Science and Mathematics Education Centre

An Investigation into Interest and Its Elicitation in Middle School Science Lessons

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This thesis is presented for the Degree of

Doctor of Science Education

of

Curtin University

March 2015

Declaration

To the best of my knowledge and belief this thesis contains no material previously published by any other person except where due acknowledgment has been made.

This thesis contains no material which has been accepted for the award of any other degree or diploma in any university.

Signature:

Date: March 2015

Abstract

Many researchers have asserted that interest is a fundamental issue to psychology and a wide range of empirical studies have shown that interest is of great significance in education. Despite this, there exists to date very little data on the dynamics of interest in natural science classrooms. Thus, the present study asked: What is it that teachers do that makes students interested in science lessons? Since scholars do not currently agree upon a definition of interest and since very few instruments suited to such an investigation have been designed, much of the present study involved the development of conceptual and practical tools to enable classroom observations. The most important of these novel tools was the Opportunity Concept of Interest (OCI), a model which synthesises existing opinions about interest into a simple definition with broad explanatory utility. Also developed were a number of questionnaires and a detailed classroom observation schedule. Together, these instruments were used to survey 193 Year 8 students in 50 high school science lessons. Correlational and factor analyses were then performed on the data. The less surprising results included findings that prior interest in science predicted general academic aptitude and that lesson interest was inversely proportional to class size. Prominent amongst the unexpected results were findings that students with low prior interest in science responded to the classroom interest environment in ways that were qualitatively distinct from their higher prior interest peers and that the novelty (i.e., unusualness) of visual teaching materials was the most influential instructional factor for eliciting student-reported lesson interest. Overall, the results reinforced the significance of interest as a critical variable in educational transactions.

Dedication

For my Heavenly Father, the Celestial Engineer who, in countless ways large and small, ordinary and remarkable, made this project possible and enabled me to bring it to completion.

Acknowledgements

Everyone who finishes a study such as the one summarised in these pages knows that the effort is only partly their own and that they owe a great debt to others. The first debt is to those scholars – some known but most forgotten – who have preceded us; their labour has provided the foundation upon which we have built. For researchers in the modern era, I believe we also owe a second great debt to technology. Without the computer, the Internet, and the extraordinary power of word processors, spreadsheets, and statistics software it would be impossible for many of us to complete postgraduate studies while also holding down fulltime employment, raising families, and so forth. Most importantly, however, we are indebted to those many, many people who have helped us on our individual academic journeys. I would like to thank the following in particular:

Dr Geoff Giddings – my supervisor – who not only guided me practically with timely and insightful feedback, but who also provided so much genuine encouragement along the way

Suzie St. George – my mother – whose thoughtful questions and intimate understanding of the teaching profession greatly assisted the development of my early ideas

Chris Tobin – my principal – who generously granted me a great deal of work flexibility so that I could complete this investigation

And finally, I would like to thank the many teachers and students who participated in the study itself. Although I cannot mention you by name for confidentiality reasons, your generosity and openness are remembered and appreciated.

Table of Contents

Chapter 9: Results

List of Appendices

List of Tables

List of Figures

Chapter 1

INTRODUCTION

“Interest is the most important word in education.”

Jacob Gould Shurman

1.1 Background

1.1.1 Teacher Effectiveness and Creativity

This study – which focusses on the concept of student interest – did not begin as such. Rather, my intention was to investigate the influence of teacher creativity on learning outcomes in science classes. Despite the significant change in direction, some discussion of the original idea is germane, as is a brief review of the theme which unites these two topics – teacher effectiveness.

While at first glance teacher effectiveness might seem easy to define, it is widely recognised as a complex, multi-dimensional phenomenon (Wimberly, Faulkner, & Moxley, 1978) and its nature has been the subject of scholarly investigation for many decades. In their summary of prior research, Kyriakides, Campbell, and Christofidou (2002) identified four broad investigative phases, each reflecting a different conceptualization.

The first phase involved studies of internal qualities thought to contribute to the making of a quality teacher. These qualities – which Mitzel (1960) termed *presage factors* – include teacher attitudes, experience, and certain psychological characteristics. Ultimately, however, this initial approach failed to meaningfully predict student outcomes and thus, in the second phase, focus shifted to teachers’ instructional behaviours, such as their pacing of instruction, behaviour management, and questioning techniques (Kyriakides et al., 2002). Ryans (1960) arrived at an economical, three dimensional model of teacher effectiveness based on behaviour which will be treated in detail in section 1.1.3.

The third phase of research reflected what Kyriakides et al. have labelled the 'beyond classroom behaviour model'. It arose out of a growing recognition that teacher behaviour *per se* was an incomplete predictor of student outcomes. In this phase, attention returned to presage factors, although a new set of factors were now in view, including: subject knowledge, knowledge of pedagogy, beliefs about teaching, and self-efficacy (Kyriakides et al., 2002).

Finally, a fourth phase emerged with the recognition that teacher effectiveness cannot be fully assessed in terms of student academic performance alone. This latter approach reflects new perspectives on the natures of both teaching and learning. Not only are other aspects of student development now considered within the remit of the teacher, but the scope of teacher responsibilities – both within the school and beyond – have greatly expanded (Kyriakides et al., 2002). The latest phase of research recognises that the number of dimensions by which a teacher may be assessed as effective or ineffective has greatly increased.

While the present work investigated teacher behaviours relating to interest, it was originally intended to focus on a presage factor: teacher creativity. Among educators there is a commonly-held intuitive opinion that creativity is a significant contributor to quality pedagogy. Consider a typical quote on the issue from Mortimore (1998, p. 229):

> There are no easy recipes or blueprints for 'good teaching'. Teachers need to blend together skills and knowledge for particular purposes, taking into account the context of the age, prior attainments and interests of a particular class of students. Imagination, *creativity* and sensitivity are also needed to communicate with, and to inspire students. [italics added]

Numerous other researchers and commentators have postulated similar relationships (e.g., Rosenshine & Furst, 1971; Yamamoto, 1963a) yet the topic has received surprisingly little research attention. In summarising the preceding 50 years of creativity research, Sternberg and Lubart (1999) declared the concept of creativity (in general) to be a neglected topic. Teacher creativity, however, is more neglected still. By way of illustration, the Journal of Creative Behavior, the elder of only two periodicals devoted to creativity research, had published a total of 715 articles to the end of 2006, of which approximately 100 (14%) addressed educational issues, but only three (0.4%) of which reported empirical investigations of teacher creativity. Further, an almost complete silence on the subject reigns in authoritative creativity texts (e.g., Isaksen, 1987; Runco, 1997; Sternberg, 1999), despite their often extensive coverage of the issue of student creativity training.

Of those studies which have been conducted into teacher creativity, the results have been varied. Davidovich and Milgram (2006), Milgram and Feldman (1979), and Knoell (1953) found significant correlations between various measures of creativity and diverse teacher effectiveness criteria. Morrow (1983) and Levine (1996) assessed teacher ideational production using the popular Torrance Tests of Creative Thinking (TTCT) and found positive correlations with classroom climate measures. On the other hand, Tafuri (1994) undertook a study similar to that of Levine but reported no relationship between TTCT scores and teacher-student relationships. Houtz et al. (1994) also used the TTCT but found no correlation between creativity scores and classroom teaching behaviours, and a similar result was reported by Yamamoto (1963b). Falkenberg (2002) is one of very few to have examined science teaching specifically. She reported that the quality of lessons delivered during the implementation of a new curriculum by primary-level science teachers was significantly related to teacher creativity.

In surveying this literature it became clear that because of the paucity of detailed studies and the ambiguity of the results reported to date, teacher creativity was, indeed, worth investigating. As it turned out, however, one particular weakness in the existing research was so significant that an entirely different matter needed to be addressed first. It was toward this that the present study was ultimately steered and the next two sections explain the link.

1.1.2 Defining and Measuring Creativity

The foregoing creativity results are inconclusive due in part to a number of theoretical and methodological weaknesses. Two such issues are directly relevant to the origins of this particular work. The first pertains to definitions of creativity, the second to the identification of teacher behaviours through which creativity might be expressed. Each of these matters is clarified below.

Like many psychological constructs, creativity itself is difficult to define (Smith & Amner, 1997; Houtz & Krug, 1995). Fortunately, it is possible to side-step this problem in practice by examining associated variables which are more amenable to both definition and analysis. Creativity researchers have often classified work in the field under four headings: the creative product, the creative person, the creative process, and the creative situation (Stumpf, 1995). Creative products, for instance, have been described as those which are '*original* (new, unusual, novel, unexpected) and also *valuable* (useful, good, adaptive, appropriate)' (Ochse, 1990; italics in original). Despite unavoidable subjectivity in the measurement of originality and value, such a definition has heuristic utility.

This leads to a second issue arising from the teacher creativity literature: what are the behaviours (i.e., 'products') that creative teachers exhibit that distinguish them from less creative teachers? A solution to this problem is suggested by Amabile's (1983) componential model of creativity which offers an economical summary of the qualities necessary for creative production in any field. According to her model, the person who generates creative products has three broad attributes: domain-relevant skills, creativity-relevant skills, and motivation (Amabile, 1983). Domain-relevant skills are the requisites for performance in the nominated field of endeavour and include factual knowledge, technical skills, and any talents necessary and peculiar to the domain. Creativity-relevant skills are those attributes which broadly enhance novel production in all domains. They include cognitive style, facility in the exploration of new cognitive pathways, and working style. The third aspect, motivation, needs no explanation here but it is treated by Amabile as an indispensable element in any creative production. Overall, the model is assumed to be multiplicative such that if any one of the components is rated at zero the creativity of any output will also be zero (Amabile, 1983).

Even a casual reflection on the definitions above readily yields insight into the nature of teacher effectiveness and suggests avenues for research and/or professional development. A problem that quickly arises, however, concerns identification of the product or products which constitute creative teacher output. What is it that teachers actually do that can be creatively altered to bring about more effective learning? This question constituted the transition point for my own research, from a study centred on creativity to one centred on interest.

1.1.3 The Transition from Creativity to Interest Research

In addressing the problem of teaching 'products', I first sought to identify major dimensions of effective teaching behaviour. This matter was resolved very economically via the results of a nine-year study by Ryans (1960) who examined the characteristics of some 6,000 teachers in approximately 1,700 American schools. Ryans' factor analysis of the data yielded three major teacher-behaviour dimensions: X_o – understanding, friendly vs. aloof, restricted behaviour; Y_o – businesslike, systematic vs. unplanned, slipshod behaviour; and Z_o – stimulating, imaginative vs. dull, routine behaviour. Dimension Z_o clearly represents the range of behaviours that are most readily influenced by creative persons. And it is but a short step to equate stimulating teacher behaviours with interesting teaching.

As observed earlier, creativity is a relatively neglected topic; yet interest – at least in the field of education – is more neglected still. First, there exists no universally accepted, cogent theory of interest – a fact observed and lamented by numerous scholars in the field including Krapp, Renninger, and Hoffmann (1998), Mitchell (1993), Silvia (2006), and Hidi (2000). Second, interest research has been largely confined to laboratory experiments and consequently there is a paucity of both appropriate instrumentation (Mitchell, 1993) and data from authentic educational settings (Tsai, Kunter, Ludtke, Trautwein, & Ryan, 2008).

The pre-history of the current study, as outlined above, may be summarised as follows: A proposed investigation of teacher creativity was forestalled by lack of theoretical and methodological equipment for assessing the critical intermediate variable of interest-inducing teacher behaviour. It is to the investigation of this latter variable that the remainder of the present work is dedicated.

1.2 Study Objectives and Rationale

1.2.1 Study Objectives

The matters outlined above led to the identification of three broad study objectives. The first of these objectives was to discover those teacher behaviours which are most significant in eliciting interest in students. Teacher behaviours were operationalised as those things that a teacher says or does within actual lesson events. Non-lesson activities, tuition, counselling events outside class time, lesson preparation actions, *et cetera*, were thus excluded.

The second broad objective of the study was to identify the significance of salient intra-student and class environment variables in the induction and/or attenuation of pupil interest. Such variables were not originally intended as research foci, but an improved understanding of interest theory demanded their inclusion. Of particular importance amongst these variables was the level of *a priori* science interest held by students.

The third objective, and one necessitated by gaps in the existing research, was the construction of theoretical and methodological tools fitted to the fulfillment of the above two goals. Indeed, the theoretical grounding of this study – hereafter labelled the Opportunity Concept of Interest – is a novel conceptualisation of the phenomenon of interest and represents the most significant aspect of this work both in terms of word length and future implications.

1.2.2 Study Significance

Inasmuch as the three objectives above are fulfilled in the current work, this study has significance for researchers in the fields of motivation, interest, and teacher effectiveness, as well as for practicing educators, and those who deliver professional development to them.

The initial chapters of this report describe the Opportunity Concept of Interest – a model which synthesises commonalities evident in the interest literature into an economical definition of the phenomenon. Given the widely divergent opinions held by interest researchers and the various theoretical and ideological commitments that often inform such opinions, it seems unlikely that the suggestions made herein will provide more than a reference point for further debate. Nevertheless, such contributions are necessary for academic progress and the ideas are proposed in that spirit.

With respect to teacher effectiveness, this study concludes with a discussion of how both the theoretical and empirical findings might be applied to improve classroom teaching. Many of these ideas are treated at a purely practical level and are presented in such a way as to make them applicable to practicing teachers. Consideration is also given, however, to some theoretical and education system issues – issues which make further research both necessary and urgent.

1.3 Research Questions and Goals

The three objectives identified above are explicated below in the form of two objective hierarchies: research questions, and instrumental goals.

Core research question: What factors affect student interest in the science classroom?

Question 1	What teacher behaviours are important in determining student interest in science classes?

Sub-question 1a	*What are the most important of the known interest-inducing factors?*
Sub-question 1b	*Do teacher inter-personal behaviours influence the development of classroom interest?*
Question 2	How does student *a priori* interest affect the elicitation of student lesson interest?
Question 3	How do classroom distractions influence student interest?

Instrumental goal: To refine the theoretical and practical tools of interest research in order to answer the research questions.

Goal 1	To facilitate more effective science classroom research generally
Sub-goal 1a	*To locate/create a theoretical model that explains how the gamut of teacher actions induce interest*
Sub-goal 1b	*To determine – from amongst the range of available options – the most practical means of assessing interest in natural settings*
Goal 2	To locate/create survey instruments to attain the research goals
Sub-goal 2a	*To locate/create a survey instrument that measures lesson interest as a dependent variable*
Sub-goal 2b	*To locate/create an observation schedule that records teacher behaviours in terms of known interest-inducing factors*
Sub-goal 2c	*To locate/create a survey instrument that measures teacher inter-personal behaviour*
Sub-goal 2d	*To locate/create a survey instrument that measures student* a priori *interest in science*

1.4 Report Outline

This report is divided into ten chapters, of which this introduction is the first. The contents of the remaining chapters are summarised below.

Chapter 2 provides a detailed introduction to the topic of interest as it pertains to education generally and to science education in particular. The results of research into both the impacts of interest on learning and the sources of educational interest are treated in some depth, thus providing a context for the theoretical analyses in succeeding chapters. After a review of previous findings, the current study is defined by its relation to existing research gaps and a new model, the Opportunity Concept of Interest (OCI), is described and explained. Finally, some important definitions and related terminology are clarified.

Chapters 3 through to 6 constitute an extended argument in support of the Opportunity Concept of Interest. Chapter 3 presents a general introduction to theories of emotion and then argues that interest itself is an emotion. Some major objections to the interest-as-emotion position are treated and refuted, and the function of interest as a conative phenomenon is discussed. Chapter 4 considers the appraisal structure of interest, addressing the proposition that the emotion of interest can be characterised as arising from distinctive cognitive processes. In Chapter 5, the construct of need is addressed. A range of need classification schemes are discussed and related to the present study. Chapter 6 summarises weaknesses in existing interest theories but shows how they repeatedly converge on a small number of common themes. The chapter concludes by showing how the OCI reconciles these themes into a model which is directly applicable to the empirical requirements of the present study. A diagrammatic representation of the OCI is given in Figure 1.1.

Chapters 7 and 8 describe the methods employed in the study. Chapter 7 is concerned with the development and validation of the four instruments used. Chapter 8 describes the study context and fieldwork procedures in detail.

Chapter 9 presents the most significant results from the field observations, relating them to the theoretical matters discussed in earlier chapters.

The final chapter discusses the implications of both the theoretical and empirical findings for improving science education. To begin with, the chapter reviews the phenomenon of declining student enthusiasm for education generally and for science in particular. This problem is then reviewed in the light of present findings. A range of suggestions for pedagogical improvement are made and obstacles to implementation are briefly treated. A schematic overview of the entire dissertation is given in Figure 1.2.

Figure 1.1: A symbolic summary of the OCI model developed in Chapters 2 to 6.

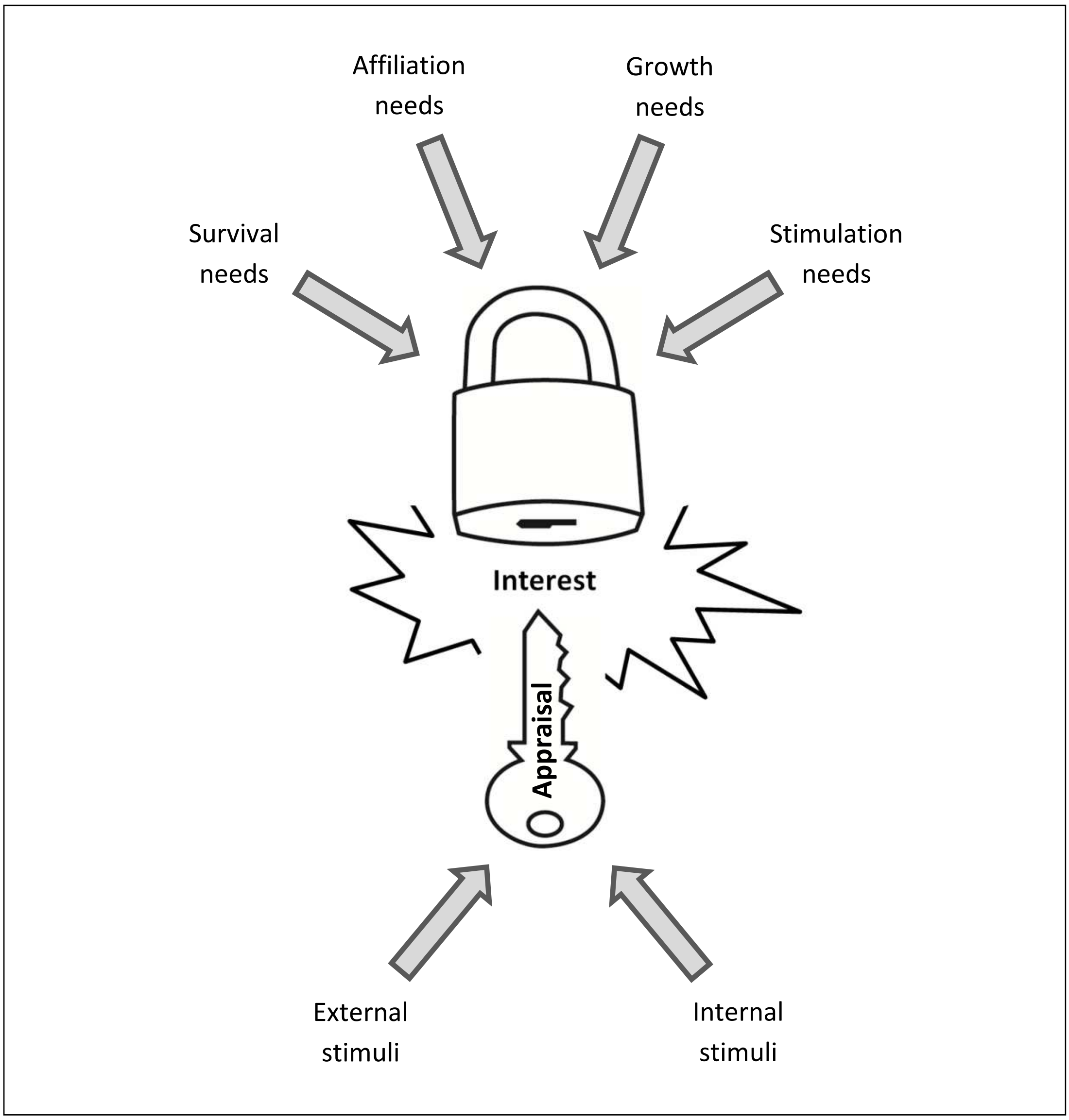
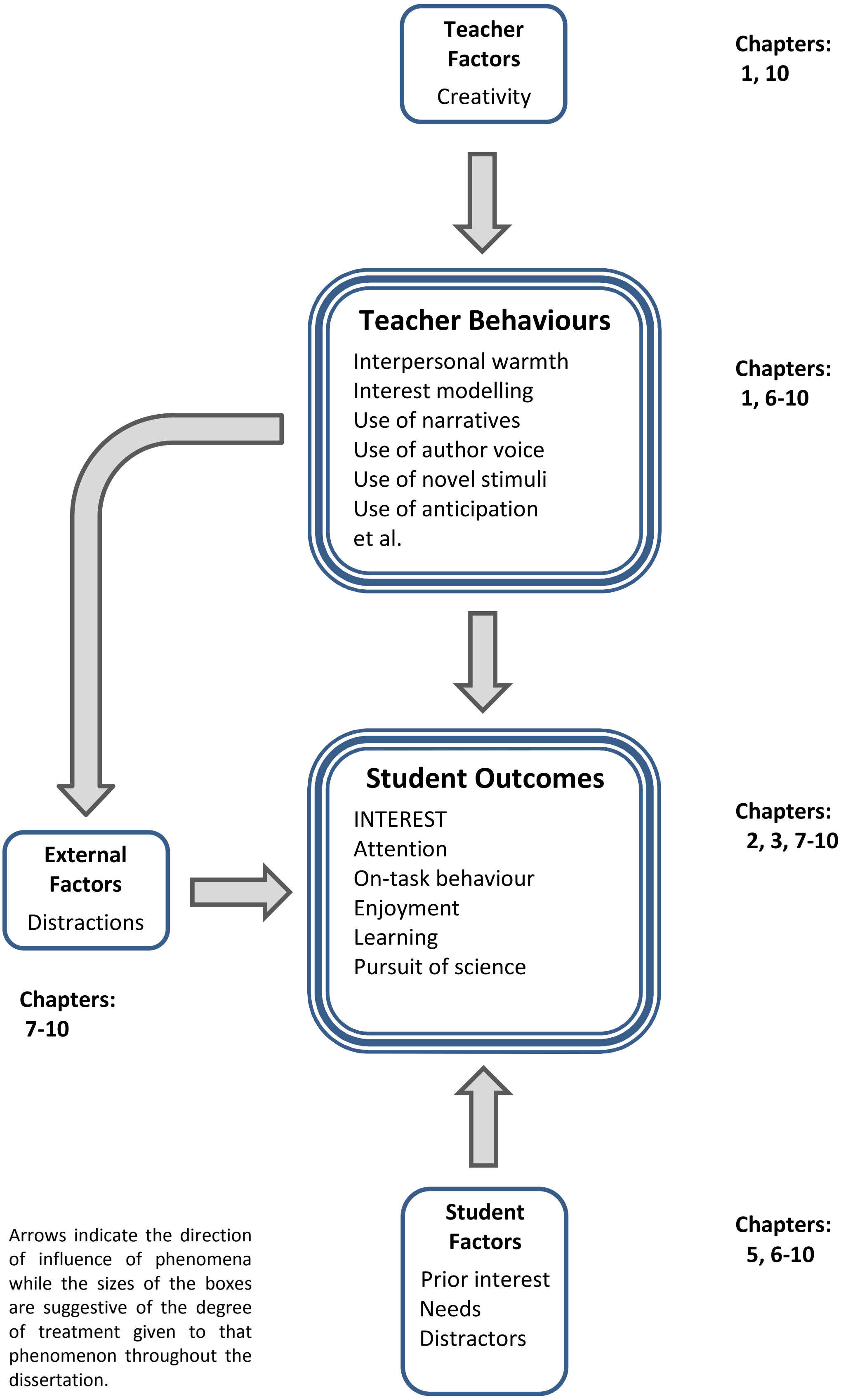


Figure 1.2: A schematic overview of the teaching-learning process highlighting aspects treated in the present work and the chapters in which they are covered.



