where necessary. Recorded on a mark sheet, these are presented to an 'internal' examiners' meeting, at which the assessments that will be given to the BSc external examiners are formally agreed.

The BSc external examiners (usually three – all of whom will be experienced architectural teachers or practitioners) interview degree year students individually, alone, each for the same amount of time (usually 20-25 minutes each). The assessments agreed by the external examiners, after due moderation between them, are then taken to the Board of Examiners (with the external and internal examiners present) for formal ratification. This is the end of the assessment process for BSc 3, and an 'unofficial' pass list is usually published shortly after the Board of Examiners meeting, with year staff available to explain the consequences of results to students and to help with any problems that may arise. Students receive formal notification of their results from the University Registry in due course.

Because BSc 2 aggregate assessments contribute 20% of the aggregate assessment for BSc 3, the BSc external examiners also review the (same session) BSc 2 work in exhibition, with the mark sheets but without interviewing students, to check that standards have been appropriately set and consistently applied.

BArch 2:

BArch 2 students are given equal amounts of pin-up space in studios that are locked after the submission deadline. As in BSc 3 there are both 'internal' and 'external' examinations, but with two additional stages. After submission and before the internal examinations, students' design work is given an assessment by panels of technical assessors, who give advisory assessments on technical aspects of the design work, which are taken to the internal examination panels for their information. Also before the internal examinations, students are examined on the economic aspects of their designs, and given assessments that contribute to the overall assessment for the Practice Management and Economics module.

In BArch 2 the internal examination panels each have four members: a chair, from the permanent teaching team in BArch 2; a member of the technical assessment panel (see above); the student's design tutor; and a member of the permanent staff of the School who has not been directly involved with teaching in BArch 2. At the internal examinations each student is allocated 40 minutes, which is divided into four parts: 5 minutes for an introduction to the work, without the student present, during which the panel is informed of the technical assessment; 10 minutes for the student to describe the work; 20 minutes for questions; and a further 5 minutes after the student has left for the panel to confer. Each member of a panel gives his or her own individual mark, with or without discussion amongst panel members, and the average is computed later to give the internal assessment of the student's work. This assessment is taken to the 'internal' examiners' meeting and agreed as that which will be given to the BArch external examiners.

The BArch external examiners (as in BSc 3) interview students individually, alone, each for the same amount of time (usually 20-25 minutes each). The assessments agreed by the external examiners, after due moderation between them, are then taken to the Board of Examiners (with the external and internal examiners present) for formal ratification. This is the end of the assessment process for BArch 2, and an unofficial pass list is usually published shortly after the Board of Examiners meeting, with year staff available to explain the consequences of results to students and to help with any problems that may arise. Students receive formal notification of their results from the University Registry in due course.

Appeals

The processes by which students may appeal against a decision of the Boards of Examiners are set down by the University.

Assessing Studio Exercises that Inform or Supplement Design Projects

Studio exercises that inform or supplement design projects usually involve skill acquisition, research, the application of evaluative or analytical techniques, or reflection on work done. Their value to student learning lies in doing them, rather than in the contribution of assessment to general performance in design work. Assessment is, in such cases, a matter of ensuring that the exercises have been done thoughtfully, that they have been completed satisfactorily, and that lessons learnt have been applied in the design projects.

Typical exercises might include:

- measuring a building and making conventional architectural drawings (skill acquisition)
- acquiring pertinent computer aided draughting or modelling techniques (skill acquisition)
- researching precedent or pertinent examples for a specific brief (research)
- evaluating a design proposal in terms of various environmental design aspects or structural performance (evaluative techniques)
- analysing a work of architecture, or the context for a design project (analytical techniques)
- composing a rationale or 'apologia' of work done (reflection)

In most instances such exercises relate directly to (inform or supplement) specific design projects, and their assessment (whether as a grade or mark, or as a matter of satisfactory completion) is wrapped up within assessment for the project as a whole. Usually the staff involved in the design project, or specialist staff who may have been assisting with the exercises, will make the assessments. Submissions for such exercises will normally be included in end-of-semester reviews (where applicable) and end-of-session examinations, as part of student portfolios, and their provisional assessments will be reviewed at those times too, alongside the design work, by the internal panel of examiners, and then agreed and ratified at the Board of Examiners.