Chapter 2

INTEREST RESEARCH AND EDUCATION

2.1 The Importance of Interest

2.1.1 The General Importance of Interest

The gaps in interest research mentioned earlier are surprising given the importance placed on the phenomenon by many psychological theorists. Valsiner (1992) opined that not only is interest a fundamental issue to psychology, it is one of the most important of the fundamental issues. He is not alone in this view. Pioneering psychologist William James considered interest to be a central directive force of the mind (Schiefele, 1991); early emotions theorist Silvan Tomkins (2008/1962) commented that the absence of interest "would jeopardize intellectual development no less than the destruction of brain tissue" (p. 188); and McDougall (1908) commented that "curiosity is at the base of many of man's most splendid achievements" (p. 315) and even believed that the fates of civilizations are correlated with the degree to which contemporary thinkers pursue topics of interest. More recently, interest has been proposed as a key factor in early learning, a distinguishing element in the development of expert performance (Hidi & Berndorff, 1998), and a significant contributor to both psychological and physical well-being (Sansone & Smith, 2000).

2.1.2 The Influence of Interest on Academic Performance

Given these comments, it is hardly surprising that researchers should find interest to be a significant factor in education also. For instance, in a study of 208 tertiary students, Schiefele and Csikszentmihalyi (1994) found that topic interest predicted not only subjective lesson experiences – such as motivation and potency – but also contributed significantly to grades achieved. Rathunde and Csikszentmihalyi (1993) found that feelings of undivided interest in the first year of high school strongly predicted various measures of success three years later. And, in an investigation of the impact of interest on text learning, Schiefele (1996) found that topic interest was positively associated with improved concentration, reported happiness, and degree of comprehension of material studied.

The preceding studies examined learning outcomes in relation to students' interests – that is, their existing preferences. Nevertheless, similar results have been found for interest evoked in the moment by the lesson experiences themselves. In an experiment with college students, Shirey and Reynolds (1988) found that ratings of sentence interestingness (as determined prior to the study) were highly significant predictors of sentence recall once intra-subject variables were controlled for. Anderson, Mason, and Shirey (1984) also examined text interest effects and compared the relative contributions of text interestingness and text readability to sentence recall by third-grade students. Interestingness explained more of the variance in recall than readability by an order of magnitude.

The results above are a small but representative slice of the research on interest and learning. In sum, interest – in its various forms – has been found to be positively correlated with attention, persistence, enjoyment, depth of learning, and recall (Hidi & Harackiewicz, 2000; Hidi & Renninger, 2006). Schiefele, Krapp, and Winteler's (1992) meta-analysis of interest in education found that on average, interest levels account for about 10% of observed achievement variance. Indeed, Schiefele later concluded that there remains no further need to establish correlations between interest and learning. What is now required, he asserted, is to investigate causal relations between the two (Schiefele, 1998).

2.2 Interest-Promoting Variables

2.2.1 Research on Interest Variables

Investigations into the nature of interest extend as far back as the beginning of the nineteenth century, to the philosophical work of Johann Herbart (Krapp, 2002). Modern interest research is often considered to have begun with the work of Daniel

Berlyne in the early 1960s, but it was not until the late 1980s that the field gained substantial empirical momentum. Since that time, interest research has gathered a sizeable body of data on a number of matters, including the types of phenomena that appear to elicit interest. A sample list is given in Table 2.1. Before proceeding to a discussion of that data, however, a number of preliminary matters must be addressed.

First, it is important to distinguish *situational interest* from *individual interest.* Both of these terms are used in somewhat different ways by different authors and have various technical nuances associated with them. For present purposes, however, situational interest is used to refer to a momentary state evoked in a person by some object or circumstance. It is used in this sense to make a distinction from individual interest – a relatively enduring preference for engagement with a certain class of objects. The variables given in Table 2.1 should be interpreted as those associated with situational interest.

Second, Table 2.1 is not organised according to any theoretical principle. The variables are presented in the order given by the authors from whom they were drawn. The only organisation by this author has been to cull obvious redundancies and to add some clarifying phrases. It should also be noted that the authors cited as sources for the data in Table 2.1 are not in every case the scholars who first reported their significance nor indeed are they the only ones to have observed them.

The third matter to note regarding Table 2.1 is that while the list is reasonably comprehensive it is not intended to be exhaustive. Fourth, the variables listed refer merely to phenomena which have been observed to be associated with interest; causation is not inferred. Fifth, each variable does not have an equal level of empirical justification for inclusion. Indeed, as Silvia (2006) observed with respect to his own compilation – the first in the table – only a few of these sources have been extensively tested by research. Sixth, many of the factors included in Table 2.1 have been derived from research on texts. Silvia (2006) has commented that the factors which promote text-based interest are essentially the same as those that promote situational interest in any context. His perspective is adopted here and thus no distinction is made between variables on the basis of the circumstances in which they were first – or are primarily – observed.

Finally, this list was used as the basis for the development of the Science Classroom Observation Schedule (SCIOS) used in the empirical phase of this study. Some of the interest-inducing factors above were identified on the SCIOS directly (e.g., humour), while others informed certain of the SCIOS scales (e.g., visual vividness/intensity). Details of the SCIOS and its construction are given in Chapter 7.

Table 2.1: A sample of factors observed to affect interest in educational settings

Factors Affecting Interest	Source
Information coherence	Silvia (2006)
Ease of comprehension of information	
Prior knowledge of subject matter	
Vividness of stimuli	
Author voice	
Concreteness of concepts	
Use of imagery	
Readers' connections with textual material	
Student familiarity with concepts	
Personal identification with characters in narratives	
Emotiveness of material	
Collative variables:	Berlyne (1960)
Novelty	
Change	
Complexity	
Surprisingness	
Uncertainty	
Incongruity	
Enhancement of a sense of personal belongingness via:	Bergin (1999)
Cultural value	
Identification	
Social support	
Hands-on activities	
Food	
Games & puzzles	
Interest modelling by teachers	
Fantasy	
Humour	
Use of narrative	
Global interest themes:	Schank (1979)
Death	
Sex	
Power	
Money	
Romance	
Provision of optimal task challenge	Schraw & Dennison (1994)
Highlighting of functionality	
Promotion of student autonomy	
Provision of choice to students	Hidi & Harackiewicz (2000)
Stimulus intensity	
Relevance of content to students	Stuckey et al. (2013)
Narrative 'post-dictability'	Kintsch (1980)

2.2.2 Defining Interest-eliciting Variables

While many of the descriptors in Table 2.1 are self-explanatory, this is not the case for all. Moreover, a reasonably precise definition for some of the terms is essential before their relationship to interest generation, interest theory, and the present study can be appreciated. Definitions for the more difficult terms are given below.

Author voice

This label is derived from text-based research and refers to the presence of personal content within texts. Accounts written in the first person, or those which include comments that make the author 'visible' to the reader, have been rated by students as more interesting than those in which the author is anonymous (Bergin, 1999). Bergin has speculated that teachers might enhance lesson interest by sharing with pupils aspects of their personal lives such as hobbies, likes, and dislikes.

Collative variables

An important early result in the history of interest research was the observation that interest is very often promoted by phenomena which are novel, complex, surprising, ambiguous, or which create uncertainty. Berlyne (1960) classified such factors under the rubric *collative variables* – that is, stimulus properties which are understood by collation against some reference point.

Among the collative variables, novelty is especially significant. Berlyne observed that novelty can be divided into sub-categories, of which *complete novelty* and *short-term novelty* are of particular relevance here. Complete novelty refers to the degree to which an object or object property is new within the entire spectrum of a person's life experiences. A synonym would be unfamiliarity. Short-term novelty, on the other hand, refers to the degree to which a stimulus is new in the temporal flow of a person's life. A phenomenon experienced recently has lower short-term novelty than a phenomenon experienced in the more remote past, regardless of how familiar that phenomenon is in an absolute sense. In the context of classroom events, short-term novelty can be treated as an aspect of experiential variety.

A noteworthy phenomenon is the non-linear relationship between complete novelty and interest. Numerous scholars, including Berlyne (1960), have observed that interest intensity demonstrates an inverted-U-shaped relationship with stimulus novelty. Thus, stimuli which are either extremely familiar or extremely unfamiliar elicit little or no interest while stimuli of moderate novelty elicit the highest levels of interest.

Vividness of Stimuli

Although numerous researchers have observed that the vividness of stimuli is positively correlated with interest, the term has yet to be properly defined for research purposes. For example, in summarising prior work on the vividness of text, Schraw and Lehman (2001, p. 35) reported that “a variety of factors enhanced the vividness of text”, and they included in their list such elements as imagery, unexpectedness of information, humour, the author’s voice, and concreteness. Since these ‘vividness enhancers’ are, in fact, known interest correlates in their own right, such a finding does not really advance our understanding. The related variables of ‘activity level’ (Anderson, Shirey, Wilson, & Fielding, 1987) and ‘intensity’ (e.g., Hidi, 1990; Hidi & Harackiewicz, 2000) suffer from a similar lack of definitional clarity.

It is proposed here that vividness should be considered a collative variable defined as the relative intensity of sensory stimuli in comparison to ambient (i.e., reference) stimuli of the same type. This matter is treated in more detail in chapter 7.

Interest Modelling by Teachers

A range of studies have shown that the degree of interest in subject matter demonstrated by teachers (i.e., interest modelling) has a significant impact on students’ interest in the content they are being taught (e.g., Long, 2003; Prenzel, Kramer, & Drechsel, 1998). This finding has a range of implications at both theoretical and practical levels, as will be discussed in chapter 5.

Global Interest Themes

In an oft-cited paper, Schank (1979) observed that certain topics seem to have universal appeal. The examples most commonly quoted in the interest literature are injury/violence, sex, scandal, power, and death, although Schank's original list also included romance, disease, chaos, "and many other concepts of this type" (p. 281). Wade, Schraw, Buxton, and Hayes (1993, p.106) have provided one of the best summations of these apparently disparate themes by observing that they all evoke "a kind of emotional interest". This matter will be taken up again in Chapter 5.

Relevance of Content to Students

Stuckey, Hofstein, Mamlok-Naaman, and Eilks (2013) have observed that topic relevance has often been identified as a factor associated with student interest. They also note, however, that the term has been poorly defined and that different authors in the field of educational research have used the word 'relevance' in different ways. They summarize the diversity of usages into the following five categories: 1) relevance as a synonym for interest; 2) relevance as connoting students' perception of personal meaningfulness; 3) relevance as a synonym for practical importance or utility; 4) relevance as connoting significance in the long-term and for society as a whole; and 5) relevance as a combination of elements from the preceding four definitions. By way of illustration, Schraw and Dennison's (1994) phrase 'highlighting of functionality' (see Table 2.1) relates to the third of Stuckey et al.'s categories, since it has been observed that students demonstrate more interest when the connection between subject content and practical application is explicated. The concept of relevance will be treated again in section 4.1.3.

Post-dictability

In an early work on interest elicited by narratives, Kintsch (1980) proposed that an important element of an interesting story is not that it is merely surprising, but that the surprising events are satisfactorily resolved by the time the tale is concluded. Kintsch coined the term 'post-dictability' to describe this capacity of story elements to be retrospectively understood by readers/hearers. Empirical support for the importance of post-dictability in promoting interest has been reported by Iran-Nejad (1987).

2.3 Issues in Contemporary Interest Research

In light of the above sketch of the various interest-associated phenomena, it is appropriate to quote Silvia's (2006, p. 78) summary of the current state of research:

> the field has a long "laundry list" of variables that affect interest, but it lacks a theory that explains why they affect interest and how they might relate to each other. What do these variables have in common? Can they be integrated into a simpler set of variables?

Silvia is not the only author to make such a comment. Schraw and Lehman (2001) reported that work in the 1990s had generated a great deal of data and commentary on variables related to interest and learning but had produced neither an overarching theory nor even a set of competing theories which might be compared. Krapp, Renninger, and Hoffmann (1998) penned similar remarks regarding the need for some kind of unifying conceptual structure for interest research.

There also exist other significant gaps in the interest literature with a direct bearing on the research questions of the present study, viz.: a) Apart from the substantial body of work on text-based interest, research on situational interest has been scarce and poorly coordinated (Hidi & Berndorff, 1998); b) interest has usually been studied as an independent variable rather than as a dependent variable (Krapp, 1999); and c) research efforts have largely been undertaken in laboratories rather than in authentic settings (Tsai et al., 2008). During the developmental phase of the current investigation, little evidence was found to indicate that these issues had been addressed in the interval since the various authors made their comments. Thus, in some instances it was necessary to devise a solution without the assistance of a clear methodological or theoretical precedent.

2.4 Issues Associated with a Working Model of Interest

Pintrich (1991) has noted that "one of the most important issues for the future viability of the field of motivational theory and research is the theoretical and definitional clarity of the constructs" (p. 200). Thus, the first challenge for the current study was to identify a viable definition of interest.

One problem in this regard is that the word 'interest' and its synonyms are embedded in everyday language – an issue common to psychological terms generally (Valsiner, 1992). As a consequence, different authors have used the word 'interest' in different ways. Many have neglected to define it at all (Schiefele, 1991) while others have conflated interest with related constructs such as intrinsic motivation, competence, involvement, relevance, or enjoyment (Reeve, 1989; Turner et al., 1998; Stuckey et al., 2013).

A second problem is that even when definitions have been given, they do not always define interest in a thorough or empirically useful fashion. For instance, Sansone and Smith (2000, p. 345) have written:

> Like many researchers, we define interest as a phenomenological experience involving both cognitive and affective components. Attention is directed and focused, and the general affective tone is positive.

As true as this statement may be in a general sense, it does not provide the theoretical and definitional clarity to which Pintrich refers, nor does it offer any tools for rationalising Silvia's 'laundry lists'. What is needed is a clear description of the nature of the cognitions and affects that are unique to the phenomenon of interest and how these things relate to attention. Indeed, one might say that a satisfactory definition of interest *is* a theory of interest.

Given the various issues just described, some would conclude, along with Silvia (2006), that a general theory of interest may be either impractical or impossible. Examination of the literature related to the phenomenon of interest, however, reveals that theorists from a variety of disciplines have consistently converged upon – or, at least, are converging upon – themes which, when taken together, amount to a workable model of interest. This 'zone of convergence' will be the focus of the next few chapters.

2.5 The Opportunity Concept of Interest

Chapters 3 to 5 of this work describe the elements of a new model of interest. In these chapters I shall argue that *interest is an emotion that arises when a person appraises an object as providing the opportunity to fulfill a need*. This perspective is termed the Opportunity Concept of Interest – or OCI for brevity. The purpose of the OCI is to provide an economical definition of interest and thus give a theoretical basis to the empirical component of this study. It is the aim of the three succeeding chapters to demonstrate, using arguments and evidence from a range of psychology scholars, that the Opportunity Concept of Interest satisfactorily fulfills this role.

It will be apparent throughout, however, that many – if not most – of the premises on which the OCI is founded are controversial or at least debated. Nevertheless, it will also be apparent that each premise has significant support from mainstream authorities and that the overall definition itself has sufficient internal consistency to justify its use as the grounding framework for this study.

2.6 Other Definitional Issues

In addition to the definitions of situational interest and individual interest already given, it is appropriate to define some other interest-related terms before embarking on the central discussions.

2.6.1 Interestingness

According to Krapp, Hidi, and Renninger (1992), the source of all situational interest lies in the properties of the object being perceived. The cumulative effect of all such interest-inducing properties is a phenomenon which some (e.g., Hidi & Baird, 1988) have termed *interestingness*. Although the assumption of Krapp et al. regarding the ultimate source of situational interest will be disputed later, their general conception of interestingness has been adopted. Thus, the capacity of a teacher, text book, video, science lesson, *et cetera* to elicit interest will be known as interestingness hereafter.

2.6.2 Defining What Interest Is Not

For present purposes, interest is treated as distinct from attention, the orientation reflex, and intrinsic motivation. All these latter phenomena overlap with interest in some way and some have even been treated as synonyms for it. A rationale for distinguishing interest from each of these other constructs is given below.

Attention

As reflected in Sansone and Smith's comment earlier, attention is frequently included in researchers' definitions of interest. Many studies attest to the relatedness of interest and attention yet Silvia (2006) has advised against equating the two, in part because many other psychological phenomena also have relationships with attention. Further, Krapp et al. (1992) have commented that the object-specificity of interest argues against equating it with attention.

Orientation Reflex

The orientation reflex is an instinctive response elicited by a range of auditory, tactile, and visual cues. It is associated with both approach responses – such as interest – and avoidance responses – such as fear (Beck, 1978; Izard, 1977). Izard (1977) has also observed that while the orientation reflex necessarily involves movements such that the person ends up facing the stimulus, no such positioning of the head in space is required during the experience of interest. For these reasons, therefore, the two phenomena are differentiated here.

Intrinsic Motivation

Many researchers treat the terms 'interest' and 'intrinsic motivation' as virtually synonymous (Hidi & Harackiewicz, 2000). Indeed, self-reported interest has often been used as a direct measure of intrinsic motivation (Hidi, 2000). To thoroughly distinguish the two terms, however, a detailed examination of each term is necessary – a requisite made problematic by the absence of a universal definition for interest, as already discussed. For the moment, however, it is sufficient to identify interest as one of several motives within the general class of intrinsic motivation (Hidi, 2000).

2.6.3 Current Definitions of Interest

Before discussing the OCI in detail, a review of existing interest definitions is necessary. The following represent the opinions of theorists who have made major contributions to the field during the modern phase of interest research. The various definitions will be compared with the Opportunity Concept of Interest in Chapter 6.

Broadly speaking, modern interest definitions fall into two major categories: descriptive definitions and emotion definitions. Note that these classifications are not necessarily used by the authors who espouse them – although there are good reasons for their use, as will be explained. Further, the focus here remains on situational interest, despite an unavoidable overlap with the phenomenon of individual interest.

Descriptive Definitions

One prominent interest theorist (Hidi, 2000, p. 311) has characterised interest as follows:

> Interest as a psychological state involves focused attention, increased cognitive functioning, persistence, and affective involvement.

According to Hidi and her colleagues (see Krapp et al., 1992), the psychological state of interest is a recognisable cluster of experiential phenomena that may arise from either of two sources: interesting environmental stimuli or pre-existing (individual) interests. These two types of stimuli are considered to produce different states – situational interest and 'actualised individual interest', respectively. They argue:

> It has not been demonstrated that the psychological processes and the effects of the two states are identical, or even comparable. (p. 10)

Ignoring for the moment any technical distinctions between interest states, the above comments exemplify the descriptive approach. In such definitions, increased cognition, positive affect, and heightened attention are usually cited as essential elements of interest.

The most thorough of the descriptive definitions is the person-object theory of interest (POI) developed from original work by Hans Schiefele and colleagues (Krapp, 1999). POI has become the basis for many – if not most – of the other descriptive definitions now in use. As one of its authors has pointed out, however, this model is not a theory in the strict sense (Krapp, 2002). Nevertheless, it does provide a useful set of concepts to explain much of the psychological phenomena associated with interest. The basic ideas of the person-object theory of interest as presented by Krapp (1999) may be summarised as follows: a) interest is the result of an interaction between a person and an object (hence POI); b) it is associated with positive experiential states, such as joy; c) it arises in response to matters which are of significance to the individual; and d) the criterion of significance is not assessed purely cognitively but also on the basis of feeling-related psychological processes. It is important to note that this description is deemed by its authors to apply only to individual interest; situational interest is not addressed specifically by the POI.

Todt and Schreiber (1998) have also reported a descriptive definition of interest. This definition entails the following elements: a) interest is a quality of experience which is fundamental to attention, understanding, learning, thinking, and remembering; b) it depends on incentives provided by the physical or social environment; and c) it is related to need satisfaction. Unfortunately, the work of these researchers has been largely published in German and the small amount of material available in English offers only a glimpse of their ideas.

Emotion Definitions

As already noted, many interest theorists assert that affective experience is a definitional feature of interest. This position – that affect is an element of interest – is markedly different, however, from the view held by some theorists (e.g., Izard, 1977; Fredrickson, 1998) who hold that interest is a distinct emotion in its own right. The difference between these two positions is very significant and represents the focus of Chapter 3. A number of the most important emotion definitions of interest are outlined below.

Deci and Ryan’s self-determination theory (SDT) has played a major role in the understanding of motivational states. Since interest is a conative phenomenon, it is not surprising that interest appears frequently in the motivation literature, including that of SDT. Indeed, in an article on the relationship between interest and motivation, Deci (1992, p. 61) has written:

> I have defined interest as the core affect of the self, suggesting that it occurs when there is an ideal match between a person's organismic condition and the environmental affordances

This definition comes closest to achieving a parsimonious yet comprehensive explanation of the nature of interest. It has been adopted, at least in part, in recent revisions of POI (e.g., Krapp & Lewalter, 2001), in Silvia's appraisal conceptualisation (see below), and it also closely resembles the OCI. It should be noted, however, that Deci and Ryan are motivation researchers and that their definition of interest has never been developed into a comprehensive theory. Thus, it suffers from a number of weaknesses which will be discussed later (see Section 6.3.3).

In a subset of the emotion definitions category are those interest definitions which address the matter of appraisal. An appraisal has been defined as "an evaluation of the significance of what is happening in the person-environment relationship for personal well-being" (Lazarus, 1991, p. 87). Appraisal approaches to emotions have a long history but appraisal explanations for interest are relatively new (Silvia, 2006). Although relationships between appraisals and interest have been proposed by a number of theorists, Silvia is the only researcher to have integrated such ideas into a conceptualisation that also takes into account other major findings in the field of interest research. Appraisal concepts of interest are treated in detail in Chapter 4.

Cognitive Definitions

Some researchers have proposed that interest is a purely cognitive phenomenon (e.g., Iran-Nejad & Cecil, 1992; Ortony, Clore, & Collins, 1988). None of these authors have proposed an interest definition that has gained significant currency, however, and the category of cognitive definitions is cited here in principle only.

Chapter 3

INTEREST AS AN EMOTION

3.1 Defining Emotions

3.1.1 Introduction

A premise not universally accepted, but central to the OCI and to this study generally, is that *interest is an emotion*. The present chapter aims to defend this position, referring first to emotion theory in general and then to interest research specifically.

The field of emotion psychology has a long history, dating back as far as the philosophic works of Aristotle and including such eminent thinkers as Descartes, Darwin, and Sartre. Despite centuries of speculation and the intensive efforts of contemporary researchers, however, the term emotion – like so many others in psychology – defies definition. Some scholars (e.g., Izard, 1993; Frijda, 1988) have commented that comprehensive emotion definitions are invariably controversial, while others have even asserted that emotion constitutes a category too diverse to properly define at all (Oatley, Keltner, & Jenkins, 2006). Given these problems, many reviewers attempting to reconcile the burgeoning literature on emotions have eschewed theory-based definitions in favour of descriptive ones (Lazarus, 1991). This approach has been adopted here and the commonly cited components of such descriptions are covered below.

3.1.2 Emotions as Person-Environment Interactions

Despite the diversity of opinion that exists in the field of emotions theory, a number of concepts enjoy general acceptance. One such concept is that emotions always concern the relationship between a person and their environment or, more technically, a subject and an object.

Thus, Arnold and Gasson (1954) have commented:

> Emotions involve a double reference, both to the object and to the self experiencing the object (p. 294)

Similarly, Frijda and Mesquita (1994) have stated:

> Emotions… are, first and foremost, modes of relating to the environment: states of readiness for engaging, or not engaging, in interaction with that environment. (p. 51)

Simply put, then, it is implicit in modern theories that emotions are not undirected feelings but are always about something. An emotion is a response by a subject to an object, whether that object is tangible or abstract, external or internal.

3.1.3 Four Response Components of Emotion

The second major point of agreement amongst theorists is that emotions are not simple experiential states but complex processes and that these processes involve an identifiable set of inter-related components. The components most often identified are: physiology, behaviour/motivation, cognition, and experience (Kaszniak, 1999; Clore & Ortony, 2000). Each of these four categories will be treated separately below. It should be noted that although considerable consensus exists regarding the nature of these components, the precise identities of the components that are essential to an emotion are hotly contested, as are the dynamics of their interactions. The objective of this chapter, however, is not to reconcile such debates but to demonstrate that interest fits the criteria for an emotion according to mainstream perspectives.

Physiology

According to Lazarus (1991), physiological activity is often used as a basic criterion distinguishing emotion from non-emotion. The onset of an emotion may influence such biological parameters as blood pressure, heart rate, hormone levels, and bio-electrical activity, as well as eliciting overt responses such as weeping or sweating. This much is quite uncontroversial. Disagreement arises, however, with respect to the specificity of physiological activity in relation to emotion. Can sadness, for instance, be reliably identified from tear production or blood pressure levels? The answer, at the gross level, is certainly not. As Popplestone and McPherson (1988, p. 113) have commented, "there are tears in jubilance, in heartbreak, and in polluted air". The notion of emotion-specific physiology has, however, gained some support from modern analytic techniques. For instance, distinctive patterns of activity have been observed in the human autonomic nervous system for such emotions as anger, fear, and disgust. Conversely, however, equivalent results have not been found for surprise or enjoyment (Ekman, 1992). Lazarus (1991, p. 78) has therefore concluded:

> I remain convinced of the potential utility of the idea that each emotion is associated with a specific pattern of bodily response but also suspicious of the empirical case for this.

Since reliable physiological indices have not been identified for every emotional state, and since physiological function *per se* cannot be indicative of emotion, Lazarus suggests that physiological change should be considered the best gauge of emotional onset. Research into the physiological parameters associated with interest is discussed in Section 3.2.3. For practical reasons, no attempt was made to measure such parameters in this study, however.

Behaviour/Motivation

Contrary to much popular opinion, it is a commonplace of emotion psychology that emotions serve important adaptive functions, mobilising individuals to deal quickly with interpersonal encounters (Ekman, 1992). Since emotions are adaptive responses in a person-environment relationship, it follows that emotions are connected to actions because it is actions that bridge the gap between an individual's inner and outer worlds. Clearly, however, emotions do not always result in action as there exists within each person a multitude of intervening psychological variables. Thus, many scholars speak of emotions as involving an 'action tendency' – an impulse which may or may not be acted upon (Izard, 1991; Frijda, 1986). It is because of this nexus between motivation and behaviour that the two apparently distinct phenomena are treated as aspects of a single response category 'behaviour/motivation'.

If we focus on motivation *per se*, this construct has been described as having two dimensions, valence and arousal. Valence refers to the ‘tone’ of a motivation, which is generally expressed as either positive or negative and which reflects a reaction tendency – that is, an inclination either to approach or to avoid a given stimulus. Arousal, on the other hand, refers to the intensity of the motivational state (Bradley & Lang, 2000). It is worth noting that many psychologists have taken a similar dimensional approach in their categorisations of emotions (i.e., as distinct from motivation), arriving at a valence-plus-arousal description indistinguishable from that given above. For instance, Arnold and Gasson (1954, p. 294) have commented that:

> An *emotion*… can be considered as the felt tendency toward an object judged suitable, or away from an object judged unsuitable. [italics added]

Given the centrality of motivation in emotion processes and the fact that conative and affective phenomena are often described in almost identical terms, the distinction between motivation and emotion is not at all clear. Indeed, Popplestone and McPherson (1988) have observed that confusion remains even amongst authors working in this field. McTeer (1972), however, has proposed a solution, suggesting that long-term or persisting reactions be classified under the heading of motivation while immediate reactions be labelled as emotion. Although it is not necessary in the current context to actually resolve this question, McTeer’s motivation/emotion distinction has particular relevance to both interest theory and the present study, and the matter will be treated again in Section 3.2.5.

Before moving on to the related matter of behaviour, the relationship between motivations and goals must also be addressed. Oatley et al. (2006) have asserted that emotions help people achieve their goals. This is a non-contentious statement but the meaning of the word ‘goals’ deserves clarification. Some authors view the relationship between emotions and goals in explicitly biological/evolutionary terms. Others such as Deci and Ryan (1985) have argued, however, that much of human motivation is based on innate psychological goals (i.e., the attainment of non-biological requirements) and that these phenomena “lend themselves more easily to psychological than to physiological theorizing” (p. vii). Neither of these perspectives inherently denies the other and thus a comprehensive understanding of emotions should consider both categories of goal. In the present study, physiological and psychological goals are treated as critical to a proper understanding of interest and the issue of goals will be treated in a separate chapter. Goal dimensions also represent a significant organising principle for the empirical portion of this work.

Let us now consider behaviour – the practical aspect of the behavior/motivation complex. Since behaviour is the physical outworking of any action tendency, it cannot be rigorously isolated from physiology and thus may be as subject to definition disputes as any of the phenomena already covered. To avoid broaching such matters – and thus to constrain this discussion to issues of the greatest relevance – treatment here will be limited to facial expression, since it is on this aspect of behaviour that the majority of studies have been focused (Popplestone & McPherson, 1988).

As a result of extensive intra- and inter-cultural studies, Ekman (1992) drew the important conclusion that humans exhibit universally recognisable facial signals. This finding has been supported by the work of Izard (1994) and is now widely accepted. Ekman, however, extrapolated this finding to make the claim that the universality of expressions indicates that emotions cannot be fully understood by the reductionistic dimensional approach described earlier. Moreover, he has commented that expressive facial behaviours should be considered evidence for the existence of basic (i.e., discrete) emotions. As with so many matters in the field of emotions research, however, not everyone agrees. Popplestone & McPherson (1988), for instance, have rejected the suggestion that *any* reliable behavioural indices of emotion have been found – facial expressions included – and consider such a lack to be evidence against the notion of basic emotions.

In summary, then, it is commonly accepted amongst contemporary theorists that emotions are intimately and causally linked to behaviours. On the other hand, the specificity of such linkages, the notion of basic/discrete emotions, and the existence of unique behaviours arising from such basic emotions remain the subjects of considerable debate.

During the practical portion of this study, student interest in science lessons was assessed using a number of behavioural measures. A detailed treatment of these measures and the resultant empirical findings are given in Chapters 7 and 9 respectively.

Cognition

According to Frijda (1986), most modern emotions theorists subscribe to the opinion that emotions consist – at least in part – of cognitions. Beyond this level of consensus, however, there exists a great diversity of opinion on their role and importance. One such prominent controversy is the matter of appraisals. An appraisal is an interpretation of the value or significance of an event in terms of a personal goal and an emotion is conceived as a psychological state arising from such an interpretation (Oatley, 2000). According to Stein and Levine (1991), it is appraisal that distinguishes emotion from simple affect. Other major theorists subscribe to the view that appraisals are not just essential to emotions but that they are the initiators of the emotion response process (e.g., Clore, 1994; Lazarus, 1991). And there are yet others (e.g., Zajonc, 1980; Izard, 1991) who, whilst not rejecting appraisals altogether, do not consider them fundamental to emotional onset. Finally, to complicate the situation still further, many researchers have observed that cognitions are themselves influenced by emotions.

For the purposes of the present study it is neither possible nor necessary to exhaustively evaluate all the perspectives outlined above. Nevertheless, the notion that appraisals are crucial to emotional onset unpins the Opportunity Concept of Interest and for this reason Chapter 5 is dedicated to a detailed treatment of the topic.

Experience

The fourth widely-acknowledged component of the emotion process is that of affect – the feeling that constitutes the essence of emotional experience. Concerning this matter, two points must be made, the first relating to terminology and the second relating to the necessity – or otherwise – of emotional experience being consciously detected.

With respect to terminology, many treat the words *emotion* and *affect* as synonyms (Averill, 1994). Most emotion theorists distinguish the two, however. For present purposes, the word affect is considered to refer to the subjective experience – or the feeling – of an emotion (Lazarus, 1991).

As for conscious awareness, yet another debate exists. While it would appear axiomatic that emotions have an experiential component, a problem arises when addressing the matter of reflective awareness. Many theorists consider that conscious affective experience is essential to every emotion. Clore (1994, p. 285) has summarised this perspective succinctly: "one cannot have an experience that is not experienced". Indeed, for Clore, as well as many others, the debate over the existence of non-conscious emotion is simply a matter of what one selects as being the necessary conditions for emotion. Yet other eminent researchers disagree. Zajonc (1994), for example, has presented a persuasive case that non-conscious affects can and do occur. He likens his empirical investigations to radiological searches for a brain tumour – a condition which can be clearly demonstrated even though the subject is themselves unaware of its presence. A final, additional complication with respect to emotional experience is that it is possible for people to consciously experience emotion without actually being conscious of the fact (Silvia, 2006; Russell, 2003). Silvia (2006, p. 143) has illustrated it thus:

> The experience of fear, for instance, can pervade conscious experience, but people may realize that they are afraid only after the fearful event has passed.

In light of the various arguments, it is reasonable to conclude that while affect is fundamental to any definition of the construct, consciousness of affect is not necessary.

3.1.4 Basic Emotions

In Section 3.1.3 above, it was noted that Ekman (1992) found certain facial expressions to be universally recognisable. It was also noted that he, amongst others, used this universality of expression as evidence in favour of basic emotions. Since interest is considered by some to be a basic emotion, further discussion of this concept is warranted.

As far back as the seventeenth century, Descartes suggested the existence of a set of fundamental emotions from which all other emotions derived (Oatley et al., 2006). Under this conception, a fundamental or basic emotion involves an affect which is qualitatively distinct. Secondary (i.e., non-basic) emotions are hypothesised to be derived from either the overlap or the blending of the elemental emotions. Izard (1977), Plutchik (1980), and Ekman (1992) are examples of contemporary theorists who subscribe to this perspective. As might be predicted, however, there are many scholars who reject the basic emotions concept, at least in its strict sense. One significant argument in this regard is that it is extremely difficult to arrive at a set of objective and generally acceptable criteria for categorising basic emotions (Turner & Ortony, 1992). Another common and related argument is that there is a lack of consensus on precisely which emotions are the basic ones, even amongst proponents of the concept. Thus, de Sousa (1980, p. 142) has commented, “The diversity in the lists [of basic emotions] is warning enough that this is an unpromising strategy.”

Lazarus (1991) has provided a practical resolution to this impasse. While rejecting the idea that basic emotions represent fundamental distinctions, he nevertheless has asserted that the principle has utility in a general sense for those working in a particular field of study. In this respect he has found some agreement with Ekman (1992) – a basic emotions advocate – who has stated that basic emotions are not single affective states but a ‘family’ of related states. The notion of emotion or affect families thus allows for the practical classification of similar states without invoking theoretical disputes. So, for present purposes, the word ‘interest’ broadly categorises such closely related phenomena as situational interest, individual interest, curiosity, intrigue, fascination, and excitement.

3.1.5 Summary

The above discussion has shown that despite a significant level of controversy regarding the details of the emotion phenomenon, a number of themes have achieved wide acceptance amongst contemporary researchers. These themes include: a) that emotions refer to a relationship between a person and an object; b) that emotions are complex processes involving numerous components; c) that emotions involve physiological responses, behavioural/motivational responses, cognitive elements, and an experiential component; and d) that emotions can be categorised into families having important similarities. The idea that appraisals are an essential component of emotions is commonly but not universally accepted. Nevertheless, since there is widespread acceptance of appraisals amongst major theorists and since the main debate does not concern the existence of appraisals but their precise role in the emotion process, the appraisal concept is included here as a key element of emotional phenomena, too.

The concepts identified above have a number of important links to the present work. First, they constitute the basis for this study's central thesis that interest is an emotion (see Section 3.2, below). Second, they provide a body of terms to describe interest, its elicitors, and its products. And third, the fact that emotions are associated with distinctive behavioural responses provided a foundation for the development of the study's instrumentation.

3.2 Interest as an Emotion

3.2.1 Introduction

The Opportunity Concept of Interest, which forms the central organising principle of this work, assumes that interest is an emotion. It is the objective of this next section to justify this assumption by reference to major scholarly findings.

Current researchers hold a diversity of opinions regarding the phenomenon of interest. First, there are those who assert that interest is, indeed, an emotion. Adherents to this perspective include Silvia (2005), Ellsworth and Smith (1988a), and Fredrickson (1998). Also included are Tomkins (2008/1962), who was the first to consider interest an emotion (see Silvia, 2006), and Izard (1977), who has asserted that interest is the most commonly experienced positive emotion. At the other pole of opinion stand Ortony et al. (1988) for whom interest is a cognitive function only. In between these two extremes are a range of perspectives. Lazarus (1991) leans toward the negative end of the continuum, and has labelled interest – along with the related states of anticipation, curiosity, and surprise – as a *pre-emotion*. Ekman (1992) has taken a more equivocal position, hesitating to accept interest under the emotion rubric while not rejecting it outright. Deci and Ryan's opinion represents a peculiar case. Their definition of interest as the "core affect of self" has already been cited, yet whether the word 'affect' was intended in its general sense (as a synonym for emotion), or in its precise sense (as the experiential component of an emotion process) is never made clear in their writings. A final, distinctive opinion is found amongst a number of specialist interest researchers who view interest not as an emotion *per se* but as representing a broader process of which emotion is a component. Authors in this category include Krapp (2002), and Hidi and Renninger (2006).

With such a diversity of views among theorists it would be possible to claim support for any perspective. Nevertheless, a significant body of opinion – as well as data – strongly suggests that interest is an emotion. The remainder of this chapter presents arguments for this case, drawing upon the core elements of emotion theory as already outlined. Note that in the following discussion, the word 'interest' refers to situational interest unless otherwise stated.

3.2.2 Interest as a Person-Object Interaction

One of the undisputed qualities of interest is that a person must always have an object to take interest in. Since this is true intuitively and since it is also not disputed on any theoretical or empirical grounds, the person-object nature of interest represents a first point in favour of conceiving interest as an emotion. It is worth noting that such a perspective is widely acknowledged amongst contemporary workers in the field. For instance, Shiefele and colleagues have developed the person-object theory of interest (POI) to explain the phenomenon (see Krapp & Lewalter, 2001; Krapp, 1999). Moreover, the English word itself owes its roots to the Latin *inter esse*, meaning 'being between' (Rheinberg, 1998).

3.2.3 Interest and the Four Response Components of Emotion

Does the phenomenon of interest exhibit all the qualities of an emotion described earlier? The following discussion addresses this question, treating each of the four emotion components – physiology, motivation/behaviour, cognition, and experience – in turn.

Physiology

Interest has been found to be associated with a number of physiological parameters. One of the most significant results in this respect is that an increase in interest is reliably correlated with decreased heart rate (Izard, 1991). This same result has been reported by Libby, Lacey, and Lacey (1973) who also found that pupillary dilation showed a significant positive correlation with the attention/interest value of visual stimuli. Other data indicate that interest is related to various bio-electrical responses. For example, a range of studies reported by Berlyne (1978) showed that exposure to interest-inducing stimuli elicited changes in galvanic skin response and electro-cortical activity. Similarly, Tomkins (2008/1962) reported that interest responses are associated with increased rates of neural firing. Hidi, Renninger, and Krapp (1992) have pointed out that findings such as these do not constitute evidence that interest is associated with any unique physiological factor. Yet this is neither surprising nor contrary to the idea of interest as an emotion. As has already been shown, distinctive physiological patterns have not been observed for many emotions and Lazarus has proposed that emotions are best identified by physiological change rather than by any specific function or functional pattern (see Section 3.1.3).

Behaviour/Motivation

Despite earlier comments that, in the context of emotion theory, behaviour and motivation constitute a single category, these two phenomena will be discussed separately here. With respect to motivation, it is difficult to discuss interest without broaching the topic of motivation in one form or another. For instance, Deci's (1992) comment that "interest is the core affect of self" arose not out of interest research but from that author's investigations into intrinsic motivation. Indeed, the relationship between motivation and interest is such a close and familiar one that its existence needs little support from abstruse scientific theorising. Hidi and Renninger (2006, p.

113) have summarised the whole matter concisely: “interest is always motivating”. Consequently, it is here assumed that interest inherently involves a substantial motivational aspect.

With respect to behaviour, a number of distinctive correlates with interest have been observed. For instance, various studies have shown interest to be positively associated with improved attention – whether defined as visual fixation (Langsdorf, Izard, Rayias, & Hembree, 1983) or as the duration of focus on a task (e.g., Reynolds, 1992). Similarly, interest has been shown to predict exploratory behaviours, such as time spent viewing an image (Evans & Day, 1971). Another strand of evidence relates to facial behaviour. A number of researchers, dating back to Charles Darwin, have sought to establish relationships between interest and facial expression. Reeve (1993), for instance, investigated the expressions of volunteers viewing short video clips. In accordance with many previous studies, he found that interested subjects had a strong tendency to demonstrate a ‘hard stare’ during viewing. Specifically, this expression was characterised by wider parting of the eyelids, less frequent closing of the eye, fewer lateral eye movements, and a diminished degree of head movement. From this sample of findings it is clear that interest is characterised by quite distinctive – if not actually unique – behaviours, a fact which argues in favour of interest as an emotion. Several measures of interest behaviour – in particular, attention to instructional tasks – were employed in the fieldwork of this study. These are discussed in detail Section 7.3.4.

Cognition

The Opportunity Concept of Interest states that interest is an emotion that arises when a person appraises an object as providing the opportunity to fulfill a need. According to this view, cognition – and specifically appraisal – is central to the emotion of interest. Due to the many issues surrounding the role of cognition in emotion and the importance of appraisals in the generation of interest, this matter will be covered separately in the next chapter.

Experience

Is there such a thing as a distinctive interest affect? Unlike the question of behavioural or physiological indicators, this is a question that cannot be resolved entirely objectively. Izard (1977, p. 216), a basic emotions theorist, has described the experience of what he calls interest-excitement as follows:

> Interest-excitement is the feeling of being engaged, caught-up, fascinated, curious. There is a feeling of wanting to investigate, become involved, or extend or expand the self by incorporating new information and having new experiences with the person or object that has stimulated the interest… Even when relatively immobile the interested or excited person has the feeling that he is 'alive and active'.

In some senses, a description of this nature is redundant since everyone knows the experience. Indeed, were there a person who did not know it, they would gain little more insight from these words than would a person who had never tasted curry gain an appreciation of that experience from an essay about it. Yet the fact that such a description is self-evident is in itself significant. It reminds us that interest involves a clearly recognisable – and commonly recognised – experiential quality.

It is not the intention here to argue that interest is a basic emotion – as Izard and some others would have it – but rather to establish whether or not interest has a distinctive experiential aspect. And since it is distinctiveness, rather than exclusiveness, that is important, it is difficult not to conclude that interest involves such a component. Ortony et al. (1988), however, have claimed that interest is not an emotion at all but a cognitive state, while others (e.g., Ainley, Hidi, & Berndorff, 2002) refer to interest as a psychological state involving a range of emotions. Each of these perspectives deserves some attention in light of the present view of the interest experience.

First, if we are to accept Ortony et al.'s view then we must classify Izard's interest-excitement description as referring to cognition rather than affect and therefore conclude that Izard's repeated use of the word 'feeling' is incorrect. It is the position taken here, however, that the experience of interest is, at least in part, an affective one and not purely cognitive.

The second matter requires a more detailed treatment. It has already been suggested that interest definitions can be divided into two broad categories: descriptive definitions and emotion definitions (see Section 2.6.3). Perhaps the most fundamental difference between these two views is that the former regards interest as involving emotions rather than being one. Those who subscribe to the descriptive view refer to the affective aspects of interest in very general terms. Thus, Hidi and Renninger (2006, p. 112) have stated that "the affective component of interest describes positive emotions accompanying enjoyment"; Krapp and Lewalter (2001, p. 212) have referred to "feeling-related valences" such as "joy, optimal arousal or feelings of competence, autonomy and social relatedness"; Sansone and Thoman (2005, p. 175) have written that "the general affective tone is positive"; and so forth. The situation is complicated further by assertions that interest may also involve negative feelings (e.g., Ainley et al., 2002). What is always lacking in such descriptions, however, is specificity regarding an affective quality – or even a cluster of qualities – that is diagnostically definitive. It is the position taken here, however, that Izard's description of the affect of interest is correct and that such an experience is sufficiently distinctive to constitute an essential component of the interest experience and thus to be considered a diagnostic feature.

3.2.4 Summary

The foregoing discussion clearly demonstrates the following: a) interest always involves a person-object relationship; b) interest responses are implicitly associated with motivation; c) interest responses have been consistently correlated with a range of clear physiological and behavioural parameters; and d) interest has clear experiential characteristics. These phenomena are considered by the majority of emotion theorists to be the requisites of an emotion. Although the issue of cognition has yet to be properly addressed, the above discussion comprehensively validates Ellsworth's (2003, p. 84) comment, that "even by the strictest standards of the strictest categorical emotion theorists, interest qualifies [as an emotion]". Thus, the first premise of the OCI – interest is an emotion – can be seen to have substantial support.

3.2.5 Implications and Applications

The above conclusion has a range of important implications for the present study and for interest research generally. Although these will be discussed in detail in Chapter 6 it is necessary here to cover some other matters related to the finding that interest is an emotion.