Assessing Essays and Dissertations

Various pieces of written work are set through the BSc and BArch degree schemes. They fall into the following categories:

- short pieces included in the design modules;
- longer pieces related to design projects;
- independent research pieces included in the design modules;
- essays and dissertations related to lecture based modules;
- the Special Subject dissertation (a 30 credit stand-alone module in the BArch)

Short pieces of written work included in the design modules might be: a review of a set book; a qualitative description of the experience of a place; the script of a presentation.... Assessment of these, carried out by staff involved in design tuition, will tend to be a matter of satisfactory completion, or be subsumed within the overall assessments for the related project.

Longer pieces related to design projects might be: a briefing document; a precedent research report; a design file; a rationale or 'apologia' for a design.... Such work will normally be supervised by the design tutors. It too may be a matter of satisfactory completion, but some may be assessed in their own right, as independent exercises related to design projects.

Independent research pieces included in the design modules might be: a biographical account of the work of a particular architect, or an essay on a contemporary issue in architecture.... Such work will normally be supervised and assessed by a member of staff who is not one of the design tutors.

Essays and dissertations related to lecture based modules might be: an essay on a topic in architectural history; a structured analysis of a case-study work of architecture.... The module leader will normally assess such pieces of work.

The Special Subject dissertation constitutes a module in its own right, and has its own methods of assessment. Various interim assessments, usually matters of satisfactory completion, are made during the preparation of the work (see module documentation).

When submitted, Special Subject dissertations are provisionally assessed by reading, and at an interview with the student. Dissertations are assessed by panels of three assessors: a chairman; the student's supervisor for the dissertation; and an external assessor. A number of assessment panels operate to cover the student cohort, each with its own chairman and external assessor. The chairmen of the panels do not normally read the dissertations under consideration; but will do so when there is a wide disparity between assessments suggested by the two other assessors. All assessors meet after the interviews to moderate the provisional assessments that will be forwarded to the BArch external examiners and then to the Board of Examiners.

Assessing Lecture-based Module Class Tests and Examinations

Lecture-based modules are single or double modules, accounting in total for one third (40/120 credits) of the aggregate assessment in each year of the BSc degree scheme. There is only one lecture-based module in BArch 2 (Practice Management and Economics).

Lecture based modules are assessed by: formal examination; class test; and coursework; or by a combination of these. The form of assessment for each module is stated in the module description. Formal examinations take place during the stipulated assessment period at the end of each semester. Class tests may take place at any time outside the assessment period, as suits the delivery of the module. Coursework is submitted for assessment at times stipulated in the module documentation. Modules may be assessed 100% by formal examination, or by class test. Alternatively a proportion – 25%, 50% or 75% - of the assessment may be allocated to associated coursework. It is not usual for a lecture-based module to be assessed 100% by coursework.

In formal examinations and class tests students are informed of the relative weighting of questions on the examination or test paper.

Formal examinations and class tests are assessed by the module leader, or by the appropriate lecturers contributing to the module. Work awarded a mark of 45% or less in the initial assessment is subjected to 'second-marking' to affirm or amend failure or borderline pass. Assessors mark according to an assessment schedule, to help ensure consistency in marking.

Scripts of all formal examinations and class tests contributing to aggregate assessment for the degree are available for inspection by external examiners at the end of each session.

Assessing Coursework that Supplements Lecture-based Modules

In coursework, students are informed of what is expected from them, and given an indication of how it will be assessed, in the module documentation. The coursework will normally be assessed by the module leader, or in collaboration with appropriate contributors to the module. In some circumstances, and with appropriate supervision and moderation by staff, students may be involved in assessing their own work or the work of others. Coursework contributing to aggregate assessment for the degree is available for inspection by external examiners at the end of each session.

Boards of Examiners and Operative Protocols

In Boards of Examiners, when the end-of-session marksheet is being inspected, a protocol is occasionally adopted where an assessment between 35% and 39% awarded in one of the lecture-based modules, may, after due consideration, be raised by the Board to 40%, but only where the student has an overall average in assessments for the lecture-based modules of 50% or over.

Appendix 3:

Student Interview Transcripts

Interview Transcripts

Student A

How do you feel about your experience on the course, from year 1 to now?