The Relationship of Interest to Other Emotions

In their book *The Cognitive Structure of Emotions*, Ortony et al. (1988) have presented a classification scheme for what they call *prospect-based* emotions. The primary dichotomy in this scheme is between hope emotions (arising from the prospect of desirable events) and fear emotions (arising from the prospect of undesirable events). They argue that within these general categories, the specific type of emotion is determined by whether the prospective event has been confirmed, disconfirmed, or remains unconfirmed, while the degree of emotional intensity is a function, jointly, of the degree to which the event is desirable or undesirable and the likelihood of the event transpiring. On the basis of these dimensions the authors argue, for instance, that hope arises when a person is pleased about the prospect of a desirable event, while disappointment arises when there is disconfirmation of such an event. Conversely, they argue that fear is elicited when a person faces the prospect of an undesirable event, while relief is experienced with the disconfirmation of such an event.

It takes little effort to insert interest – as conceived in the present work – into these authors' scheme. The OCI holds that interest is the emotion arising when an opportunity (i.e., prospect) for need-fulfillment is detected. Such a definition fits very closely with the description of hope given above. Indeed, Ortony et al. listed the words anticipation, excitement, and expectancy as synonyms for hope, words which echo Izard's term *interest-excitement.* Curiously, however, they did not consider interest an emotion at all, a conclusion based in part on the results of a linguistically-based investigation into people's use of emotion words by Clore, Ortony, and Foss (1987). On account of the extensive arguments already provided above, however, their rejection of interest as an emotion is rejected here. Nevertheless, the general structure of Ortony et al.'s scheme has been described in order to: a) demonstrate that mainstream emotions theorists have repeatedly converged on conclusions very similar to the OCI; and b) illustrate how interest might be understood in relation to other emotions.

A Proposed Classification System for Situational and Individual Interest

It was observed earlier that affective and conative phenomena are difficult to distinguish. It was also noted that a parsimonious solution to the problem has been proposed by McTeer (1972), viz.: long-term, persisting reactions ought to be labelled as motivations, while short-term reactions should be termed emotions. This distinction can be validly applied to interest theory as a means of differentiating situational interest from individual interest. If we apply McTeer's criteria, then according to the OCI, situational interest is an emotion while individual interest is a motivation. This division is not perfectly discrete; the former can be seen to overlap with the latter. Nevertheless, there are theoretical and practical values in making the distinction. In the present study, the levels of individual interest in science generally and situational interest in science classes specifically were both measured, each using separate instruments, and their relationships were extensively analysed (see Chapters 8 and 9).

Chapter 4

INTEREST AND APPRAISAL

4.1 Introduction to the Theory of Appraisals

4.1.1 Introduction

The second clause of the OCI states that the emotion of interest arises when a person *appraises an object*. The matter of appraisals has already been introduced briefly but will now be treated in detail.

According to modern theorists, emotions are not random occurrences but arise in lawful fashion as a response to stimuli (Frijda, 1988). Part of this lawfulness is that emotions are initiated by cognitive assessments of the potential of stimuli to affect the individual. These cognitions have been termed *appraisals*. Parkinson (1994, p. 493) has stated, "Appraisal theorists suggest that… what gives an object emotional impact is its relevance to the individual's personal concerns". The object in this context may be a literal, concrete thing or an abstraction – an idea, a topic, or "any other content of the cognitively represented life-space" (Krapp, 2002, p. 410). According to appraisal theory – and thus, also, the Opportunity Concept of Interest – the object does not 'contain' the emotion, nor does any object invariably elicit a specific emotion. Rather, an emotion arises in someone due to the conclusion that an object has the capacity to affect them.

An important distinction must be drawn here between knowledge and appraisal, since they are often confused. According to Lazarus and Smith (1988), knowledge refers to cognitions – whether primitive or complex – about the way things are and how they work. In any interaction knowledge is necessarily invoked; yet, if an interaction does not implicate a personal investment of some sort, the cognition is 'cold' and is not an appraisal. Conversely, if an interaction has consequences for something in which the person has a stake, then the cognition becomes charged, or ‘hot,’ and is thus an appraisal. This distinction may be illustrated by reference to a simple teaching scenario. Most high school students recognise what a Bunsen burner is, know what it is used for, and are able to recall some safety precautions associated with its operation. All this is knowledge. Certain students, however, when asked to actually light a Bunsen burner become afraid (i.e., experience an emotion) because they conclude they will be burned by the flame. This latter cognition – the assessment of danger from the apparatus – is an appraisal.

Another matter deserving clarification here is *perception* – a word which has two distinct usages, both significant to appraisals. The first usage is as a synonym for understanding or interpretation. In this regard, Rogers (1951) applied the term *perceptual field* to describe the world as it is interpreted and experienced by an individual. Implicit in this term is the idea that one’s understanding (i.e., perception) of reality may differ from objective fact. Again, the Bunsen burner provides a useful illustration. For teachers and chemists who have used the apparatus many times, a Bunsen burner is a mundane object whose behaviour is predictable and manageable. For a small number of students, however, the Bunsen burner is an object of terror, a monster that might attack at any moment. The object is one and the same, but the perceptions are utterly different. Consequently, the emotions aroused in a teacher by a Bunsen burner – if any – will be entirely different to those aroused in a pyrophobic pupil. The other usage of perception is as a synonym for sensory detection; this meaning has direct relevance to appraisals, too. It is clear that a person’s perceptual field is dependent, at least in part, on the data available from the senses. In the case of a physical object it follows that changes in the quality or quantity of sensory data may alter a person’s understanding and hence appraisal of an object. Although the issue of perception does not affect debates over the nature of appraisals *per se* or their role in emotion processes, it is clear that perception is intrinsic to appraisal and thus can be a significant factor in the elicitation of emotions, including interest. For this reason, measures relating to perceptual clarity were included in the instruments used for this investigation (see Section 7.3.4).

4.1.2 Appraisal Structures and Processes

Appraisal theorists hold that specific emotions are associated with specific appraisal patterns. Thus, the study of appraisal phenomena is divided into work on *appraisal structure* – the patterns of cognition underlying each emotion – and *appraisal processes* – the sequencing of appraisal patterns during emotions (Silvia, 2006). Together, these ideas form a framework for evaluating the appraisals models that have been proposed for interest and thus, also, the OCI.

Appraisal Structures

It is widely agreed that the most fundamental appraisals are those that ascertain the likelihood of harm or benefit arising from a given stimulus. Stimuli evaluated as harmful will result in negative emotions, whilst those judged beneficial will result in positive emotions (Ellsworth & Smith, 1988a; Frijda, 1988). Lazarus and Smith (1988) have termed these evaluations *primary appraisals*. *Secondary appraisals* relate to other subject-object interaction factors such as coping potential, blame (Lazarus & Smith, 1988), causal agency, effort, and the certainty of the event (Keltner & Ekman, 2000). It is secondary appraisals that determine the exact nature of the emotion (Lazarus & Smith, 1988).

Appraisal Processes

Before considering interest appraisals, an introduction to appraisal processes (i.e., sequences) is necessary. The following outline is taken from the model proposed by Stein and Levine (1991). While their model differs in some details from those of other researchers, it shares sufficient similarities to justify its use in the present context as a framework for the discussion of appraisal processes generally.

According to Stein and Levine's model, appraisals are inextricably reliant upon pre-existing cognitive capacities and their model involves two such capacities which enable appraisal processes to take place. The first is the ability of each person to store information about subjective states and bodily reactions. These representational systems consist of: a) information regarding states that are desirable and those that are undesirable; b) information about conditions that lead to such states; and c) information regarding priorities for the attainment or avoidance of those states. This information is, in other words, a value system which provides reference points for the assessment of stimuli. Since this value system involves only knowledge, it provides resources for appraisals but is not, in itself, an appraisal. The second element in the model is the capacity to detect change, both within and without. This capacity includes the ability to assess changes in comparison to one's stored values and goals. Stein and Levine assert that a critical part of the change detection system is a 'meaning analysis' of incoming data which involves an attempt to integrate incoming information with existing knowledge structures.

The first actual process in their model – but one not technically considered an appraisal – is hypothesised to follow directly from our change-detection capacity. When discrepant (i.e., novel) information is detected, the mismatch causes an interruption to thinking which in turn causes further cognitions plus autonomic nervous system activity. Thus, novelty detection is said to be the first process in emotional onset and the one that triggers all succeeding processes. The notion of incoming data being compared to existing knowledge structures bears a strong resemblance to Berlyne's collative variables – variables well known to be involved in the elicitation of interest (see Section 2.2.2). Stein and Levine argue, however, that all emotional responses owe their inception – at least in part – to novel information. Frijda (1988) and Scherer (1984) have taken an identical position and even Izard (1977), who rejected the necessity of appraisals in emotion, also recognised the intimate connection between novelty and emotional onset. The importance of novelty to interest, education, and this study in particular, will be discussed further in Sections 6.4.1 and 10.3.4.

Following generic emotional activation, Stein and Levine have asserted that the nature of individual emotional experiences is dictated by any of a suite of appraisals, such as the importance of the goal, the capacity to cope with goal failure or success, and the certainty of goal realisation. This perspective is in accord with the views of many other theorists although the relative importance afforded each appraisal type differs from one scholar to another.

Implications of Appraisals

A direct implication of the concepts presented above is that as appraisals change, so too do emotions. Thus, appraisals account not only for the diversity of emotional experience but also for transitions between emotions. Indeed, the explanatory power of appraisals is such that Scherer (2001, pp. 389-390) has commented:

> As far as one can see, there is, at present, no viable alternative to an appraisal (in the broad sense of the word) explanation for the general prediction of the elicitation and differentiation of emotions.

While there are some scholars (e.g., Zajonc, 1980; Panksepp, 2003) who do not share Scherer's confidence, their objections do not concern the significance of appraisals *per se*, only their precise relationship to emotional initiation. Since these debates are highly technical and peripheral to present purposes, the position adopted here is that interest induction depends on appraisals. Specific interest appraisals will be discussed in Section 4.2 and the measurement of appraisal-related phenomena in this study will be discussed in Chapter 7.

4.1.3 The Significance of Value Appraisals

As already described, value appraisals (i.e., primary appraisals) assess whether harm or benefit may arise from a stimulus or situation. Lazarus and Smith (1988) refer to such appraisals as primary not due to their position in the temporal sequence of an emotional process but because they establish the emotionality or 'heat' of a situation. *Value* in a primary appraisal can equally well be referred to as an object's *significance*, (Alexander & Jetton, 1996; Ellsworth & Smith, 1988a), its *importance*, or its *motivational relevance* (Lazarus & Smith, 1988; Stuckey et al., 2013). Viewed from a different perspective, values can also be described as an individual's internally represented *goals* (Austin & Vancouver, 1996; Lazarus, 1999), their *needs* (Kasser, 2002), their *aims* or their *purposes* (Ryan, 1995). This proliferation of value-related terms can obscure the fact that the same phenomenon is being referred to. The most significant fact to note in respect of values – however described – is that without an evaluation of personal significance, no emotion will be experienced.

4.1.4 Summary

An appraisal is a cognitive process during which a stimulus is assessed for its potential to impact something that a person values. Appraisals rely on other cognitive capacities and processes, including stored knowledge and the ability to detect change. Stored knowledge provides a value system for appraisals while change detection is the process which actually initiates emotional response. The nature of any individual emotion that follows change detection is determined by: a) primary appraisals of potential harm or benefit; and b) secondary appraisals which determine the precise emotional quality.

4.2 The Appraisal of Interest

4.2.1 Previous Interest Appraisal Models

It has been observed that while appraisal approaches to emotions in general have a long history, appraisal approaches to interest are very recent and, thus, few in number (Silvia, 2005; 2006). Indeed, at present only two appraisal models for interest have been presented in the psychological literature.

Ellsworth and Smith (1988a) investigated appraisal dimensions of interest but only as part of an attempt to differentiate between a range of positive emotions including love, surprise, happiness, and hope. They found that interest could indeed be differentiated from other positive emotions but that only one dimension – *attentional activity* – was decisive. The dimension of *importance* was found to be highly correlated with interest but, since it was also highly correlated with other emotions in the study, it was not considered diagnostically useful. Unfortunately, Ellsworth and Smith's results do not provide any insight into interest over-and-above what has already been described. That subjective importance was found to be significant merely confirms a basic principle of appraisal theory. As for attentional activity, it is debatable whether this is an appraisal, an allied cognitive process (see Lazarus & Smith, 1988), or a consequential behaviour.

Silvia (2005), on the other hand, has proposed a specific appraisal structure for interest. In what he admits is a simple and preliminary formulation, he suggests two components: 1) an appraisal of stimulus novelty-complexity; and 2) an appraisal of coping potential. These appraisals have their origins in Scherer's (2001) stimulus evaluation checks (SECs) and that author's appraisals model, both of which will be discussed further below.

The first of Silvia's interest appraisals, the novelty-complexity appraisal, is derived from one of Scherer's SECs termed the *novelty check*. Under Silvia's conception, however, the novelty-complexity appraisal is more than an assessment of simple newness; it refers to evaluations of a family of properties – including ambiguity, uncertainty, complexity, and contradiction (i.e., collative properties; see Section 2.2.2) – which interrupt cognitive processes and bring an object to a person's attention. The second appraisal in Silvia's scheme is that of *coping potential*. Coping potential appears in the appraisal structures of many emotions but in the case of interest, Silvia has suggested that it "probably refers to people's appraisals of whether they can understand [an] ambiguous event" (p. 90).

Silvia summarised his proposed structure by postulating that interest is evoked by stimuli appraised as "not understood but understandable" (2006, p. 58). In support of this, he reports the findings of four experiments in which participants responded to either visual imagery or poetry. Using both subjective and objective measurement techniques, he found that novelty-complexity and coping potential appraisals did, indeed, predict subjective interest ratings of various aesthetic stimuli. These appraisals continued to predict interest even after controlling for personality traits such as curiosity and openness. On the other hand, the same appraisals did not predict enjoyment, a related positive emotion.

In light of the theoretical issues treated earlier, however, Silvia's appraisal structure for interest appears incomplete on a number of counts. The first problem concerns the absence of any clear primary appraisal. If the novelty check is such an appraisal, Silvia does not suggest what personal value the novelty/collative variables might hold for an individual. A related problem is that novelty is widely regarded as a necessary initiator for all emotions and thus Silvia appears to be reiterating a well-established principle of generic emotional onset rather than identifying a unique interest appraisal. A third problem for his model is that while coping potential may indeed influence interest experiences in many instances – such as in his own experiments – the possibility of other appraisal types being involved in interest generally cannot be ruled out. The above considerations suggest that Silvia's conception of interest is not definitive and thus inadequate for the purposes of this study.

In his book *Exploring the Psychology of Interest* (2006), Silvia commented that:

> the field [of interest research] has a long "laundry list" of variables that affect interest, but it lacks a theory that explains why they affect interest and how they might relate to each other. (p. 78)

To illustrate this point, he provides a sample of factors known to induce or enhance readers' interest in texts including coherence, ease of comprehension, prior knowledge, themes of death or sex, vividness, author voice, imagery, readers' connections, importance, character identification, familiarity, unexpectedness, emotiveness, and engagement (see Table 2.1, Section 2.2.1). While it is easy to recognise how unexpectedness relates to novelty, and how coherence and ease of comprehension relate to coping potential, it is not at all clear how such variables as author voice (see Section 2.2.2 for a definition) or themes of death and sex fit with his model. Even more significantly, Silvia's description of interesting stimuli as those which are "not understood but understandable" seems, in fact, to be contradicted by variables such as familiarity and prior knowledge.

In respect of the 'laundry list' Silvia has written, "What do these variables have in common? Can they be integrated into a simpler set of variables?" (p. 78) Unfortunately, Silvia's own model does not provide a satisfactory answer to these questions. Another approach is required.

4.2.2 Appraisals and the OCI

The Opportunity Concept of Interest assumes that interest is an emotion with more specific characteristics than identified by Ellsworth and Smith, yet one with a broader scope than suggested by Silvia. The OCI appraisal structure of interest, hitherto only described summarily, is now explained fully.

OCI Appraisals in Detail

The OCI defines interest as an emotion elicited by the appraisal that an object provides the opportunity to fulfill a need. This general appraisal can be broken down into two components: 1) a primary appraisal of need-fulfillment potential; and 2) a secondary appraisal of opportunity – that is, of fulfillment likelihood. This structure does not preclude the involvement of other appraisals but the themes of need-fulfillment potential and likelihood are here considered to be necessary and sufficient.

Unlike in Silvia's scheme, novelty checks – that is, interruptions to cognitive processing caused by the collative properties of stimuli – are not included among the OCI appraisals. As has already been discussed, novelty-evaluation processes are widely considered to be essential to the onset of all emotions and thus have no value in discriminating interest. Novelty is, however, postulated to play another role in the elicitation of interest via the direct provision for certain needs, but this matter is treated in Chapter 6.

Support for the OCI Appraisal Structure

It was suggested earlier that research has been converging upon a conception of interest like the OCI for some time. We can see an example of this in Scherer's stimulus evaluation checks – from which Silvia drew some of his main appraisal ideas. Scherer's SECs include nearly identical appraisals to those proposed in the OCI, viz.: goal/need significance (c.f. need-fulfillment potential) and outcome probability (c.f. fulfillment likelihood). It is therefore surprising that Scherer never actually discusses interest *per se*. Despite this omission, the similarities of Scherer's conclusions to those of the OCI are striking and are here treated as support for the present conception.

The OCI appraisal structure also displays a distinct likeness to the expectancy x value model used to explain motivational levels (see Tolman, 1955; Heckhausen, 1977; Shah & Higgins, 1997): *value* is clearly akin to need-fulfillment potential (see Section 5.1.2), and *expectancy* is a synonym for likelihood. Of course, the OCI is proposed here as a model for an emotion, not a motivation. The relationship between emotion and motivation was discussed earlier, however, and it is clear that the two represent points along a single continuum rather than discrete phenomena. Consequently, expectancy x value theory furnishes support for both the OCI and for the differentiation of situational interest and individual interest as proposed in Section 3.2.5. In this respect, it is significant that both Tsai et al. (2008) and Sansone and Smith (2000) have referred to the expectancy x value relationship in their discussions of interest induction.

Implications of OCI Appraisals

The OCI appraisal structure has a range of implications for interest theory and teaching practice, as well as for the present study. A major theoretical result is the prediction that interest should be extremely common. Since the primary OCI appraisal (i.e., need-fulfillment potential) applies to any object relating to any need, and since needs are virtually ubiquitous, it is to be expected that this appraisal condition will be met very frequently indeed. Similarly, the secondary OCI appraisal (i.e., fulfillment likelihood) only limits interest onset when opportunities for subject-object interaction are completely absent. Since fulfillment opportunities might be available even via remote interactions with an object, there are a great many circumstances in which this second appraisal criterion will be met. While empirical data on the occurrence of interest is lacking, Izard (1977; 1991) has opined that interest is the most common emotion and one nearly always present in the psyche. His view is congruent with the predictions of the OCI.

The most salient teaching implication of the OCI appraisals is that there can never be any object, activity, event, or lesson that is guaranteed to elicit interest in a given student. Rather, interest will only arise when classroom stimuli relate to something a student values. Consequently, it is a mistake for teachers to assume that their subject – or any component of their subject – is inherently interesting. Equally, however, no topic is inherently boring. What matters in all circumstances is the match between the student and the stimulus. It is toward an understanding of this important match that the empirical portion of this study is directed.

A final matter arising from the OCI appraisal structure concerns the relationship between interest and negative emotions. The two OCI appraisals imply that interest should be a positively-toned emotion. Interest, however, is often reported in emotionally negative circumstances. This situation was graphically illustrated by a student who participated in the present study. On her own initiative, she described a lesson during which a teacher had demonstrated the operation of the alimentary system using physical analogues of saliva, mastication, digestion, and excretion. “It was the most disgusting thing I have ever seen in my life,” she explained. It was also, she said, one of the most interesting and memorable experiences of her schooling career; and she added, “I aced that test”. Such reports are by no means unusual. During an investigation into unpleasant experiences, Ellsworth and Smith (1988b) found that approximately half of their subjects also reported experiencing interest during the events in question. Ainley et al. (2002) and Hidi and Harackiewicz (2000) have also reported this phenomenon.

So, how can negative emotions be reconciled with the appraisals postulated by the OCI? Appraisal theory itself offers an answer to this problem. Emotions are often discussed as if they occurred in isolation from one another. Such abstractions are necessary for the purposes of research and instruction but they belie the complexity of reality. In the flow of daily events, threats and opportunities occur in great variety, both concurrently and sequentially. If we accept appraisal theories as explanatory of isolated emotions, it is no great leap to posit that multiple, simultaneous stimuli will elicit multiple, simultaneous appraisals and hence simultaneous – or nearly simultaneous – emotions (c.f. Ortony et al., 1988; Ben Ze’ev, 2000). Thus, if a teacher brings a python into class, students may be both interested and afraid at once: interested because of the opportunity for a new experience (and perhaps bragging rights if permitted to handle the reptile), and afraid because of potential harm. Indeed, one might expect interest to be more readily detectable in negative circumstances – wherein it represents a contrasting emotion – than in positive situations where it would tend to blend in with similar emotions such as enjoyment.

4.2.3 Summary

Only two appraisal models have previously been proposed for the emotion of interest, but both have failed to adequately explain the wide variety of circumstances in which interest is known to be elicited. The OCI, however, provides a satisfactory alternative by positing that interest involves two key appraisals: 1) a primary appraisal of need-fulfillment potential; and 2) a secondary appraisal of opportunity or fulfillment-likelihood. This position is supported by similar formulations proposed by other researchers, including Scherer's stimulus evaluation checks and the expectancy x value relationship often cited to explain motivational strength. The frequent reports of interest being experienced in association with negative emotions do not negate the status of interest as an emotion and can be readily explained by reference to appraisal theory.

Chapter 5

INTEREST AND NEEDS

5.1 Introduction

The third and final clause in the OCI states that the emotion of interest arises when an object is appraised as offering an opportunity to *fulfill a need*. The source, nature, scope, and significance of needs will be considered in this chapter.

5.1.1 Need and the Self

Fundamental to the OCI is the widely acknowledged concept of ‘self’. Krapp (2002) has defined self as “the central area of an individual’s structure of personality” (p. 409). Other aspects of personality exist, more distant from this core, but the self is:

> the integrative center of the organism, the set of psychological processes that is attempting to make experience whole, to feel authentically behind its behaviors, and to grow. (Kasser, 2002, p. 125)

The self is not conceived to be a static entity but a dynamic one, characterised by both change and growth. Nor is self a mere construction from social imitation but the consequence of a deliberate interaction between the individual and their environment (Krapp, 2002). Each self has its own inclinations and a person’s engagements with the world around them are directed by those inclinations toward expansion and refinement (Deci, 1998). The self is also understood to have an intrinsic desire for optimisation – or, as Ryan (1995) has put it, a tendency to “promote growth, integration, and the resolution of psychological inconsistencies and conflicts” (p. 397). A reflection of this orderly, optimising trend of the self is that people have purposes, goals, or needs which their behaviours aim to fulfill. Thus, a student does not enter a science classroom as a *tabula rasa*, but as a highly differentiated identity with a peculiar set of needs that they consciously, or otherwise, aim to fulfill. Thus, whether they recognise it or not, teachers are mechanisms by which student needs are either satisfied or thwarted.

5.1.2 Clarification of the Word 'Need'

Since the word 'need' carries with it overtones from its use in other psychological contexts, some clarification is necessary. Need is not to be understood here purely in the sense implied by drive theory – that is, a biologically-based requisite which arises cyclically and recedes into quiescence upon satisfaction. Instead, as per the outline in Section 4.1.3, need refers to a thing valued or important to the individual but which is in some sense lacking. This is not to imply that the thing lacking is essential or even beneficial to the person's actual well-being – need is simply a subjective state of want. In the following discussion the terms 'goal' and 'need' are used interchangeably.

5.2 Need Classification

As detailed in Chapter 4, an emotion arises when an individual appraises an object as having the potential to affect something they value. Self, need, and emotion are thus intimately related aspects of the psyche and the field of emotion research necessarily shares territory with that of goal/need research. Although it is not practical to discuss the matter in great detail, a general introduction to need theory is necessary for a number of reasons. First, the notion of need is embedded in the OCI and dimensions of need inform the empirical component of this study. More importantly, however, an understanding of need provides insight into the nature of interest as a whole.

The field of goal/need theory is broad. Austin and Vancouver (1996) have compiled a list of 31 theories of goal-like constructs and their list is not exhaustive. Consequently, no attempt is made here to address every aspect of the topic or every theorist. Instead, the focus will be on a small selection of taxonomies which attempt to rationalise the spectrum of human needs into useful and economical dimensions. These dimensions will, in turn, be used as part of the structure of the observational schedule employed in the field work.

5.2.1 Maslow's Hierarchy of Needs

The most famous and well-regarded need taxonomy is Maslow's hierarchy of needs (1970). Maslow postulated that the desires or motivations which occur to an individual may be organised into five basic need classes: 1) physiology; 2) safety; 3) belongingness/love; 4) esteem; and 5) self-actualisation. Maslow theorised that such needs impose themselves on awareness in the order listed and that motivations to fulfill needs at the higher levels are predicated on satisfaction of the needs at lower levels. Thus, a student would not be motivated to work for the approval of a teacher (an esteem need), for instance, if they were starving (a physiological need); the search for food would take absolute priority.

Maslow made other distinctions regarding the properties of needs at different positions in the hierarchy. The four lower-level needs he described as *deficiency needs* because without them the individual would actually be harmed or impaired. For the highest echelon in the scheme, however, he used the term *actualisation needs*. This category represents all inclinations to expansion, personal growth, and the fulfillment of individual potential. He also acknowledged that the urgency of needs diminished with ascension through the hierarchy. Thus:

> The higher the need, the less imperative it is for sheer survival, the longer gratification can be postponed, and the easier it is for the need to disappear permanently. Higher needs have less ability to dominate, organize, and press into service the autonomic reactions and other capacities of the organism. (p. 98, 1970)

Maslow's hierarchy is part of a sophisticated philosophy of motivation of which one other aspect is relevant to the present discussion – the notion of 'love identification'. Simply put, love identification means that when one person loves another, the first person will tend to respond to the other's need as if it was their own. Indeed, as Maslow put it, in such a situation, "the other's need *is* his own need" (p. 99, 1970, italics in original). An extension of this idea has implications for student-teacher interaction and will be discussed in Section 5.2.4.

In the period since Maslow first proposed his system, many have recognised its limitations. McInerney and McInerney (2002) have summarised the problem well:

> While acknowledging the apparent logic of Maslow's hierarchy, humans are very complex creatures and there are many situations that contradict his approach. (p. 431)

Indeed, there is no system of categorisation that represents human need dynamics so perfectly that another theorist has not seen fit to dispute it or suggest a modification. Thus, as Ford (1992) has noted, all taxonomies are subject to the idiosyncrasies of their creators and cannot be considered an ultimate truth. Nevertheless, while Maslow's strict hierarchical arrangement is no longer considered acceptable by many, the notion of basic needs is widely employed since dimensional need classifications reduce an otherwise endless list to a very short one (Ryan, 1995).

5.2.2 Ford and Nichol's Goal Dimensions

Another dimensional classification approach is that of Ford and Nichols (cited Ford, 1992) who structured their own system by first distinguishing within-person goals from person-environment goals. Under these two broad headings they have identified various sub-classes, each containing yet further divisions. For example, their within-person category contains affective, cognitive, and subjective organisation goal sub-classes, with the affective sub-class subsuming the goals of arousal (also called entertainment), tranquility, happiness, bodily sensations, and physical well-being. The full taxonomy is set out in Appendix A and implications for empirical measurement in the present study are treated in Section 5.4.4.

5.2.3 Physiological vs. Psychological Needs

Yet another approach begins by distinguishing physiological requisites from psychological ones. Physiological needs are readily recognised – food, water, sleep, etc. – and equate to the first level of Maslow's hierarchy. Whilst the emphasis with these phenomena is on the survival of the organism at a purely biological level, some researchers (e.g., Izard, 1993; Tomkins, 2008/1962) have drawn attention to the fact that physiological factors have the capacity to activate emotions. Indeed, it is virtually self-evident that physical requirements have such significance to people that the possibility of their satisfaction or frustration readily evokes strong emotional responses. In the present context, then, it is reasonable to infer that opportunities for physical need fulfillment may elicit the emotion of interest.

With respect to psychological needs, various classifications have been suggested. A commonly-cited approach is that proposed by Connell (1990), who synthesised previous work on motivation and social interactions into three need themes: *competence*, *autonomy*, and *relatedness*. Competence refers to the need to interact effectively with one's surroundings and to be able to attain personally valued outcomes. Autonomy refers to the need to choose, to be self-initiating, and thus to act in accordance with one's self. Relatedness refers to the need to be both connected to and valued by others (see also Reeve, 2005; Deci, 1998). Deci and Ryan consider these psychological needs to be innate, not learned, and thus universal to all cultures and backgrounds. They believe that they are not deficits in the sense implied by drive theories but spurs toward personal growth (Deci & Ryan, 2000), and, as has previously been noted, they consider these needs to be more conducive to psychological – rather than physiological – methods of analysis. This three-way classification has been widely adopted by other researchers (e.g., Krapp & Lewalter, 2001; Sheldon & Filak, 2008; Van den Broeck, Vansteenkiste, De Witte, Soenens, & Lens, 2010) and provides important insights into the nature of student lesson interest and, indeed, student behaviour more generally.

5.2.4 Practical Implications

Although a summary of theoretical need dimensions will be given in Section 5.4, some preliminary conclusions relating to classroom practice and the current study can be drawn from the ideas presented already, especially those of Maslow.

The most immediate objective of science education is the inculcation of specialist knowledge and some rather rarified skills. As needs, these skills and knowledge clearly belong to Maslow's actualisation category – the highest tier in his hierarchy. While it is debatable whether all needs in the lower tiers must be fully sated before actualisation needs become motivating, it is certainly true that the higher-order needs have "less ability to dominate, organize, and press into service" (Maslow, p. 98, 1970) human resources than do survival, belongingness, and esteem needs. This suggests that the inclination to learn science might be quite easily overwhelmed by any of a range of unsatisfied lower-level needs, even seemingly trivial ones. In the present study, therefore, students were surveyed for a number of potentially distracting need phenomena, including both hunger and pain (see Section 7.4.2).

Maslow's principle of 'love identification' may also have some utility in the classroom context. In its simplest form, this is the notion that a person who loves another will treat the needs of the beloved as their own. It is not unreasonable, however, to extrapolate this into a more general principle of value-by-association – that is, people tend to value the things that are valued by the people they value. More crudely, it is the principle of: "If it's good enough for them, it's good enough for me." There is some empirical support for this idea. For instance, Long (2003) found that student interest in subject matter was significantly influenced by the rapport they had with their teacher plus the teachers' own interest in the content being taught. This may help explain the observation reported by Bergin (1999) that student interest is enhanced by the degree to which a teacher models interest. It would also suggest that teacher relational skills play a role in interest development. The parameters of teacher interest modelling and teacher-student interaction were both specifically surveyed in this study (see Sections 7.3.4 and 7.6 respectively).

5.3 Arousal, Stimulation and Need

The taxonomies described above exhibit a variety of emphases. Some needs are well-represented in all while others appear exaggerated in one system but neglected or absent elsewhere. An important example is *arousal/entertainment*, which appears as a third-tier sub-goal in Ford and Nichol's taxonomy but does not appear at all in the other systems. While it is probable that there are other such need categories which do not enjoy wide – or even adequate – theoretical acknowledgement, arousal is particularly significant in relation to both interest theory and teaching; it thus deserves attention here.

5.3.1 Stimulation/Arousal as a Need

In Ford and Nichol's system, arousal is described as "experiencing excitement or heightened arousal" (Ford, 1992, p. 88) and is classified as an affective sub-goal. Also found in their affective category is the *bodily sensations* sub-goal, which is described as "experiencing pleasure associated with physical sensations, physical movement, or bodily contact" (Ford, 1992, p. 88). Together, these statements imply that there exist physiological needs which are not immediately essential to survival. A large body of empirical evidence from both humans and other animals supports this conclusion.

Bennett, Diamond, Krech, and Rosenzweig (1964), for instance, investigated the impacts of exposing rats to differing levels of environmental stimulation. They found that compared to those kept in isolation, rats that were consistently stimulated developed a thicker neocortex and produced more acetylcholine. Beck (1978) summarised a range of allied results showing that sensory deprivation diminished visual-motor co-ordination in kittens, caused visual degeneration in chimpanzees, and reduced both learning rate and emotional stability in various other experimental animals. More recently, Bengoetxea, Ortuzar, Bulnes, Rico-Barrio, Lafuente, and Argadona (2012) reviewed research on human post-natal brain development. They concluded that the development and consolidation of neural circuitry depended on stimulation from the outside world and that deprivation induced major disturbances in neural patterns. Gordon (1998) similarly concluded that stimulus deprivation of neonates resulted in later mental, motor, and emotional disturbances. And Suedfeld (1981) summarised three decades of sensory deprivation research by stating that there now exists overwhelming evidence that sensory deprivation increases the desire for stimulation in adults.

The above data pertain to physical stimulation but equivalent results have been found for cognitive stimulation. Fowler (1981) investigated relationships between the cognitive stimulation of young children and the development of exceptional performance. He found that high levels of cognitive stimulation were "indispensable for the ontogenesis of precocious, complex cognitive development" (p. 359). At the other end of the performance spectrum, Woods, Thorgrimsen, Spector, Royan, and

Orrell (2006) reported findings from a study of dementia patients. The use of a technique known as Cognitive Stimulation Therapy was found to improve not only the subjects' cognitive functioning but also their self-reported quality of life.

Such results as those reported above make it clear that physical and cognitive stimulation must be considered as needs. Whether they represent aspects of the same phenomenon or are, in fact, different needs altogether, it is not necessary to evaluate here.

5.3.2 Arousal Theory

The next matter to address, and one closer to the central objectives of this work, is identification of the key mechanism by which stimulation needs are actually met. To do this, some further theoretical matters must be first addressed– specifically, *optimal arousal* and *generalised arousal*.

Early analyses of electrical activity in the brain discovered the alpha wave pattern – a consistent, high-amplitude cycling of voltage in the brains of people who are awake but relaxed and unfocused. This pattern was found to break down when the subject's attention was attracted to some stimulus, when they engaged in a demanding intellectual activity, or if they became anxious. The change in the pattern of electrical oscillation became known variously as *desynchronisation*, the *arousal pattern*, or the *arousal reaction*. Later work identified the origin of this pattern with the brainstem reticular formation, otherwise known as the *reticular activating system* (RAS). It was also found that desynchronisation was associated with changes in a range of other physiological parameters such as heart rate, blood pressure, and pupillary dilation. The intensity of such responses has been termed *arousal level* (Berlyne, 1978).

Berlyne (1960; 1978) used arousal as a cornerstone of his explanation of exploratory activity and curiosity (i.e., interest) and in this he employed two central elements – the concepts of *optimal arousal* and *arousal potential* – each of which is described in turn, below.

The concept of optimal arousal did not originate with Berlyne but had been developed by various researchers since the first decade of the twentieth century (Fisher, 1986). The principle of optimal arousal means that people have an ideal – and thus preferred – arousal level. When arousal is at this ideal level many other aspects of organismic functioning are also optimised, including subjective satisfaction, and both cognitive and physical performance. A direct implication of this idea is that people will seek more stimulation when their arousal level is too low and reduce stimulation when it is too high. Graphically, this can be represented as an inverted-U-shaped function, such as in Figure 5.1. Berlyne's view differed from other researchers in some important details but the broad principles apply to all. It is noteworthy that Ford and Nichols derived their arousal goal category directly from the ideas of these theorists (Ford, 1992).

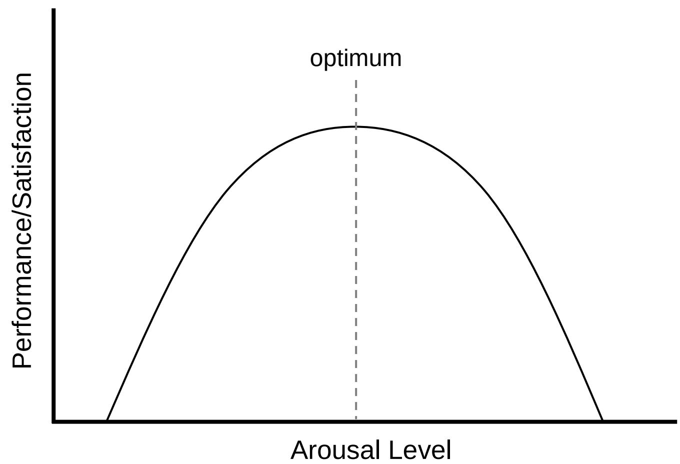


Figure 5.1: The idealized (inverted-U-shaped) relationship between arousal and performance/satisfaction

Berlyne's second key concept – *arousal potential* – refers to the capacity of a stimulus to induce arousal. It is synonymous with stimulus intensity and is the property which enables a person to adjust their internal arousal level to the optimum. In isolating arousal potential, Berlyne paid particular attention to the *collative variables* (CVs) – arousing aspects of stimuli which are informational in nature (see Section 2.2.2).

Berlyne's views on arousal were complex, controversial, and underwent change over the course of his career. Many have since taken issue with his explanation for the inverted-U-shaped curve and have suggested alternative mechanisms (e.g., Silvia, 2005; Apter, 1989). Others have pointed out that neither arousal nor stimulation are unitary phenomena and that their several aspects must be individually accounted for when attempting to explain arousal (e.g., Zuckerman & Como, 1983; LeDoux, 1996). It has also been recognised that individuals show marked differences in their preferred stimulation levels (Zuckerman, 1990; Apter, 2007). Despite these issues and challenges, the idea that arousal is important in promoting performance retains favour among contemporary researchers (e.g., Pfaff, 2006) and the notion of optimal arousal levels continues to be widely used (e.g., Andretic, van Swinderen, & Greenspan, 2005; Rusting & Larsen, 1995; Fischer, Langner, Birbaumer, & Brocke, 2008).

The last idea to address with respect to stimulation/arousal is that of generalised arousal. Notwithstanding the discovery of many specific arousal pathways, Pfaff (2006) has presented both theoretical arguments and empirical findings in support of the existence of a generalised force of arousal. According to Pfaff, generalised arousal provides a mechanism for the interaction of the specific systems; thus, arousal by one mechanism can induce arousal in another. He cites experimental results which demonstrate interactions between hunger and emotional reactivity, and between pain and sexual arousal. Such a position is in accordance with those of early theorists such as Berlyne yet is founded on recent data.

5.3.3 Implications of Arousal as a Need

Despite differences among the perspectives described above, a number of key ideas can be identified which are directly relevant to the present work and, more broadly, to teaching practice.

The first of these key ideas is that arousal, in its various forms, is an important human need and that arousal potential represents the capacity of stimuli to induce arousal and thus provide for such needs. Whether arousal and stimulation are unitary phenomena it is not necessary to resolve for present purposes. Similarly, there is no need to conceive of an optimal arousal level which is common to all individuals or even common to one individual for all time. Rather, what is important is the recognition that people have a preferred arousal level that is attained via some (generally) intermediate level of stimulation and that this preferred level improves performance in the tasks they undertake.

The second key idea is that since stimulation is largely obtained from the environment – which for present purposes is the classroom setting – teachers cannot help but influence students' arousal levels, either upward or downward, by the circumstances they create in each lesson. The collative variables are particularly important in this regard and were specifically measured in the practical component of this study. A further corollary is that if there is a wide discrepancy between students' preferred arousal levels and the level of stimulation they are provided, students may themselves manipulate their circumstances to attain the preferred state. This is a probable source of much off-task behaviour. A final implication is that stimulation of any kind – whether cognitive, emotional, or physiological – may meet a student's general need for stimulation, at least in part.

5.4 Application of Need Dimensions to the Current Study

It is not the intention here to rigorously define a new taxonomy of need. Nevertheless, since the OCI assumes that interest will be elicited whenever a person appraises an object as offering to fulfill a need, some framework of need dimensions is necessary in order to operationalise the OCI for the classroom observations. This has been done by summarising the various need themes cited earlier into four broad dimensions, viz.: *survival*, *affiliation*, *growth*, and *stimulation*. These are not mutually exclusive categories but each does represent an important theme not adequately covered by the others. The scope of each term, its use in the current context, and some educational implications are briefly described below.

5.4.1 Survival Needs

Survival needs are equivalent to Maslow's physiological needs. They include the needs for food, water and sleep but not stimulation – which constitutes a separate category. Although the perfect fulfillment of survival needs does not seem to be an absolute prerequisite for the emergence of higher needs, students experiencing dramatic deprivation with regard to survival resources will have little or no capacity to attend to education, even if they are physically present in a classroom. Since it is not the role of the teacher to provide for such needs in the ordinary teaching context, survival needs were not surveyed in the present study. Nevertheless, the distracting effect of unsatisfied physical needs was specifically measured (see Section 7.4.2).

5.4.2 Affiliation Needs

A number of studies have reported associations between the quality of school relationships and academic performance. Berndt and Keefe (1995), for instance, found that relational stability between a student and his or her friends was positively correlated with lesson involvement and grades achieved. Anderson, Manoogian, and Reznick (1976) found that intrinsic motivation for a free-style drawing activity among preschoolers declined significantly when pupils were ignored by the researcher. These are manifestations of what are here termed affiliation needs. This category is equivalent to the relatedness category of Connell (1990) and it includes what Maslow intended in his belongingness/love dimension plus those aspects of his esteem dimension where the implication is that a person seeks esteem from the approval of others rather than within themselves alone. Affiliation factors were measured in the current study in a number of ways (see Section 7.3.4)

5.4.3 Growth Needs

Growth needs include all those related to the expansion and optimisation of the individual and relate closely to those intended in Maslow's actualization need category. Two broad aspects of personal growth are in mind here: the expansion of the individual in a 'quantitative' sense (i.e., the capacity to do more); and the expansion of the individual in a 'qualitative' sense (i.e., the capacity to do better). Thus, Connell's competence category is subsumed in this dimension and his autonomy category is also partly implied. Growth needs include all inclinations to augment knowledge and skill, and to expand one's productive output and influence.

As previously discussed, the science classroom explicitly provides opportunities for the fulfillment of growth needs more than for any other single need category. If, however, a given student does not personally identify with the knowledge domains and skill sets being fostered – that is, if the topics being taught do not offer to enhance something close to their sense of self – then they will experience little or no interest in science lessons. For this reason, attempts to assess growth variables using purely external measures of delivered content are limited in their power to predict student interest. For practical reasons, however, coarse measures of this kind were employed in the current study.

Even when instructional topics do touch on valued knowledge domains, there still remain constraints to interest. Content from a domain which a person personally values but which is either significantly above or below their current development level is unlikely to be found interesting. This is closely related to the problem of challenge. A number of authors (e.g., Csikzentmihalyi, 1990a; Malone & Lepper, 1987) have suggested that optimal challenge is a key factor in the creation and maintenance of interest. Empirically, Danner and Lonky (1981) showed that children who were given the opportunity to select activities to work on tended to select those that were just beyond their current level of competence. Interestingly, however, a recent study by Abuhamdeh and Csikszentmihalyi (2012) reported that this type of behaviour was only demonstrated for activities that were both intrinsically motivated and goal-directed. They found that for extrinsically motivated tasks – such as those which students are often obliged to complete in a classroom – the trend was to prefer tasks that demanded the least challenge. This finding is in accord with the OCI assertion that needs are deficits considered relevant to the self. Notwithstanding this latter detail, subjectively perceived task challenge was directly measured in the present study (see Section 7.4.1) and some implications of this issue are discussed in Chapter 10.

5.4.4 Stimulation Needs

A large number of measures associated with stimulation were used in this study, relating in particular to emotional and physical phenomena. With respect to the latter, various stimuli were considered, including food. Bergin (1999) reported that food often promotes interest in the classroom context. It is here assumed that the attraction of food in class is derived from its stimulation value more than its nutritional value. The use of food in class is therefore included here as a stimulation factor rather than as a survival factor.

5.4.5 Needs and Education

In addition to the matters already covered, an understanding of needs has further implications for education. As explained earlier, needs are considered here to mean any gap which a person desires filled. They do not have to be grand in scope or deep in significance; the sole criterion is that a person identifies with the deficit personally. Thus, 'micro-needs' are constantly being created in all sorts of daily activities: a joke without a punchline, an anecdote without a conclusion, and a document stuck in a printer all represent needs for those invested in the outcome. Similarly, conceptual structures (i.e., schemata) are major need generators. Holes in our personal understanding of life are not only abundant, but their abundance increases in proportion to the magnitude of our understanding. Thus, learning paradoxically induces the need for further learning – a phenomenon which helps to explain the origins and dynamics of individual interest.

For the above reasons, the educational context is as much a creator of needs as it is a satisfier. Indeed, teachers create 'micro-needs' in every lesson whether they recognise the fact or not. Two mechanisms are important in this regard. First, any expansion of knowledge inevitably brings with it an awareness of further knowledge that has yet to be attained. Second, teacher-generated questions, problems, narratives, and projects all have the potential to frame or to act themselves as 'micro-needs'. The difference between stimulating and boring teaching, therefore, lies significantly in how well these needs are created, sequenced, and fulfilled.

In the mind of educators, the 'need' is to create knowledgeable, employable, right-minded citizens. The pupil's perspective, however, is hardly so abstract. Their needs are to be affiliated, to be stimulated, and to grow. Students find schooling interesting, therefore, to the same degree that it promises to fulfill these needs and continues to make good on that promise over time.

5.5 Support for the OCI Position on Needs

The previous sections of this chapter have developed the argument that interest arises when a person perceives that an object may fulfill a need. This position is supported by numerous earlier researchers. For instance, over a century ago Dewey (1913) wrote:

> The genuine principle of interest is the principle of the recognized identity of the fact to be learned or the action proposed with the growing self; that it lies in the direction of the agent's own growth, and is, therefore imperiously demanded, if the agent is to be himself. (p. 7)

And:

> the type of pleasure found in legitimate interest… lies in meeting the needs of the organism. (p. 12)

Much more recently, these principles have been illustrated empirically. For instance, Isaac, Sansone, and Smith (1999) measured self-reported task interest in university students who completed an experimental task under one of three social settings: alone, with another person, or alongside but independent of another person. The students had previously been assessed for interpersonal orientation – that is, the degree to which they valued and sought social interaction. The study showed that those participants who rated high in interpersonal orientation also reported greater interest in the task when it was performed in the company of others than when performed alone.