I really did enjoy the first year. I think the main reason is that I need a lot of encouragement and I felt like second year I had a bad tutor and I just felt that in the first year had lot more encouragement and there were a lot more courses and different things like the computer courses and everything and then second year I felt that we were really left on our own. With the building construction part we just had one week courses every now and then, but not consistency throughout. Then in the third year we were left to do a lot of research and I didn't feel that we had enough tutorial time. Whereas in the first year I feel we did.

What was your favourite project during the whole three years?

The think I enjoyed the most was the Treforest office building, we had the CADW people came to the university to ask for our help. I really enjoyed having real clients and real people to work with. There was other tutors as well so I'd go to their office and I was really challenged by that.

What was your least favourite project?

I think my second year library project – that's the one – I had a tutor that told me to do certain things, to make this lighthouse and I did it and then in the crit they didn't like it and then he said why did you do that, I can't believe you did that and they basically hated it. I changed my design and I just don't think it was remarked.

What did you find particularly challenging about the course?

I think the last project that I did, because it was a gallery and it was a confined site and we all needed a lot of help with the lighting study and computer Ecotect problems and I don't know if it was the technical things, but it would help if there was a technician in the lighting model room. That's why I found that one quite a challenge.

What about the Philosopher's garden?

I really actually enjoyed that one, because it was more about thinking about why you are designing that way and doing it in conjunction with a book as well and basically using materials of the times – I really enjoyed it.

Did you find that at some point during your course you felt you really began to understand how to do architecture?

I think really from the very beginning I did think it was going to be a lot about maths and working out calculations. I knew it was going to be a bit about art but the way it all came together, I really liked that.

How have your perceptions of architecture changed over the last three years?

Yes, I think its more about an art form than I thought it would be sort of how you go and see different pieces of artwork. I think its seen as artwork and people trying to make statements sometimes but it has to be balanced with practicality.

In your 'A' levels you did particularly well in Arts Subjects. How do you think this relates to your performance in design?

Yes it actually really helped, in some ways it really helped because I had an art background – I did architecture and art history and that helped probably why my

results were better in first year. But in other ways I found that sometimes I would express myself artistically and then people would not like it. And so this is an architecture course, and you need to be pen and ink. So in some way, I think mainly in the second year that I started coming out when we had massacre days and I used this as my main driving concept and sometimes I don't know why, I guess that it was individuals.
But you tended to express yourself artistically, rather than taking a scientific approach. So another thing in the school of architecture, everything sort of a tick box thing - have you done this, have you done that etc... you know, your site drawing, 1:250 and your plans...

In your first year you took a test to find out your cognitive style. You came out as an Analytic Imager [explained the terms]. Do you think that this relates to your way of thinking?

Yes I know that in different designs I spend a lot of time thinking about each individual little part and when it comes to presenting it it becomes a bit separate. With the image one I can feel confident with - I can express that but when it comes to construction, I tend to battle with that and I tend to write more about that an my service strategy and that, I tend to write it rather than draw it because I don't really understand most of it.
You achieved quite reasonable marks for building technology, did you find it quite hard to integrate that?
I found it difficult to apply that to my design. I'd always do the sort of designs where I couldn't just look in a journal and say that this has been done before and I guess I needed quite a lot of help about incorporating this into my design so. I understand the concepts of it all, well not all but I understand that things are much more difficult when it comes to putting them into the building.
Did other students feel they needed more guidance in the second year?
Yes, I think a lot of people on the course struggled but nobody on the course ever says anything.

Student B

How do you feel about your experience on the course, from year 1 to now?

I found, I think, I suppose it was last year kind of like the design process, kind of idea of concepts and ideas clicked and it was only at the end of last year that really happened – that's when I started thinking that bit differently. But in the first year and the second year we had the same head of year which I felt for me staggered my own process of learning.
But she wasn't around all the time was she? (she was on maternity leave)
I felt that that disadvantaged me – the fact that we had had that person for two years

What was your favourite project during the whole three years?

It was probably the summer project we had last summer, you know the one that doesn't count. That was probably my most enjoyable project.

What was good about it?

I think we'd had a couple of weeks break and it was only a short project and there wasn't a lot of pressure put on it and it just let you play around and I think I just enjoyed it – it was nice, we didn't have to do construction, all that kind of stuff, it was just ideas which was good. Shortly followed by my first project this year – the CADW offices in Treforest.

What was your least favourite project?