In a more far-reaching investigation, Krapp and Lewalter (2001) undertook a longitudinal study of school-aged students in German vocational courses and work settings to investigate the development of their individual interests. Part of their work included an analysis of the influence on interest development of the three psychological needs; competence, autonomy, and relatedness. In interviews with 71 students after two years of vocational study, 73 percent referred to competence as an important reason for their interest development, while 67 and 41 percent referred to social relatedness and autonomy, respectively, as significant. Similarly, Thorndike, Weiss, and Dawis (1968) compared vocational needs to reported vocational interest for two groups: university undergraduates and government job applicants. They reported canonical correlations between need and interest variables of 0.78 and 0.74, respectively.

Todt and Schreiber (1998) have summarised such results by stating: “In a general sense interests may be called instruments of satisfactions of needs” (p. 25). These authors are referring specifically to individual interests, but they address the emotion of interest, too: “The state of being interested… depends… in an essential way on incentives [provided] by the physical and social environment” (p. 25).

The various theoretical and empirical works cited above thus support the OCI contention that interest is associated with the fulfillment of needs.

Chapter 6

SUMMARY AND IMPLICATIONS OF THE OCI

6.1 Introduction

Having thoroughly discussed the clauses of the Opportunity Concept of Interest in preceding chapters and before proceeding to a treatment of experimental methods, an overview of the OCI, a discussion of its relationship to other major interest theories, and mention of some hitherto untreated implications of the OCI are necessary. The purpose of this chapter is two-fold. First, it aims to summarise the weaknesses inherent in existing theories. Second, it aims to demonstrate that the OCI overcomes these weaknesses and thus provides a defensible, comprehensive basis for the empirical investigation of interest.

6.2 Overview of the OCI

The OCI is a model which describes situational interest (a response evoked in the moment by proximal circumstances) as distinct from individual interest (a long-term preference for certain stimuli/objects). It states that interest is an emotion that arises when a person appraises an object as providing the opportunity to fulfill a need. Since people are almost continually beset with needs, the OCI suggests that interest should be experienced very frequently. This does not imply, however, that interest is experienced to the same degree in every instance. Emotions are experienced along a continuum of intensity and different words are used to denote their varied levels. Thus, an interested person might describe themselves as interested, intrigued, or fascinated. It is even possible for interest to manifest at a level below conscious awareness.

Under the OCI approach, the level of interest experienced is related to the degree to which a need is touched. Objects that offer to meet needs perceived as close to the central personality complex (i.e., the self) will elicit stronger interest than objects which offer to meet more peripheral needs. Nevertheless, because the self is irrepressibly in search of optimisation, opportunities for either partial need-fulfillment or else fulfillment of relatively superficial desires may elicit interest to some degree. No ‘wisdom’ is implied in these inclinations, however; people may experience interest in objects which meet needs only indirectly or in objects which fulfill urges for things that are ultimately harmful. Conversely, people may feel no interest in things which are, in an objective sense, beneficial.

The OCI assumes that it is the opportunity for need fulfillment – rather than the satiation of a need – that evokes interest. Thus, interest is here considered to be an approach emotion as opposed to enjoyment which is a consummation emotion. Reeve (2005) has put forth a nearly identical idea:

> When an activity *involves* our psychological needs, we feel interest. When an activity *satisfies* our psychological needs, we feel enjoyment. (p. 102, italics added)

Since it is possible for a person to be involved with an object in a way that is both immediately fulfilling and also offers potential for yet greater fulfillment, enjoyment and interest may overlap. This latter consideration raises another issue – that of simultaneous emotional states. Appraisal theories allow that one emotion may occur with another – either concurrently or in rapid succession – as a result of stimuli having multiple implications for personal well-being. Thus, the fact that interest sometimes occurs in the context of unpleasant circumstances does not inherently contradict its status as a positive emotion. A diagrammatic summary of the key OCI themes has been presented in Figure 1.1.

6.3 The OCI in Comparison to Other Interest Theories

6.3.1 Introduction

Having thoroughly explicated the OCI in the preceding chapters, it is now possible to compare the OCI with existing interest theories. First, some general points of similarity between the theories will be identified; then, points of divergence between the OCI and other models will be discussed on a case-by-case basis.

6.3.2 The 'Zone of Convergence'

A thorough survey of the literature on interest theory reveals a handful of recurrent themes associated with interest; these are outlined in Table 6.1. The themes identified are not apparent in the work of every theorist and the significance of each has been variously interpreted – nevertheless, they constitute a 'zone of conceptual convergence' and it is this theoretical 'space' that the OCI aims to describe. Note that the phenomena in Table 6.1 are related to interest elicitation only; commonly cited consequences or products of interest are omitted.

Table 6.1: The 'zone of convergence': Recurrent themes related to the elicitation of interest which are found in the education and psychology literatures.

Themes	References
Interest involves both affective and cognitive components	Hidi & Baird (1986); Izard (1991); Krapp (1999); Ainley et al., 2002); Silvia (2005)
Interest involves an interaction between the person and an object	Deci & Ryan (1985); Hidi & Baird (1986); Krapp & Fink (1992); Krapp (1999)
Interest is related to need-fulfillment	Thorndike, Weiss, & Dawis (1968); Izard, (1977); Todt & Schreiber (1998); Krapp (1999); Sansone & Smith (2000); Reeve (2005)
Interest is initiated by information discrepancies	Berlyne (1960); Hunt (1965); Schank (1979); Izard (1991); Stein & Levine (1991); Loewenstein (1994); Bergin (1999); Silvia (2005)
Interest is related to the growth of the self	Dewey (1913); Izard (1977); Mitchell (1993); Krapp (1999); Deci & Ryan (2000)

Table 6.1 clearly illustrates that the OCI aligns with the opinions of many scholars who have tackled the phenomenon of interest over the preceding century. In light of

this information, it seems surprising that a conception such as the OCI has not already gained wide acceptance. In this regard, however, Krapp (1999) has observed that the diversity of current conceptualisations reflects “different metatheoretical and methodological beliefs, general theoretical orientations, and paradigms of empirical research” (p. 24).

In the following pages, points of difference between the OCI and existing, major interest models are discussed. Some of these distinctions are obvious and others subtle. It is the opinion of the author, however, that such matters must be addressed in order to arrive at a conceptual system which has both internal consistency and wide explanatory power.

6.3.3 The OCI in Comparison to Deci and Ryan

The model of interest seemingly closest to the OCI is that of Deci and Ryan. Their view has been summarised as follows:

> I have defined interest as the core affect of self, suggesting that it occurs when there is an ideal match between a person’s organismic condition and the environmental affordances. (Deci, 1992, p. 61)

This statement agrees with the OCI in recognising that interest is affective, involves an interaction between a person and an object, and originates from the central personality construct of the self. Indeed, it would appear at first glance that the OCI and Deci and Ryan’s perspective are identical. Closer analysis of these authors’ writings reveals this is not the case, however. First, they do not explain whether the word ‘affect’ refers to the experience of an emotion or to the complete emotional process (see Section 3.2.1). Second, their reference to “a person’s organismic condition” is not, as one might initially think, a reference to a person’s needs – at least, not as conceived under the OCI. They have stated:

> doing what one finds interesting… does not have the explicit intent of satisfying the basic needs in the immediate situation. (Deci & Ryan, 2000, p. 230)

In other words, Deci and Ryan's conceptions of need, need fulfillment, and motivational response differ from those upon which the OCI is founded. They limit their view to the three psychological needs mentioned earlier and consider that motivation can arise "without the prod of a need deficit" (p. 230). Thus, they view interest as a factor which exists independently of need-fulfillment, as illustrated in one of their explanations:

> need satisfaction … is necessary for the enjoyment of the activity, but [the person's] explicit purpose in [doing that activity] is not likely to be need satisfaction. He would be doing what interests him… (Deci & Ryan, 2000, p. 231)

Thus, Deci & Ryan's characterisation of interest leaves its essential nature undefined. This problem arises, at least in part, because interest has never been their primary concern. Interest is a relevant matter for them but it is only one of many addressed under the umbrella of their much broader self-determination theory. Not surprisingly, these authors have made no attempt to explain the interest 'laundry lists' or tackle other major problems associated with interest theory. Although their definition has value, it has neither the scope nor the specificity needed for measuring the science lesson interest environment.

6.3.4 The OCI in Comparison to Descriptive Definitions

In Section 2.6.3, a number of descriptive definitions of interest were presented. These include the person-object theory of interest (POI) and the views of Hidi and Renninger. The respective authors are largely in agreement with one another and their ideas share many similarities with the present conception. Nevertheless, the OCI differs on some important matters. One such point of variance is that descriptive definition authors do not acknowledge interest as an emotion. Equally significantly, they distinguish between two 'psychological states' of interest. Krapp et al. (1992, p.10) have written:

> Although the state of interest, in the sense of an *actualized individual interest*, seems closely related to the experiential state of *situational interest*, it has not

> been demonstrated that the psychological processes and the effects of the two states are identical, or even comparable. (italics added)

Silvia (2006) has objected to this distinction, commenting that such a strong claim ought to be supported by strong evidence – evidence that has yet to be provided. He argues for a simplification of terminology and suggests that the experience be labelled 'interest' while enduring object preferences be referred to as 'interests'. This proposal is in accord with Lazarus' suggestion regarding emotion families (see Section 3.1.4).

The descriptive definitions cited are more thorough than Deci and Ryan's, but their elements do not cohere into a unified whole. This fact – and the insistence on differentiating interest into sub-classes – made them difficult to apply in the present study. (Note that despite this author's agreement with Silvia's comment regarding the terms 'interest' and 'interests', the phrases 'situational interest' and 'individual interest' will continue to be employed for the remainder of this work.)

6.3.5 The OCI in Comparison to Silvia

Silvia's model of interest has already been described in detail in Section 4.2.1; in summary he has claimed that interest may be described as an emotion evoked by stimuli which are "not understood but understandable" (2006, p. 58). This conception aligns with the OCI in many ways, including that interest is an emotion arising from appraisals of circumstances. The major shortcomings in Silvia's approach have also been treated earlier but may be summarised as follows: a) no clear primary appraisal is identified; b) the novelty appraisals he refers to are not unique to interest; and c) appraisals other than coping-potential cannot be ruled out. A consequence of these issues is that Silvia's model does not explain the mechanisms by which many well-known educational strategies induce interest and thus his model cannot be translated into a comprehensive system for measuring interest in science classes.

6.3.6 The OCI in Comparison to Izard

The final major interest definition to be addressed here is that of Izard (1977; 1991). In congruence with the OCI, he has asserted the following about interest: a) it is an emotion; b) it is associated with novelty; and c) it is closely related to phenomena that affect the self. According to Izard, however, interest exists in the organism prior to person-object interactions. He thus rejects appraisal explanations of the emotion.

Although Izard's perspective and the OCI differ with respect to appraisals, this difference may be largely a matter of terminology: What the OCI treats as interest evocation, Izard treats as interest amplification; yet in both cases the optimisation of the organism is in view. Nevertheless, Izard's ideas have not been widely adopted by interest researchers and still less by education scholars. Part of this may be attributed to the fact that, like Deci and Ryan, Izard's main concern is neither interest *per se* nor pedagogical improvement. Rather, his ideas on interest (and indeed education) appear in the larger theoretical context of his differential emotions theory. It is difficult to extract from his writings, therefore, an empirically useful interest definition.

6.4 Implications of the OCI

Many implications of the OCI have already been treated in the preceding chapters. Two remaining matters, previously deferred, are now covered.

6.4.1 The OCI and Novelty

Novelty is a phenomenon that features repeatedly in the interest literature, including Silvia's (2006) appraisal structure of interest, and Bergin's (1999) summary of interest-eliciting factors. Novelty is claimed by many appraisal theorists to be a factor in the onset of all emotions, yet it seems to have a special relationship with interest. Berlyne (1960) explored this idea extensively, defining different types of novelty and explaining the mechanisms by which novelty and related variables might elicit curiosity and exploration. The prominence of novelty has, similarly, prompted

Silvia to propose novelty-complexity as one of the two essential interest appraisals. And yet, as already discussed, novelty is not the only factor involved in promoting interest.

A resolution of this problem is suggested by the need dimensions discussed in Chapter 5. It is proposed here that apart from its role in alerting people to possible need-fulfillment sources, novelty is capable of fulfilling some needs in its own right. Ample evidence has already been presented to show that stimulation – in its various forms – is a basic human need and that this need is satisfied by the arousal potential (i.e., stimulus intensity) of objects. Since novelty is an important source of arousal potential, the OCI suggests that novelty will be interesting to people in need of stimulation and it is hypothesised here that novelty is highly sought after for this reason. In the present study, lesson event novelty became a major focus of the empirical research and numerous measures were designed to assess both its prevalence and influence (see Chapter 7).

6.4.2 The OCI and the Interest 'Laundry List'

Silvia (2006) has commented that the field of interest research has produced a 'laundry list' of factors pertaining to the evocation of interest but no theory which explains why they affect interest or how they are related to one another. The Opportunity Concept of Interest offers a plausible solution to this dilemma and an OCI-based explanation of each of the factors from Table 2.1 is given in this section. Note that, as previously discussed, a large number of the listed factors are derived from studies of student interest in written texts. When the word 'text' is used below, however, it is intended to mean written, spoken, or multimedia information and 'reader' is intended to mean 'interpreter'. Educational examples are used exclusively here but this does not imply that the principles apply only to educational contexts.

Simple Need Fulfillment

The role of a number of the interest elicitors in Table 2.1 can be explained in terms of simple need fulfillment. Thus, social support and social identification clearly relate to affiliation needs; provision of choice and promotion of autonomy relate to growth/autonomy needs; and puzzles and optimal challenge relate to growth/competence needs. Other phenomena owe their influence to stimulation. The peculiar role of novelty in this regard has already been covered but there are many other phenomena which are found interesting because of their arousal potential. For instance: hands-on experiences provide physical stimulation; the global interest themes tend to provide emotional stimulation; and the collative variables – such as uncertainty, surprisingness, and incongruity – all contribute to mental stimulation. As has previously been discussed, vividness and intensity should be considered collative variables and their effects on interest should be attributed accordingly (see Section 2.2.2).

Proximity to Self

Next there are 'self-proximity' factors, such as character identification and readers' connections. For each of these, the principle at work is the degree to which a text relates to something close to the reader's sense of self. Self-proximity will generally tend to make objects interesting regardless of other variables.

Perceptual Clarity

Then there are factors whose value does not lie in the provision for needs *per se*, but in making information understandable. Thus, coherence, concreteness, and ease of comprehension all improve the accessibility of data, meaning that the value of the information to the individual – that is, its need-fulfillment potential – is more readily perceived. Highlighting of activity purposes and/or object utility also serve the role of improving a person's understanding of the need-fulfillment value of objects.

Multiple Interest-enhancements

Some interest-inducing factors owe their interestingness to multiple sources. Hands-on activities have already been identified as providing for stimulation needs, yet such activities may also provide opportunities for greater individual autonomy (growth/autonomy needs), social interaction via group work (affiliation needs), or the development of manipulative skills (growth/competence needs). The exact needs provided for will vary depending on the activity in question. Humour should also be included in this 'multiple source' category. Humour is probably best understood as a provider of emotional stimulation but mental stimulation is often an important outcome, too. Familiarity is another factor that promotes interest in varied ways.

Familiar things are often close to one's sense of self and to things in which one has already developed an individual interest. Familiar things may also promote quiescence and de-stimulation, and thus act as down regulators for the over-stimulated. And familiar things are, inevitably, things that are readily understood and thus their need-provision qualities rarely have to be explained.

Miscellany

The factors from Table 2.1 not yet covered are those that are either synonymous with ones dealt with already (e.g., emotiveness, prior knowledge) or are difficult cases. The latter category includes modelling, author voice, imagery, fantasy, narrative and post-dictability. With the exception of modelling (already discussed in Section 5.2.4) explanations for the interest-value of each of these factors are postulated below.

Author-voice – that is, the inclusion in text of personal information about the author (see Section 2.2.2) – may contribute to interest in a number of ways. Such information increases the degree to which the reader identifies with the author (i.e., it increases 'self-proximity') and hence increases relational closeness; it may also increase the degree to which the reader empathises with the author, thus contributing to emotional stimulation. Clearly, author-voice is not a binary phenomenon but a factor whose influence varies with the quantity and quality of the 'voice'.

Imagery, narrative, and fantasy are related factors, although each has its own idiosyncratic influence on interest. In the case of imagery, it is suggested here that its influence on interest varies depending on circumstances. In a science classroom, for instance, imagery may be used to help illustrate a concept (e.g., by analogy), in which case it acts to improve comprehension. In the case of narrative, however, imagery is the vehicle for an experience which may be cognitively or emotionally stimulating. When narrative is used in science classes, however – as when a teacher tells a story about themselves – the emphasis is less on the imagery used but on 'author voice'. As for fantasy, this factor offers a wide range of possible mechanisms for the elicitation of interest; only a few are suggested here. If the originator of the fantasy is the student themselves, for instance, then that student will have opportunities for experiencing autonomy and competence. If the originator of the fantastical content is some other author, however, then it serves the same role as imagery. And of course fantasy is closely allied to novelty.

Post-dictability – the capacity of story elements to be understood upon the resolution of a tale – is unique among the phenomena listed. Kintsch (1980), who coined the term, considered that this quality was important in the evocation of interest in narrative readers. It is here proposed, however, that satisfaction or enjoyment is a better descriptor of the emotion evoked by a story that concludes well. The distinction, though technical, has direct relevance to teaching. An effective story is not merely one with a good ending but one in which anticipation – that is the desire for a conclusion – is created and sustained throughout. Thus, a narrative functions as a unit and post-dictability is a property of a whole work, not the ending alone. This is certainly what Kintsch had in mind when proposing the term originally. According to the OCI, however, interest is an approach emotion which arises when a person perceives a need-fulfillment opportunity. Thus, the emotion aroused during a narrative by anticipation of its denouement is interest, while the emotion associated with a satisfactory conclusion is enjoyment. Despite this distinction, it is also true that a satisfying narrative experience – or, indeed a satisfying experience of any kind – will tend to elicit interest for further engagements with the stimulus in question. These comments may seem pedantic but they actually have direct relevance to pedagogy, even in science lessons. Lessons or units of work which build anticipation, which have both a structure and a conclusion which resolves their several elements, will be more interesting and more satisfying to pupils.

General Principles

Having discussed the contents of Table 2.1 individually, a few observations are necessary regarding the entire list. First, very few of the factors identified there can be considered ‘pure’ interest elicitors; virtually all have multiple implications for human need, even those for which only one has been given here. Second, most of the factors actually operate in conjunction with others; for instance, a narrative that is not easily comprehended will elicit little interest. In this regard, novelty recurs as an almost universal prerequisite for interest: old jokes are boring; repetition of the same experiment will yield diminishing interest returns; and even a brilliantly-structured narrative will be unlikely to elicit interest on its forty-third telling.

Summary

The mechanisms by which the phenomena in Table 2.1 elicit interest can be quite economically explained by the OCI framework, and it thus represents a valid theoretical foundation for assessing interest in science classes and for building the instruments required for the present work.

Chapter 7

DESIGN AND VALIDATION OF INSTRUMENTS

7.1 Introduction

The present chapter describes the selection and design of the instruments used in this study. For three instruments that were purpose-built during the investigation, their development, structure, and validation are described here. A fourth instrument was borrowed from previous researchers. Since it did not perform as anticipated, it was re-analysed and restructured in order to provide useful results. Its structure and the processes used in its analysis are fully described.

The four instruments contributed collectively to a holistic assessment of the science classroom interest environment. They gathered data on the following broad categories of phenomena: a) teacher behaviours expected to induce interest; b) other factors expected to affect interest levels; and c) student interest-related responses. Ideally, information from each of these categories would be collected by separate instruments. For the sake of economy, however, two instruments gathered data from more than one of these categories at the same time. These instances are identified in the relevant sections below.

7.2 Overview of Instrument Design

Psychometric instrument development follows a consistent pattern. Broadly speaking, it begins with a review of relevant literature during which important aspects of the phenomenon in question and similar instruments are identified. Next follows construction, with attention paid to scale salience and overall administrative economy; advice from relevant stakeholders on scale structure or item wording is often sought at this point. A pilot testing phase usually takes place next and this is followed by statistical analysis of derived data. Results from these latter phases inform a refinement process which generates a final version of the instrument.

The strategies used in and emphases placed on each of the above phases differ according to the nature of the instrument and the purpose for which it is intended. In the present context, the exploratory nature of the investigation significantly influenced instrumental design.

7.3 Science Classroom Interest Observation Schedule (SCIOS)

7.3.1 Introduction

The Science Classroom Interest Observation Schedule (SCIOS) is a complex observation template comprising three electronic spreadsheets and a one-page paper form; observations are made on the Schedule using a time-sampling strategy. The SCIOS not only provides a systematised format for recording data on classroom interest phenomena, it also calculates and displays important results automatically, making later analysis easier. The development of the SCIOS is described in the next section and the full structure of the instrument is detailed in Section 7.3.4. Final versions of the instrument's various components can be found in Appendices B and C.

7.3.2 Development and Validation of the SCIOS

Development of the SCIOS followed the generic pattern outlined in Section 7.2, viz.: theoretical research; preliminary construction; pilot testing; validation; and refinement. These phases are discussed below.

Theoretical Research

With respect to theory, the various conceptualisations of interest underpinning this study have been discussed extensively in earlier chapters and a rationale for each of the variable categories measured by the SCIOS has already been given. This material will not be revisited. Some theoretical treatment of observation schedule construction is warranted, however. Classrooms are extremely complex and dynamic environments. If researchers wish to make meaningful observations of teacher-student interactions they must narrow the focus of their attention and ensure that subjectivity does not enter into their assessments. Observation schedules offer a means of achieving both of these goals by allowing the assessment of carefully selected, predefined aspects of the environment under study (McIntyre, 1980). They are commonly used in educational settings.

Although a great number of informal instruments of this kind exist, a much smaller number of thoroughly validated schedules have been published in the educational research literature. Examples include M-COSMIC (Modified Classroom Observation Schedule to Measure Intentional Communication; Clifford, Hudry, Brown, Pasco, & Charman, 2010) and OPTIC (Observing Pupils and Teachers in Classrooms; Merrett & Wheldall, 1986). No observation schedule published to date addresses the issue of lesson interestingness, however – hence the need for the SCIOS.

Unlike the published schedules just mentioned, the SCIOS was never intended to diagnose the degree to which observed behaviours reflect internally consistent, mutually exclusive dimensions. Indeed, the present level of knowledge in the field of interest research does not permit the development of such a schedule. Instead, the SCIOS was designed as an exploratory tool and it thus differs in a number of ways from many diagnostic-type instruments. First, most measures on the SCIOS were not coalesced into theoretically-derived scales. Rather, they were treated as independent variables in their own right – variables which may or may not overlap with others being measured at the same time. Second, some measures were included speculatively, for the purposes of either testing a hypothesis or evaluating their potential to predict variables measured by other means. These speculative measures are indicated as such in the relevant places in Section 7.3.4.