I suppose it didn't start too well up at St-Fagans and then I suppose last years library.
What was it about that that you found problematic
I just wasn't inspired by anything I think I was a but lost, I didn't really know what I was supposed to be doing. I think I ignored some advice that I was given
.
But at that point you seem to have got something that made things click. Was it something to do about that particular project?
I think it was, with that project something about seeing other people's projects and other people's minds click as well and you start seeing why people are getting the better mark, you can understand. I think I looked at the better guys, the guys that got a first this time around. I saw what they were doing and why I couldn't understand why they were doing it, so I tried to do what they were doing.

What did you find particularly challenging about the course?

I'd say Treforest

What was it about that?

Because it was the first project where I'd kind of started to think about what I was doing and it was hard because I had Richard as a tutor which was really helpful. It was just trying to understand where his ideas came from and how he thought about them which I was trying to suss out, but I found it quite hard to... I suppose with Richard giving ideas, you've got to come up with your own of an equivalent standard – I found that quite a challenge, but that was really beneficial I think.

How have your perceptions of architecture changed over the last three years?

Yes, I'd probably say they were (sic). When we'd finished this project I'd just had enough and I think everyone put so much effort into that project and seemed to spend so much time on this project even that this one.
But how have your views of architecture changed
I think I had a better understanding of it now. I still feel that in construction I'm not that good. I don't feel that I've got much of a construction basis.

In your 'A' levels you had a balance between Arts and Sciences. How do you think this relates to your performance in design?

Definitely the design and technology, maths – no not at all I don't think, geography – not really

And the design and technology?

Just because I learned drawing skills and I learned the sequence of how were supposed to do design projects and that is really really structured and I suppose that's why.
So the drawing, your pencil rendering, these are techniques that you developed before you came here and the perspectives is something which we did at school. We learned how to do orthographic drawings and how we're supposed to set out plans and stuff, you know that kind of stuff – so yes that was useful.

What about the Philosopher's Garden

We had fun, I did it with Rob (points to neighbouring student display) we had a lot of fun doing it. Again I think that it was our tutor just didn't like us, the way we worked and the style I think we worked in. I thought we had a pretty good idea, but perhaps we didn't portray it across in the end. I thought it was a good project, I just felt a little disadvantaged on this.

In your first year you took a test to find out your cognitive style. You came out as an Intermediate Verbaliser [explained the terms]. Do you think that this relates to your way of thinking?

I wouldn't say about verbalisers, I don't think I can write, I don't know if that's what it means, I cant put things down in words very well I don't think. I think that's where my downside is. I do think I can picture things and draw stuff up and just imagine what its going to be like – I think I can do that pretty well.

What about the intermediate?

– that's probably fair,

I can see you've done some little ecotect studies but have you always found it easy to integrate building technology?

It doesn't seem to run parallel with what we are doing. By the third year we should be doing it by ourselves – running it along side as we do the process. I did this in the last two days before we handed it in. Its just the way I worked because they gave me this block week, but I wasn't ready for it then so then I was continuously trying to catch up with other people. I think that kind of stunted me.

Student C

How do you feel about your experience on the course, from year 1 to now?

I do believe that I've learned a lot particularly after the juncture between first and second year. I don't know, whether it was different tutors, but a came a lot more aware of what I was doing coming into second year. I think it was <tutor> who was my first tutor in second year and he sort of opened my eyes to what I was trying to achieve on one of these projects and since then I improved more and more so.
What do you think it was about <tutor> that did that?
I think he just pushed me more, in the first year I really felt I wasn't being pushed and I think that was probably why. We were all so busy doing St.Fagans work that you didn't have as much time to concentrate on what you were designing and so when it got to the second year we had a lot more time for that sort of thing and I started to improve.

What was your favourite project during the whole three years? (and why?)

I'm very much a late designer, and I always redesign everything in the last two weeks for example this was done in the last two weeks. (pointed to project for landscape institute). So I would say that my housing scheme in my second year and my gallery were my big designs. The housing – I tried something completely new, I worked on an idea from the very beginning and tried to push myself quite a bit. Then for the gallery at the end, I took my idea and changed it quite a bit and made it a lot more practical. My housing scheme was good, but not overly practical but this one is more a realisation of a design and an idea put together.

What was your least favourite project?

I would probably say it was close between the library project in second year (I'm skipping the first year) and this landscape design project in third year (pointed). Mainly because I didn't have time to develop it more in the end this was quite rushed and I really think I could have pushed it a bit further. I mean I could sit down now and do it.
What about the Philosopher's Garden?
That was a very strange one because I got paired with someone and we didn't work particularly well on it. We tried to follow on an idea that we had very early through and I don't think it was particularly well received. We were just trying something different from what both of us had done.

What did you find particularly challenging about the course?

Both third year projects were very difficult, The second year ones, looking at the brief now were not particularly hard, but of course you only need experience. Both third year ones, I found it quite difficult to get going on the landscape institute one. Not sure of the reason, whether I thought that I wasn't happy with my first design and I spent a long time on it until I finally redesigned in two weeks. And the Hoxton one was a very very difficult one to fit onto the site, it was such a massive project to put on a tiny little site – not very easy at all.

How have your perceptions of architecture changed over the last three years?

I do – not so much through this course, but I've worked for a firm both summers so I've seen the complete contrast between what you do in university and what you do in work and so my perception is that the university work we do is becoming more realistic as you expect, but there is a long way to go and maybe that will come up in fifth year, I don't know.

Do you think that those times in practice have impacted upon what we see here?

Its given me better computer skills, that's not made a big difference to my grades because they started to improve before I could use it. I think that it has probably given me a bit more of a rational design mind, I'm a bit more aware of construction, workings and things like that.

In your 'A' levels you had a good balance between the Arts and Sciences. How do you think this relates to your performance in design?

I was informed that to do architecture you needed to do maths and physics which I was OK with maths, I was happy with and I just missed out on my A which I deserved really, but the physics was very hard for me. I think I might have been better doing another art based subject or something like that.

Do you think that they would have helped you more in terms of your degree

Yes, a better overall understanding of how a building would work, but in terms of my presentation its not helped me at all but that was through my school that was a very science based school.

In your first year you took a test to find out your cognitive style. You came out as an Intermediate-Bimodal [explained the terms]. Do you think that this relates to your way of thinking?

Do you regard yourself as a bit of an all rounder?

Yes its definitely not a strength in my work, I'd definitely say I was more of an all rounder type, never great at anything, but I can do something alright.

Student D

How do you feel about your experience on the course, from year 1 to now?

Its certainly something that I've learned a lot on, just comparing how much I've learned to a point a year ago. Its been a lot and considering what we were considering at the end of the second year to what we're doing now – there's a big difference. I'm not entirely sure whether I'm going to continue yet, its something I'm going to look into on the next few weeks, but considering what I thought it would be before the degree, it has fulfilled that and it been a broad range of what I like doing.

What was your favourite project during the whole three years? (and why?)

I think the last one where I managed to succeed an put it all together.

What was it about that?

The brief was good, the brief was interesting. It was a challenge in getting the thing done. I tried really hard and it was the development cycle which was just like me – the atrisian aspect of design, just keep pounding at it and trying to get it right through talking to <tutor>.
Initially I wasn't succeeding but then through then through a lot of work, I started making progress.

Was there something that <tutor> added to that process ?

Certainly

What was your least favourite project?

The second year library was horrible, I hated that. That was because, it was my working technique – the brief was quite interesting but that way I was working was just poor. It was a lot of work put in, but the outcome wasn't that good.
What about the Philosopher's garden?
It did seem a bit pointless, because we were all looking to gain credits, it was an interesting brief but it would have been better placed at the start of the year when we had more enthusiasm. Rather than at the end when we were all ...(unintelligible). But yes it was interesting.

What did you find particularly challenging about the course?

The last one, no question – the last one. Because the Treforest one was interesting the brief demanded you to put an office in but you also had to be sensitive to conservation so it was an addition and conservation at the same time. The site was so big you could spread and do what ever you want. The last one, the gallery the site was tight and the brief was huge and you also had to be much more considerate towards the art in terms of the conservation and the lighting.

Did you find that at some point during your course you felt you really began to understand how to do architecture?

Just after the last one when things hadn't gone very well – I was lucky to get a B+ but I wasn't happy with the work. The second year work I had done previously was better than the Treforest one. So from then on I just tried my hardest to just improve and learn from the mistakes I make.

How have your perceptions of architecture changed over the last three years?