Preliminary Construction

Construction of the SCIOS involved the creation of measures for three types of interest-related variables. First were dependent variables reflecting student situational interest (e.g., student attentiveness to instructional tasks). These were chosen on the basis of results reported in the existing interest literature or were hypothesised from the author's teaching experience. Second were independent variables related directly to the need categories previously discussed (e.g., levels of physical stimulation). Third were independent variables which had been identified from earlier research as eliciting interest but which had complex relationships with needs. Novelty is an important example in this category (see Section 6.4.1 for a discussion of this matter). Although the various SCIOS measures were not arranged into scales, each was assigned to a broad category to assist in formatting and data analysis. (These categories are indicated in the Type column of the SCIOS Summary spreadsheet; see Appendix D).

Three kinds of measurement strategy were developed for the above purposes. First were binary measures of presence or absence; second were simple numerical measures; and third were ordinal rating scales. Examples of each of these strategies are given in Section 7.3.4.

Pilot Testing

After the initial drafting phase, early versions of the SCIOS were applied to actual science classrooms. Nine lessons were observed in this way and the instrument evolved through various iterations, each improving the clarity and efficiency of the last.

The SCIOS was originally intended to measure all externally assessable aspects of lesson interestingness. The pilot testing process demonstrated that some variables identified by previous researchers could not be meaningfully measured by an observation strategy, however. Significant in this regard were many of the collative variables, including ambiguity, uncertainty, discrepancy, and incongruity. Such variables were dropped from the Schedule and, due to their abstract nature, no alternative measure was developed. It was also originally intended that the SCIOS sample the lesson environment at five-minute intervals. As a result of extensive testing plus feedback from the study's supervisor, two minutes was established as a cycle interval which maximized data yield while ensuring measurement reliability.

Once a stable version of the SCIOS had been produced, a further seven lessons were surveyed using the complete set of assessment protocols. Only minor adjustments were made to the instrument as a result of this process.

Validation

Psychometric instruments should demonstrate both reliability and validity; the reliability and validity of the SCIOS are treated below.

The reliability of observation schedules is generally expressed in terms of inter-rater agreement – that is, the degree to which different observers using the same instrument and measuring the same event concur in their estimates of the behaviour under consideration (Merrett & Wheldall, 1986). Since the present study involved only one observer, inter-rater agreement could not be assessed. The reliability of the SCIOS was therefore established by attention to the reliability of the different measures separately. In the case of the binary and numerical measures, unreliability could arise due to observer error. No subjectivity was inherent in the measures themselves, however, and thus these measures – which constitute the majority used on the SCIOS – were considered reliable. For the ordinal scales, rater subjectivity was inherent in their use. In order to maximise their reliability, diagnostic features for the various levels of each parameter were specified. For instance, teacher interest-modelling was measured on a scale with three levels, annotated as follows: '1' = apparent disinterest; '2' = engagement; and '3' = apparent excitement. For a small number of the scales, even this annotation approach was not feasible, and their reliability rested on the consistency of the observer. Given that the observer had developed the instrument in its entirety and had practiced its administration over an extended trial period, the reliability of judgments was considered satisfactory for the present exploratory purposes.

Construct validity refers to the degree to which a scale or instrument actually measures what it claims to be measuring. Various aspects of construct validity and numerous means of assessing them have been described in the psychological literature. The aspects most relevant to the SCIOS are content and concurrent validities.

Content validity refers to the extent to which a measure represents a balanced and adequate sampling of a construct's dimensions. It is established by ensuring that the instrument addresses all those facets of a phenomenon that have been identified by theory (Mitchell & Jolley, 1996). The theoretical basis of the SCIOS has already been covered and the instrument comprehensively represents both principles and empirical findings reported by previous research. For reasons already noted, however, a small number of known interest elicitors could not be included on the SCIOS (e.g., some of the collative variables). Such omissions therefore constrain the conclusions which may be drawn from SCIOS data.

Concurrent validity is established when one measure demonstrates significant agreement with another measure of the same construct. Since the SCIOS was developed specifically to account for the lack of suitable instrumentation in the field of interest research, concurrent validity could be established for neither the instrument as a whole, nor for most individual measures. Nevertheless, some measures could be correlated against student self-report data. One example is particularly relevant here. The SCIOS measure Student Attention demonstrated a highly significant correlation with Student Lesson Interest (r=0.539, p<0.001). This result supports the validity of the Student Attention measure. The details of this and related analyses are covered in Chapter 9.

Summary

The SCIOS provides an objective and comprehensive tool for exploring interest-related aspects of science lessons. It does not, however, constitute a refined diagnostic instrument for evaluating lesson interestingness in its entirety.

7.3.3 Structure of the SCIOS – An Overview

The SCIOS is comprised of the Teacher Interaction Form and the SCIOS Electronic Workbook. Their contents are summarised here. Detailed descriptions of the Electronic Workbook are given in Section 7.3.4.

Teacher Interaction Form

The Teacher Interaction Form (TIF) is a single, A4 sheet displaying a generic classroom seat layout. Potential student seating positions are represented by a seat icon which is divided into two sections, as in Figure 7.1. The number of interactions initiated by a teacher toward the student in each position is recorded in the upper portion of the seat icon, while the number of interactions initiated by the student to the teacher is recorded in the lower portion. The Form contains more seating positions than are present in an ordinary classroom and the researcher must cross out unused positions prior to the commencement of an observation session. In the case of questions directed by the teacher to the class as a whole, such generic interactions are recorded in a separate section at the bottom of the page. The Form also has spaces for recording a class code and the date. A copy of the TIF is included as Appendix B.

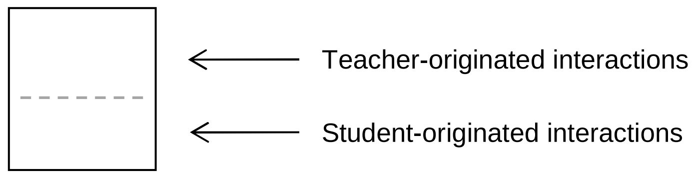


Figure 7.1: A seating position icon from the SCIOS Teacher Interaction Form, showing the upper and lower portions for recording teacher-originated and student-originated interactions, respectively.

SCIOS Electronic Workbook

The SCIOS Electronic Workbook consists of three linked spreadsheets: 1) the Observation Template; 2) a spreadsheet for compiling results from the Teacher Interaction Form; and 3) a Summary Table. The latter two spreadsheets calculate maxima, minima, sums, and averages from observation records. They are not described further here but samples of completed versions are included in Appendices D and E.

The SCIOS Template – which constitutes the largest and most complex element of the instrument – includes a small number of cells devoted to the recording of general administrative information and a much larger Data Table. The Data Table is divided into three vertical and numerous horizontal panels. The middle vertical panel – known as the Data Grid – is the location for actual data entry. It consists of 37 columns, each representing a potential two-minute observation cycle. The left vertical panel provides a descriptive summary of the information to be recorded in each row of the Grid and it is further divided into horizontal sub-sections. The right vertical panel computes various statistics, many of which output directly to the Summary Table.

The contents of the horizontal panels are given below:

- ○ Summary Data and Calculator
- ○ Class Observations
  - • *Interest Responses*
  - • *Disruptions*
- ○ Pedagogy
  - • *Location*
  - • *Resources Used*
  - • *Teaching Actions*
  - • *Learning Focus*
  - • *Other Actions*
- ○ Sensory Mode Data
  - • *Sight*
  - • *Sound*
  - • *Touch*
  - • *Smell*
  - • *Taste*
- ○ Channel Data
  - • *Mental*
  - • *Physical*
  - • *Emotional*

The overall layout of the SCIOS Template is shown in Figure 7.2 and a completed example is provided in Appendix C.

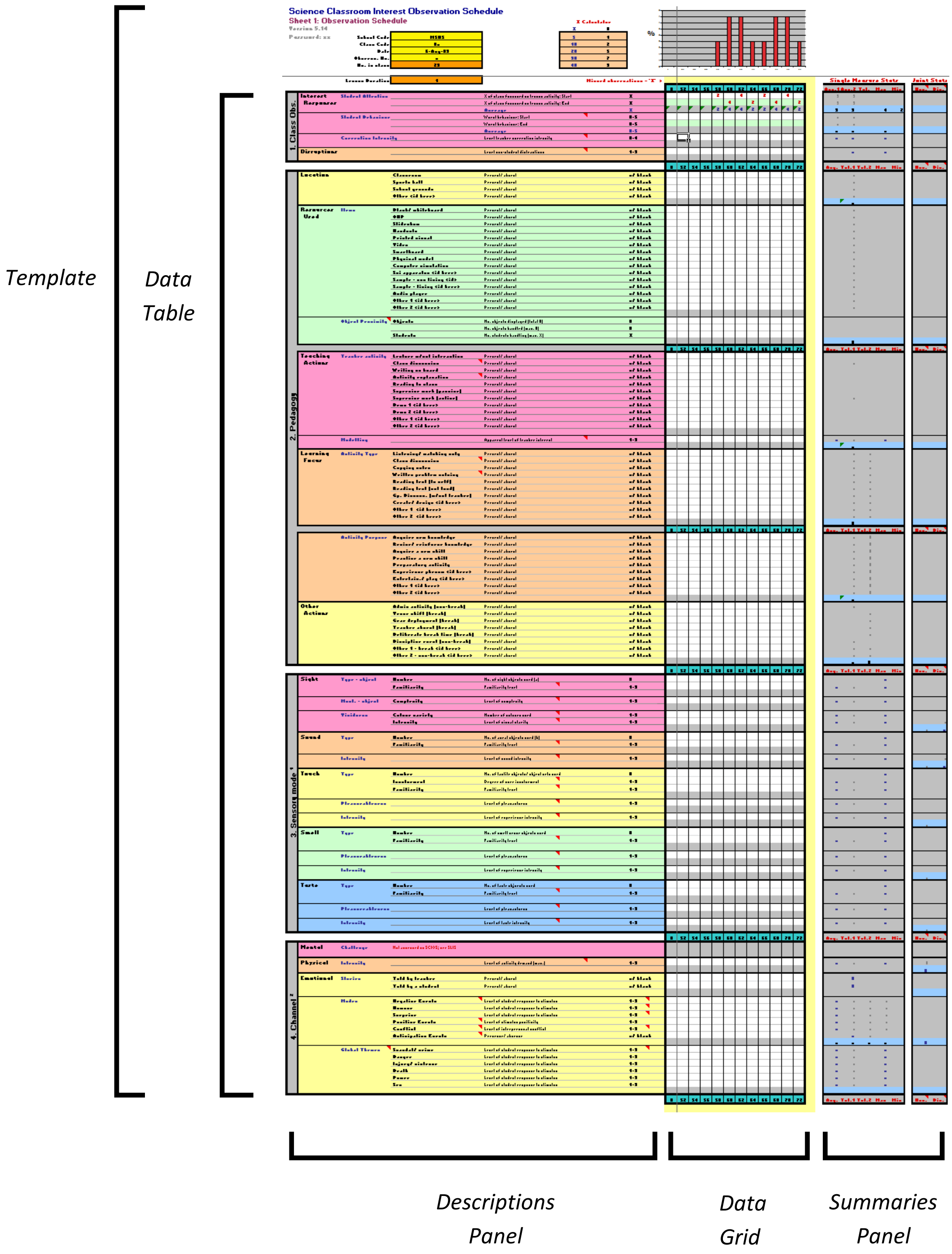


Figure 7.2: Sample of the SCIOS Template indicating the major sections.

7.3.4 Structure of the SCIOS – In Detail

Due to the level of detail in the SCIOS, a system of nomenclature is needed to enable clear communication about its construction. Figure 7.3 illustrates the approach used hereafter.

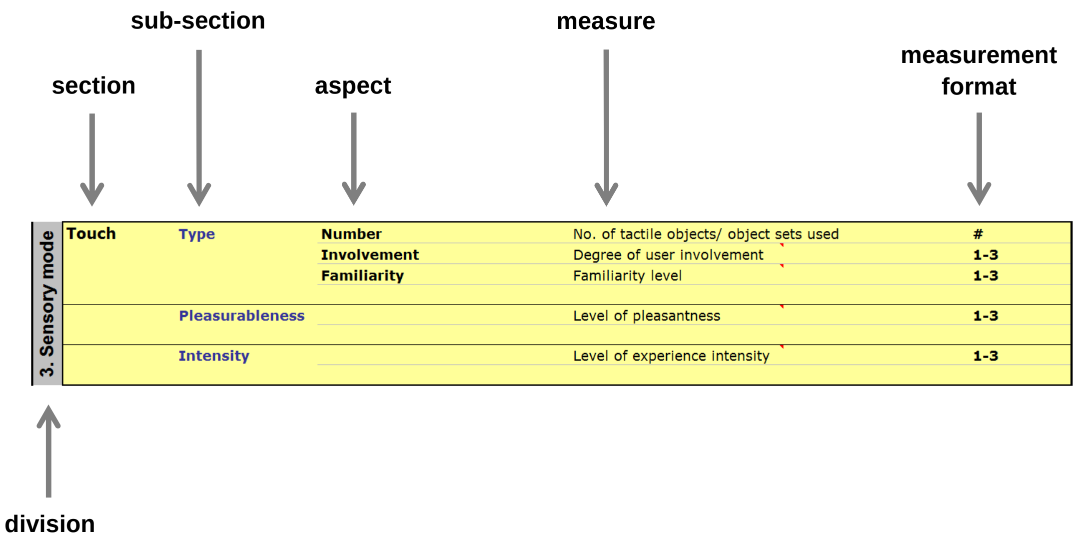


Figure 7.3: Nomenclature used in descriptions of the SCIOS.

Summary Data and Calculator

In the top left-hand corner of the Template and above the Data Table, are six cells for recording general administrative information such as a class identification code, the number of students in the lesson, total duration of the lesson, and the date. To the right of this is a Percentage Calculator which determines the number of students representing specified percentages of the class under observation; its role is described in detail below. To the right of the Calculator is a grey panel presenting student attentiveness data in graphical form; it is also described in detail below.

Division 1: Class Observations

The Class Observations division of the SCIOS Data Table contains two sections. The first of these, the Interest Responses section, has three sub-sections: Student Attention, Student Behaviour, and Correction Intensity, each being a dependent variable related to student lesson interest. The Disruptions section represents an independent variable hypothesised to be negatively correlated with student interest.

Pupil attentiveness was operationalised as the percentage of the class participating in the intended instructional activity at the moment of observation; it is referred to here as Student Attention. Since the number of students varies significantly from one class to another and since percentage values are often difficult to estimate mentally, the Percentage Calculator is provided to assist in the calculation process. The Student Attention variable is one of two measures that are recorded twice in each observation cycle. An extra row of cells displays the Student Attention average for each cycle and it is this value that is portrayed in the graph at the top of the spreadsheet.

The variable Student Behaviour was hypothesised to be inversely proportional to lesson interestingness. It is assessed on the SCIOS as the worst behaviour demonstrated by any student at the time of observation. It is judged on a six-point scale as follows:

0 = No disruptive behaviour
1 = Low volume, off-task talking
2 = Loud, off-task talking
3 = Horse-play; students out of their seat in order to act disruptively
4 = Acts of gross disrespect to the teacher or other students; highly physical, off-task behaviour
5 = Behaviour such that teaching is impossible

Like Student Attention, Student Behaviour is assessed twice per observation cycle. The SCIOS calculates the average value for this variable and represents it in a separate row of the Table. This data is not represented graphically, however.

The third whole-class variable is Correction Intensity which is included speculatively on the assumption that it will vary, like Student Behaviour, in inverse proportion to lesson interestingness. It is estimated on a five-point scale according to the following criteria and is recorded only once per observation cycle.

0 = No corrections given
1 = Corrections consisting of a few words only

2 = Corrections consisting of sentences but the flow of the teaching process is not stopped

3 = Correction stops the flow of the lesson

4 = Correction results in a significant consequence for a student or students, such as expulsion from the class

The final whole-class variable is Disruptions. This variable assesses only disruptions caused by phenomena entirely beyond the influence of the teacher such as loud noises from neighbouring classes or nearby gardening machinery. (Disturbances caused by students are accounted for in the Distraction scale of the Science Lesson Interest Survey; see Section 7.4.2). The Disruptions variable is rated on a subjective, three-point scale as follows:

1 = A noticeable interference which may or may not be perceived as disruptive

2 = An interference which has a detectable influence on the teacher or students

3 = An interference which makes lesson progress impossible

The Disruptions variable was included on the assumption that phenomena which interfere with student concentration would diminish their situational lesson interest.

Division 2: Pedagogy

Pedagogy is the largest division of the SCIOS Template. It categorises lesson events according to five factors, viz.: Location, Resources Used, Teaching Actions, Learning Focus, and Other Actions. Each of these factors is assigned to its own section and subsumes a range of possible strategies, items, or locations. Every measure is binary; thus, the use of any given strategy is registered with an ‘X’ in the cell for the relevant observation cycle. The five sections are described below.

Location is self-explanatory. Each venue in which teaching takes place during a lesson is identified and the total number of such locations is tallied by the Summary Table. This measure is one of a number contributing to the overall assessment of short-term novelty.

Resources Used has two sub-sections. The first, Items, lists the tools which a teacher might employ during the course of a lesson such as overhead projectors, whiteboards, and photocopied handouts. Like Location, this variable contributes to the assessment of short-term novelty. The second sub-section, Object Proximity, is for use only when the teacher employs demonstration items such as geological or botanical samples, or a chemistry apparatus. In this sub-section are recorded the gross number of objects displayed, the number of objects actually handled by students, and the percentage of students who participated in the handling of objects. The Object Proximity measures assess the intensity of student sensory experiences and thus relate class experiences to physical stimulation. They were included speculatively.

The Teaching Actions section has two sub-sections, viz.: Teacher Activity and Modelling. Teacher Activity records whether the teacher was lecturing without interaction, lecturing with interaction, writing on the board, reading to the class, *et cetera*. Teacher Activity variety contributes to lesson short-term novelty. Teacher interest modelling has been identified as a positive factor in interest elicitation and is theorised to affect student interest via affiliation (see Section 5.2.4). This parameter is measured in the Modelling sub-section on a subjective, three-point scale as follows:

1 = Appears bored
2 = Engaged
3 = Appears excited/animated

The next section is Learning Focus; it is divided into Activity Type and Activity Purpose sub-sections. Activity Type refers to the activities students are expected to be participating in at each point in the lesson. Although this parameter is allied to the Teacher Activity parameter, it measures an independent aspect of lesson experience. It is an aspect of lesson short-term novelty.

Similar teaching activities can be employed to very different ends. A demonstration may, for instance, be used as an instructional device, as part of content revision, or purely for entertainment’s sake. For this reason, the Activity Purpose sub-section lists the major purpose categories for lesson activities. Each purpose is associated with a speculative general need category which is listed in the Type column of the Summary Table spreadsheet.

The Other Actions section records aspects of lesson events which are not instructional in nature. Such lesson aspects include roll marking, disciplinary action, and teacher absence. Since some of these – such as teacher absence – are *de facto* break times, the duration of such events is subtracted from the gross lesson duration to give a net teaching duration value (see Teaching Duration in the Summary Table spreadsheet).

Division 3: Sensory Mode Data

The SCIOS distinguishes the sensory modes through which lesson stimuli are perceived by students. Each sensory mode is treated separately below.

On the SCIOS, a visual object is considered to be any object perceived by sight and intended by the teacher to be instructional in effect. Thus, visual objects include physical samples, pictures, written text, and diagrams or charts but do not include incidental items such as markers, roll marking books, *et cetera*. All visual objects are assessed in the Sight section which is divided into three sub-sections: Type, Movement, and Vividness.

The Type sub-section records data on two aspects of visual phenomena: Number and Familiarity. Number simply records a count of all visual objects used in the lesson. Familiarity refers to the unusualness of an object and is assessed in each case according to a subjective, three-point scale, as follows:

1 = Familiar
2 = Unusual
3 = Bizarre

Object number is an aspect of lesson short-term novelty; Familiarity is a measure of stimulus complete novelty.

Object Movement is the second Sight sub-section. Movement is here considered to be related to short-term novelty and is reported – if it occurs – on a subjective, three-point scale as follows:

1 = Simple motion – e.g., a marble running down a ramp
2 = Regular motion – e.g., carts on a model roller coaster track
3 = Complex motion – e.g., video footage of an aerobatic demonstration

The visual object Vividness sub-section is divided into two aspects: Colour Variety (aesthetic vividness) and Intensity (the brightness of an object relative to its environment). It has already been observed that stimulus vividness increases situational interest (see Section 2.2.2). Whether this is the result of improved information uptake, increased physiological stimulation, or some other factor, current theory has not established. Nevertheless, visual vividness parameters are expected to be positively correlated with lesson interest.

Colour Variety is assessed on a subjective, three-point scale, as follows:

1 = Two colours only – e.g., black text on a white background; a black and white photograph
2 = A few colours (three or four) – e.g., simple coloured graphs
3 = Many colours (more than four) – e.g., colour photographs

Intensity is also measured on a subjective, three-point scale, as follows:

1 = Weak (hard to see) – e.g., a faded marker on a whiteboard
2 = Clear – e.g., non-luminous objects seen under ordinary classroom lighting
3 = Vivid – e.g., a sharp colour photograph projected in a darkened room

For the purposes of the SCIOS, an aural object is any sound stimulus intended to be part of the instructional sequence. Thus, every lesson inevitably includes one aural object – the teacher's voice. Each student who provides lesson input – such as reading a text aloud – is considered to be an additional aural object. Videos are very rich in aural object variety and constitute a problem for assessment on the SCIOS. This problem and its solution are described in Section 9.1.2.

Aural objects are assessed in the Sound section, which has two sub-sections: Type and Intensity. The Type sub-section has two aspects, Number and Familiarity, both of which are assessed in the same manner as their visual equivalents. Aural object Intensity is assessed as the clarity of an aural object relative to environmental noise. In practice, aural clarity is a function of both relative volume and pitch, although volume is the most important factor. Thus, a voice which would be clear in a silent room may become difficult to hear when a neighbouring class is noisy. For simplicity, this parameter is assessed on the following subjective, three-point scale:

1 = Difficult to hear
2 = Clear
3 = Excessively loud

Aural intensity was hypothesised to have the same relationship to lesson interest as visual vividness.

Tactile stimulus data are recorded in the Touch section of the SCIOS; there are three sub-sections: Type, Pleasurableness, and Intensity. The Type sub-section records data on Number and Familiarity in the same manner as described previously for visual objects. The third aspect – Involvement – relates to the degree of participation that students have with tactile stimuli. This parameter was predicted to be positively associated with interest via its influences on experiential vividness, clarity of perception (see Section 4.1.1), and personal autonomy (see Section 5.2.3). The Involvement parameter is assessed on a subjective, three-point scale, as follows:

1 = Sensing or handling
2 = Using
3 = Constructing or modifying

Involvement is closely related to the Object Proximity measures but emphasises the tactile nature of the experience.

The Pleasurableness sub-section measures the degree to which tactile sensations from lesson objects constitute a pleasant or unpleasant experience. This factor relates to stimulation needs and is assessed on a subjective, three-point scale as follows:

1 = Unpleasant – e.g., a slimy toad
2 = Neutral – e.g., a test tube
3 = Pleasant – e.g., a stroke from a duckling's feather

The Intensity parameter for tactile stimuli was hypothesised to affect lesson interest via its provision for stimulation needs; it is measured in much the same way as for the other sensory modes, viz.:

1 = Weak (difficult to detect)
2 = Moderate
3 = Intense

Olfactory and gustatory stimuli are assessed in the Smell and Taste sections of the SCIOS respectively. Both are divided into three sub-sections: Type, Pleasurableness, and Intensity. The assessment procedures for smell and taste objects are essentially the same as those used for touch objects, above, and the role of each parameter in influencing interest was expected to be similar. No smell or taste objects were used in the classes observed in this study, however.