In the way that I would approach a problem in design, there's been a lot learned there and its hard to describe because its more unconscious – you tend to learn to do things the best way. But all the time you learn little things and there has been an enormous difference in the way I would have designed.

In your 'A' levels you did particularly well in Arts Subjects. How do you think this relates to your performance in design?

Yes, because I think Cardiff's a bit in the middle between art and science. Its not like the Bartlet that's very arty. But its not like a very technical university as well. I think that the DT stuff enabled me to know a bit about structure and about art and design at the same time. English was an essay subject so it meant that I wasn't completely new to the essays we were doing here.
I would have thought maybe that learning the science stuff would be the best thing to do because everybody picked up on the arts stuff very quickly here by seeing what other people did. It was harder on the technical side.

In your first year you took a test to find out your cognitive style. You came out as Wholist-Bimodal [explained the terms]. Do you think that this relates to your way of thinking?

The second one (bimodal) definitely sounded a bit familiar with the analysing a problem I think maybe now, I'm learning to become a bit more analytical but I think naturally I'm thinking the whole problem

A number of other students have mentioned technology as being an important aspect of their learning. Is this the case with you?

I'm always scared of producing something that is based purely on concept. I never want to do that. I want a concept that would back up the technical aspects so in both the last designs I've done, there's been a trend for just seeing a problem and just trying to solve it from an early stage. With large gestures of slicing through a building. There's some similarities there.

Do you use Ecotect?

Ecotect I really only got into in the last one but that was very useful.

Have you found Form Z helpful in terms of your learning?

Yes, but less to do with conceptual design, much less because form-Z is - you're less close to it, it's less like a play tool – you can quantify it, I was doing floor areas, trying to size up how the brief would fit on the site with Form-Z, but even then it was quicker to just do it by hand. So really Form-Z was more of a resource for the project where I can generate the elevations, the plans. AutoCAD and Form-Z the two of them at once, a 2D profile in AutoCAD going into Form-Z.

Student E

How do you feel about your experience on the course, from year 1 to now?

Yes, I've definitely learned quite a lot about technology and the way buildings work, just normal things that I wouldn't have known before I did the course about buildings, about regulations about...but generally about design experience, I found it quite a struggle at some points to come up with something that the tutors liked and that would satisfy the actual grades that I wanted to get. But I definitely had learned and want to continue it and its something that I can work on until fifth year – I do want to get that great. But I think generally it has been a bit difficult.

What was your favourite project during the whole three years? (and why?)

My favourite was actually the third year last project which was the hoxton gallery, I think that was my favourite. I moved steadily from one point to another with my tutor and the design work just every week improved in terms of the actual design of the building so that I could get on with the regulations and the lighting and things like that.

What was your least favourite project?

There was one that I did struggle with a lot and it was the second year housing project that I did. I didn't really enjoy that. It was a difficult project and I didn't really improve on it over the weeks that we had to design the building. I just couldn't – got stuck - mindblock couldn't pull out things.
[Subsequent to the interview the interviewee stated that the philosopher's garden was a favourite project]

What did you find particularly challenging about the course?

Was it the housing project?
Yes

Did you find that at some point during your course you felt you really began to understand how to do architecture?

Yes, I think that it was in the second year actually when I turned around an thought I know what is required now in different projects and sort of ideas that they wanted. I understood what kind of buildings, what they require of the work, where as in first year I was just doing things that the rest of the year did and asked other people what I am supposed to be doing and I'd produce the work but I wasn't too sure what to produce, it was mostly my own work whereas looking at further reading has well helped a lot in terms of what drawings I should really produce to satisfy.
What sort of reading?
Journals, quite a lot of journals. I didn't have the time to read fully books an novels about architecture. I had time to look through journals and every week maybe one or two and see what they had in new innovations and so on.

And then you used those to inspire your own work?

Yes

Then does that mean that you tended to think from a practical, this is how someone else has done it rather than by starting from a philosophical standpoint.

Yes

How have your perceptions of architecture changed over the last three years?

Well definitely, first year was a bit clueless really. I came in thinking that architecture was a combination of arts and maths and it was those two subjects and you just work out how buildings are built. I didn't realise that it was going to be you designing your own stuff and working out how those buildings were going to be constructed. I thought you'd learn about other buildings and history of architecture and those sort of things. Now I've realised that, well I've not realised, I think that architecture is about providing sort of comfort for society, its giving that little bit more help to those people who need it, that don't know the same things that I do. So really it has changed because I thought that architecture was just my sort of hobby but then I realised that it was something about other people.

Is that a view that you got from your reading or from the other tutors here?

Well it think the tutors, the professors and some of the external people, like when I talked to the engineers or even the external examiner, they are always saying stuff like how will this benefit this place. That made me think that this is for other people.

In your IB you had a balance between the arts and sciences. How do you think this relates to your performance in design?

Yes, definitely, one of mine was Japanese and that hasn't helped but I think that I thought there'd be much more maths and physics in it I think, that's why my highers were in maths and physics. Before I chose my IB I knew that I wanted to do architecture at university so I said I'd do Maths and Physics but I've realised that theres not that much of that at all and now I wish in a way a should have done art as this would have benefited me much more. I didn't do art at A level or GCSE as I knew I do that in my own time anyway. I think geography helped probably the most in terms of land, ground.

What about learning to draw? Where did you learn to do these pencil renderings (pointed) Is that something that you developed while you were here as a technique or is it something that you learned to do before you got here.

Yes I never would have done that before, that's definitely from the school. Construction drawings definitely from the school. Plans and things – I used to do that when I was quite young – I used to draw plans of my house so things like that I didn't find difficult and just doing these kind of 3D drawings but the most challenging thing is getting the right drawing to make it look right.

In your first year you took a test to find out your cognitive style. You came out as an Analytic Verbaliser [explained the terms]. Do you think that this relates to your way of thinking?

I think that's quite true, I don't like seeing things in a broad way and I like to break things down so that I can understand it. That might help in some ways, probably for the technical side, the actual design aspects of the building. In terms of the design ideas and concepts, I have been very closed, like it took a while. Nearly every tutor at one point has told me can you broaden, can you think wider, don't try and analyse everything. Think wider, open it up a bit more, your so closed. I'm very office like or standard and need to go for something wacky and wild. But I've never really preferred that, I think I'm more of a technical person. Its not appropriate for the design aspect, I think its appropriate for the actual construction and building and making things

Have you done much in the way of Environmental Analysis?

These two were blown up, they were A1s, that's why it looks so small. The side there is with the environmental, structural and fire strategies. And the lighting I did some images but I think they got thrown away, I left them in the studio so I couldn't show them.

Do you think your analytic, scientific side helped with the environmental analysis

Yes I think so – I found this the easiest part of the course, the technical requisites. I really enjoy doing it as well, I think it helps. Its quite factual, that's why I like it..

Appendix 4:

Division of 'A' Level Subjects into Arts and Science subjects

Separation of subjects into arts and sciences.

Arts	Sciences
Art	Accounting
Archaeology	Nuffield Biology
Craft and Technology Design	MEI Mathematics
CRITICAL THINKING	Mechanics 2
Design	Economics
Design And Technology	Mechanics 1
Communication Studies	Mechanics
Classical Studies	Mathematics (Statistics)
Classical Civilisation	Mathematics
Art and Design -Fine Art	Biology
Chinese	Nuffield Chemistry
Business Studies	Chemistry
Art With Art History	MEI Further Mathematics
Art & Design - 3D Studies	Geology
Hist. Europe	Geography
Art and Design	General Studies
Art and Crafts	Further Mathematics
Art & Design - Textiles	Computer Science
Art & Design - Graphics	Computing
Art & Design - Photography	Environmental Science
Chinese Language & Literature	Electronics
Italian	Economics and Business
Theatre Studies	Information Technology
Textiles and Dress	Pure & Applied Mathematics
Spanish	Science
Russian	SMP Further Mathematics
Practical Music	SMP Mathematics
Photography	Social Biology
Painting	Nuffield Physics
Music	Pure Maths with Mechanics
Modern History	Sociology
Modern Greek	Pure Mathematics 2
Media Studies	'School Council' Geography
Government & Politics	Pure Mathematics
Jact Classical Civilisation	Psychology
Drama and Theatre Arts	Statistics
Industrial Studies	Physics
History of Art	Physical Education
History	Applied Mathematics
Welsh (as a second language)	Additional Mathematics
Graphic Communication	
German	
French	
Fine Arts	
English Literature	
English Language & Literature	
English Language	
English	
Law	