Division 4: Channel Data

Lesson event stimuli can also be classified according to the 'processing channel' they most affect, viz.: mental, physical, or emotional. Since each of these three 'channels' is associated with distinctive need-fulfillment possibilities, the SCIOS permits analysis of teacher actions in relation to each channel separately.

Mental channel (i.e., cognitive) variables relating to interest include degree of intellectual challenge, relatedness of content to existing interests, and the match between content and holes in personal schemata. No such variables are assessed on the SCIOS, however, since they cannot be meaningfully estimated by an external observer. Consequently, the inclusion of the Mental channel section on the SCIOS is only an acknowledgement of its importance. Actual measurement of cognition-related variables was achieved in this study through the Science Lesson Interest Survey (SLIS; see Section 7.4) and the Interest in Science Questionnaire (ISQ; see Section 7.5).

Physical channel experiences are rarely, if ever, the purpose of pedagogy in science lessons. Nevertheless, the physical channel is used incidentally during a wide range of tasks, from the manipulation of simple scientific apparatuses – such as microscopes and magnets – through to athletic activities such as might be undertaken during biometric data gathering. The variables recorded in the Touch section account for all tactile aspects of science lesson experiences. For the assessment of whole-body involvement, a single Physical channel measure – Intensity – is given on the SCIOS. This parameter measures the physical demand of practical tasks undertaken by students on a subjective, three-point scale, as follows:

1 = Passive – e.g., using a protractor and ruler to draw diagrams; using a microscope
2 = Active – e.g., walking between survey sites
3 = Demanding – e.g., running as part of a heart-rate monitoring activity

Physical Intensity was hypothesised to relate to the fulfillment of stimulation needs.

In the Emotional channel section are summarised a wide range of affective phenomena identified by interest researchers as salient to the elicitation of student interest. Emotional channel data are broadly categorised on the SCIOS into three sub-sections: Stories, Modes, and Global Themes. These categories are not intended to be independent and a given event may register in more than one of these categories simultaneously. All Emotional channel phenomena were hypothesised to provide for stimulation needs, at least in part (see Section 5.3.3).

The Stories sub-section comprises two rows for the recording of narrative events: one for stories told by the teacher and another for stories told by students. The relationship between narratives and needs is complicated and their interest-eliciting power is likely to be the outcome of a number of need-fulfillment factors, not simply emotional stimulation (see Section 6.4.2). For this reason, the allocation of Stories measures to the Emotional channel section does not represent a definitive classification but an approximation for convenience. Any clearly emotive content in narratives – or in parts thereof – is recorded separately in the Modes sub-section, as described below.

The Modes sub-section subsumes six emotion-related experience types, viz.: Negative Events, Humour, Surprise, Positive Events, Conflict, and Anticipation-evoking Events. The identification of these categories is based upon the findings of interest research rather than those of affect research and, although each category is distinctive, they do not show mutual exclusivity. A description of the assessment of each Mode follows.

Negative Events are educational events evoking feelings such as fear, shock, disgust, or sadness. Excluded, however, are negative emotions arising from the personal environment of the class, such as feelings of anger or shame arising from teacher punitive action. Negative Events are rated for their emotional intensity using a subjective, three-point scale, as follows:

1 = Anticipated – a negative response is suggested by the material in question but is not detected in any students
2 = Detected – a negative response is detected in at least one student through facial expressions or exclamations, etc.
3 = Significant – a strong negative response is detected in a few students or else a mild negative response is detected in the majority of the class

A Humour event is rated on the SCIOS every time a teacher employs an action which is either intended to be amusing or has that effect. Humour is rated on a subjective, three-point scale, as follows:

1 = Anticipated – no response is detected amongst the students even though a witticism has been used
2 = Detected – less than 50% of the students laugh
3 = Significant – a majority of the class laughs

The SCIOS does not accommodate humour which is deprecating of class participants, although this may indeed impact the classroom environment.

Surprise is rated on a subjective, three-point scale similar to those used for both Negative Events and Humour, i.e., anticipated, detected, or significant surprise.

Positive Events are those which are significantly positive in tone but are not humourous. Included in this category are praise of the whole class by the teacher and meaningful stories with happy endings. Positive Events are thus distinct from Negative Events not only in the feelings elicited, but also because intra-class relational events are included. Positive Events are rated on a subjective, three-point scale as follows:

1 = Mildly positive – the event is positive, rather than neutral, in intent

2 = Distinctly positive – the event is clearly positive

3 = Uplifting – the event makes a noticeable difference to classroom affective tone

This parameter shares some territory with the Warmth scale derived from the Questionnaire on Teacher Interaction (see Section 7.6).

Conflict is assessed according to principles similar to those applied to Negative Events. Thus, Conflict events are only those with pedagogical – rather than punitive or personal – significance. It may arise during classroom debates and discussions, or may be recognised when viewing or reading instructional material. Such events are assessed on a subjective, three-point scale as follows:

1 = Anticipated – a difference of perspective is clear although no emotion is apparent

2 = Detected – the conflict situation generates clear emotional responses

3 = Heated – the conflict situation generates strong emotional responses

The emphasis in making judgments about Conflict is the degree to which a sense of conflict is actually expressed by the students present. Consequently, an article about the use lethal injections as capital punishment may rate lower than a debate over litter in which the students become passionate about their topic.

Anticipation Events are those circumstances in which students are led into a condition of expectation regarding the future. The cause of the anticipation may or may not be explicitly intended by the teacher but must be clear. Such events include promises of rewards at the end of the lesson and whodunit-type stories. Anticipation Events are not rated for intensity, but simply for presence or absence in that particular observation cycle.

The final sub-section, Global Themes, derives from the work of Schank (1979) who postulated that certain themes have perennial, universal appeal and will elicit interest in virtually any audience. These themes have been discussed earlier and their unifying characteristic is that they are emotional in nature (see Section 2.2.2). The most pertinent Global Themes are scandal/crime, danger, sex, death, power, and injury/violence and each is allocated a separate row on the SCIOS. Lesson events which include any of these Global Themes are rated for the intensity of the experience on a subjective, three-point scale as follows:

1 = Anticipated – the theme is present but no response is detected among students

2 = Detected – some response is detected in at least one student

3 = Significant – a strong response is detected in at least a few students, or responses of some kind are detected amongst the majority of students

7.4 Science Lesson Interest Survey (SLIS)

7.4.1 Introduction

As previously discussed, research to date has largely focused on interest as an independent variable (Krapp et al., 1992) – a fact reflected in existing measurement approaches. The present study, however, was focused on interest as a dependent variable. As might be expected, therefore, no instrument could be found which suited the present task and it was necessary to construct a new questionnaire, the Science Lesson Interest Survey (SLIS).

The SLIS was primarily designed to measure student situational interest in science lessons. Scales for three independent variables with known or hypothesised relationships to interest were also included, however. Two of these variables – novelty and difficulty/challenge – were identified from previous research and have been discussed in earlier chapters. The final variable, distractions, was hypothesised as an interest detractor and was included speculatively.

Responses to all SLIS items are made on Likert-type scales with four values, viz.: 1 = strongly disagree (SD); 2 = disagree (D); 3 = agree (A); and 4 = strongly agree (SA). For the Interest, Novelty, and Difficulty scales, half of the six items in each are worded negatively and hence scored in reverse. All Distractions items are worded positively and scored normally. For ease of hand scoring, items are arranged in cyclic fashion, in six blocks of four items each. Scale descriptions and sample items are given in Table 7.1.

Table 7.1: Science Lesson Interest Survey (SLIS) scale descriptions.

Scale Name	Description	Sample Item *
Interest	Measures the degree to which the student perceived the lesson as interesting	Today's science lesson seemed to go fast. (+)
Novelty	Measures the degree to which the student perceived the lesson as presenting entirely new experiences	The facts we learned today were new to me. (+)
Difficulty	Measures the degree to which the student perceived the lesson content as being personally challenging	The work we did today was simple. (-)
Distractions	Measures the degree to which the student perceived themselves as distracted during the lesson	Other students distracted me in class today. (+)

* Items denoted (+) are scored as per the description given above; items denoted (-) are reverse scored.

7.4.2 Development and Structure of the SLIS

Researchers and laypersons alike have observed that during interesting events people experience enjoyment, a sense of time passing swiftly, and a desire to continue interacting with the stimulus in question. Such observations formed the basis for a prototype Interest scale which addressed all major aspects of the interest experience. The roles of novelty and challenge in eliciting interest have already been covered in Sections 6.4.1 and 5.4.3 respectively. On the basis of this information, prototype Novelty and Difficulty scales were derived in a fashion similar to that used for creating the Interest scale. The fourth SLIS scale, Distractions, aimed to measure all major phenomena having the potential to distract students during lessons. It was designed to address both internal factors (e.g., hunger and diverting thoughts), and external factors (e.g., interference from other students). All prototype SLIS scales comprised six items.

Gable, Wolf, and Keilty (1993) have advised researchers to administer a draft version of any instrument to a small group of representative subjects and then discuss the process and the instrument itself afterwards. A prototype of the SLIS was administered to 34 students in two separate classes of Year 8 students at the school in which the final study was undertaken. Students participating in these trials did not participate in the rest of the investigation. Five of these 34 students volunteered to provide feedback and they made helpful comments on item wording. Their suggestions were included in a range of modifications to the SLIS and a second version of the questionnaire was then trialed on a class of 26 students. After this, further adjustments were made, resulting in the third and final version which is reproduced in Appendix F.

7.4.3 Validation of the SLIS

The SLIS varies from the structure of many conventional questionnaires. First, the scales are not independent and thus the criterion of discriminant validity – often estimated as the mean correlation of a scale with other scales – is not appropriate for this instrument. Second, the Distractions scale was not designed to function in the conventional manner (i.e., with items reflecting various aspects of a single underlying phenomenon) and thus it was not meaningful to determine the internal consistency reliability of this scale. Further, since the Distractions scale gathers information on the whole spectrum of distraction experiences, the Distraction score for each student was calculated as the sum of their item scores rather than the average.

Bearing in mind the aforementioned qualifications, the SLIS was statistically validated by examining: a) the factor loading of items on each relevant scale using factor analysis with varimax rotation; b) the internal consistency reliability of relevant scales using Cronbach's alpha reliability statistic; and c) the ability of all four scales to differentiate between classes using the η^2 (eta^2) statistic from a one-way ANOVA. Analyses were performed on data from both of the trials as well as the study proper. The latter data are presented in Tables 7.2 and 7.3 below.

Table 7.2: Factor loadings of items on the scales of Interest, Novelty, and Difficulty from the Science Lesson Interest Survey (SLIS) – class as unit of analysis (N = 50).

Scale	**Item No.**	**Factor Loadings**		
		Interest	Difficulty	Novelty
Interest	1	0.82		
	5	0.93		
	9	0.94		
	13	0.88		
	17	0.89		
	21	0.90		
Difficulty	2		0.92	
	6		0.82	
	10		0.92	
	14		0.87	
	18		0.79	
	22		0.85	
Novelty	4	0.43		0.77
	8	0.69		0.50
	12			0.87
	16			0.84
	20			0.90
	24	0.66		0.54

Table 7.2 shows that the factor loadings of all items on their intended scales exceed 0.40, the minimum value conventionally accepted as satisfactory when the class is the unit of analysis. It is also apparent, however, that three items from the Novelty scale (i.e., items 4, 8, and 24) loaded heavily on Interest. Indeed, in two instances, the loadings were more significant on Interest than on the intended dimension of Novelty. Nevertheless, the wording of these items is unambiguous:

Item 4: The facts we learned today were new to me.
Item 8: I had new experiences in this science lesson.
Item 24: I learned how to do new things in science today.

Since students cannot have been misled regarding the phenomena under consideration, and since novelty is known to be highly correlated with interest, these data do not invalidate the instrument. Indeed, they constitute a significant result in their own right and are discussed in more detail in Section 10.3.3.

Table 7.3: Internal consistency reliability of scales (Cronbach's alpha coefficient), and the capacity of each scale to differentiate between classes (η^2 statistic from a one-way ANOVA) for the SLIS – individual and class as units of analyses (N = 915 and 50 respectively).

Scale	**No. of Items**	**Unit of Analysis**	**Alpha Coefficient**	**ANOVA η^2**
Interest	6	Individual	0.86	0.271 ***
		Class	0.96	
Difficulty	6	Individual	0.81	0.196 ***
		Class	0.94	
Novelty	6	Individual	0.77	0.238 ***
		Class	0.93	
Distractions	6	Individual	NA	0.104 ***
		Class	NA	

*$p<0.05$, **$p<0.01$, ***$p<0.001$

As evident in Table 7.3, when the class was used as the unit of analysis, the alpha coefficients for the scales Interest, Difficulty, and Novelty ranged from 0.93 to 0.96; when the individual was used as the unit of analysis, these coefficients ranged from 0.77 to 0.86. Such values are in accordance with accepted standards for internal consistency reliability (Nunnally, 1978). One-way ANOVAs – using the class as the independent variable – revealed that all four scales showed a significant capacity to distinguish between classes ($p < 0.001$). These data confirm the SLIS as a valid and satisfactorily reliable instrument.

7.5 Interest in Science Questionnaire (ISQ)

7.5.1 Introduction

Many authors (e.g., Ainley et al., 2002) have found that persons with prior (i.e., individual) interest in a topic report greater situational interest in stimuli related to that topic than people without such prior interest. It was important, therefore, to account for this variable in the present study and thus to find a suitable instrument to measure it. Preliminary research discovered the Study Interest Questionnaire. This instrument addressed the matter in question but significant modification was required before it could be used with middle school students. The result is the Interest in Science Questionnaire (ISQ). The ISQ has a single scale comprised of nine items, four of which are scored in reverse. All items are assessed on a four-point, Likert-type scale identical to that used for the SLIS. A typical item from the questionnaire is: *Sometimes I do science activities in my spare time, just for the fun of it.* The construction and validation of the ISQ instrument are described in the following sections and a copy of the final version is included in Appendix G.

7.5.2 Development of the ISQ

The original instrument, the Study Interest Questionnaire, was devised by Schiefele, Krapp, Wild, and Winteler (1993) and in its original form the questionnaire contained 18 items organised into three, equal-sized ‘scales’: Feeling-related Valences, Value-related Valences, and Intrinsic Orientation. According to its authors, these scales do not, in fact, constitute separate factors and the instrument is uni-dimensional.

The original questionnaire was designed for tertiary students whose course of study was voluntary. Subjects in the present study were Year 8 students obliged to take the course. These facts necessitated a redesigning of the instrument. The modified version, the ISQ, features a reduced number of items – most of which have been re-worded for the lower secondary school context – and does not retain the ‘scale’ structure of the original.

7.5.3 Validation of the ISQ

A 10-item prototype of the ISQ was trialed in the same classes as those in which the SLIS was tested (see Section 7.4.2). Participating students were interviewed afterward to provide feedback. As a result of this process, numerous items were reworded and one was eliminated, leaving nine items. The ISQ’s internal consistency reliability was assessed using Cronbach’s alpha reliability statistic. Both trial and final study data were examined; the latter returned an alpha value of 0.87 (N=195) which represents an adequate level of reliability. In light of the instrument’s theoretical provenance and the internal consistency results, it can be considered satisfactorily valid and reliable.

7.6 Questionnaire on Teacher Interaction (QTI)

7.6.1 Introduction

The significance of social variables in determining lesson interest has been discussed in Sections 5.4.2 and 6.4.2. Teacher relational behaviours were assessed in this study via the Questionnaire on Teacher Interaction (QTI), an instrument developed during several studies in the early 1980s (Wubbels, Créton, & Hooymayers, 1992). It originally comprised 77 items but the Australian version, developed by Fisher, Henderson, and Fraser (1995) comprises only 48. Given that the QTI addresses factors of direct significance to the present work and given that it was written in language appropriate to middle school-aged children, it was adopted with only minor wording changes. Despite its pedigree, however, problems were found with the instrument and it was necessary to reorganise the results before they could be meaningfully collated against the student response variables under investigation. The original structure of the QTI, its application in the present context, and its reorganisation are described below.

Table 7.4: Question on Teacher Interaction (QTI) scale descriptions and sample items (adapted from Scott & Fisher, 2004).

Scale Name	**Description** (The extent to which the teacher…)	**Sample Item**
Leadership (LEA)	… leads, organises, gives orders, determines procedures, and structures the classroom situation.	This teacher holds our attention.
Understanding (UND)	… listens with interest, empathises, shows confidence and understanding and is open with students.	This teacher is willing to explain things again.
Uncertain (UNC)	... behaves in an uncertain manner and keeps a low profile.	This teacher lets us boss her/him around.
Admonishing (ADM)	… gets angry, expresses irritation and anger, forbids and punishes.	This teacher gets angry quickly.
Helpful/Friendly (HFR)	… shows interest, behaves in a friendly or considerate manner, and inspires confidence and trust.	This teacher is someone we can depend on.
Student Responsibility & Freedom (SRE)	… gives opportunity for independent work, gives freedom and responsibility to students.	We can influence this teacher.
Dissatisfied (DIS)	… expresses dissatisfaction, looks unhappy, criticises, and waits for silence.	This teacher is suspicious.
Strict (STR)	… checks, maintains silence and strictly enforces the rules.	We have to be silent in this teacher's class.

7.6.2 Description of the QTI

The QTI consists of eight teacher behaviour scales, viz.: Leadership (LEA), Understanding (UND), Uncertainty (UNC), Admonishing (ADM), Helping/Friendly (HFR), Student Responsibility & Freedom (SRE), Dissatisfied (DIS), and Strict (STR). Items are responded to on a Likert-type scale of five values from 0 (this behaviour is never displayed) to 4 (this behaviour is always displayed). For ease of hand scoring, items are arranged in cyclic fashion, in twelve blocks of four items each. There are no reverse scored items. A description of the QTI scale structure is given in Table 7.4 and a copy of the complete instrument is included in Appendix H.

The QTI is based on a model which defines teacher interpersonal behaviour according to two orthogonal dimensions. The Proximity dimension is a continuum with poles of Co-operation and Opposition, while the Influence dimension is a continuum from Dominance to Submission. According to this model, teacher relational behaviours can be represented as sectors on a circular chart, as in Figure 7.4. Each of the eight sectors is represented on the QTI as a scale, with the scale named after the qualities most characteristic of that sector (Brekelmans, Wubbels, & Créton, 1990). During the QTI's development, the scale structure of the instrument was validated in a range of educational contexts (Wubbels, 1993).

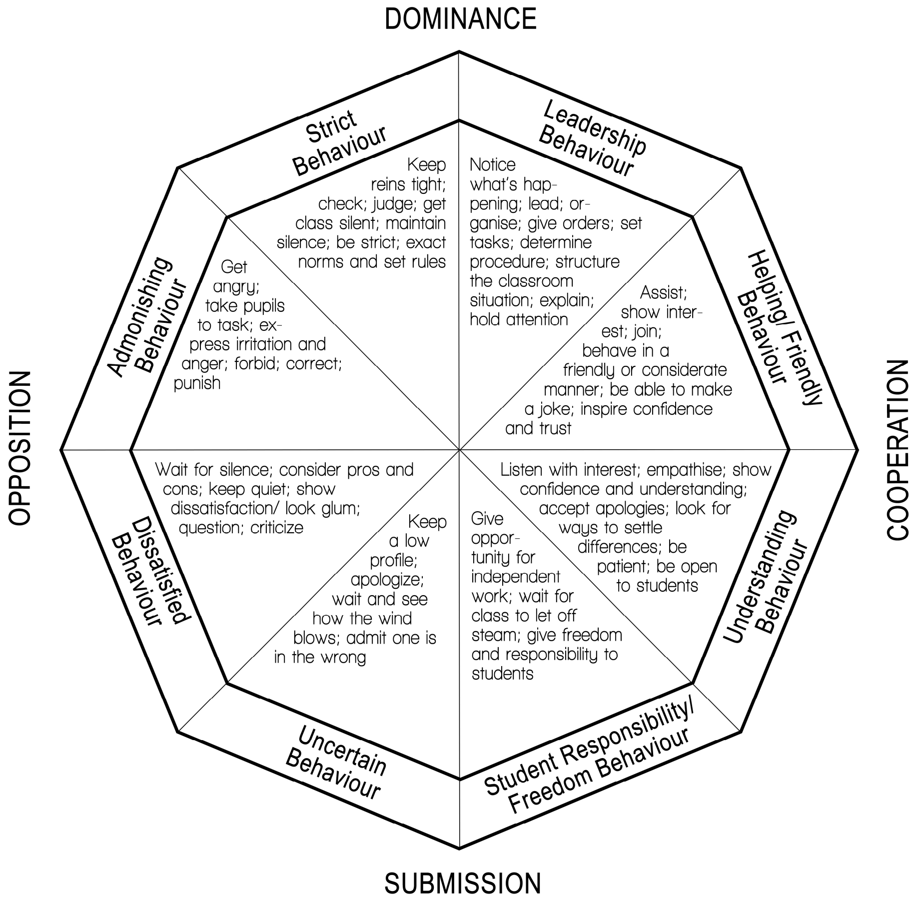


Figure 7.4: Dimensions of the model for teacher interpersonal behaviour (Source: Fisher, Fraser, & Wubbels, 1993).

7.6.3 QTI Data Issues and Factor Re-analysis

As already noted, significant problems arose in connection with data obtained by this instrument. Specifically, when the results were correlated with student interest variables, an unexpectedly high number of QTI scales demonstrated significant correlations. This suggested that the QTI scales were themselves highly correlated. An examination of inter-scale correlations showed that this was, indeed, the case. These results are presented in Table 7.5

Table 7.5: Correlations (r) among QTI scales – individual as the unit of analysis; N=192.

	Lea	Und	Unc	Adm	HFr	SRe	Dis	Str
Lea	-							
Und	0.801***	-						
Unc	-0.553***	-0.502***	-					
Adm	-0.540***	-0.542***	0.571***	-				
HFr	0.778***	0.840 ***	-0.553***	-0.547***	-			
SRe	0.274***	0.440 ***	-0.029	-0.150*	0.476***	-		
Dis	-0.587***	-0.596***	0.677***	0.690***	-0.669***	-0.169*	-	
Str	-0.328***	-0.376***	0.325***	0.532***	-0.466***	-0.195**	0.525***	-

$*p<0.05$, $**p<0.01$, $***p<0.001$

As described earlier, the eight QTI scales were originally intended to represent aspects of two orthogonal teacher-behaviour continua. The degree of scale correlation evident in Table 7.5, however, indicated that factors other than the intended two were in operation. In light of this, the current data were subjected to exploratory factor analysis. Principal components analysis with varimax rotation was used to derive two-, three-, four-, and eight-factor solutions, of which the best was a three-factor solution. A scree plot showing this solution is provided in Appendix I.

A process of factor identification was then undertaken, as follows. First, items that were found to load significantly on more than one of the new factors were eliminated; 32 items survived this process. Second, the clusters of remaining items were labelled according to their most prominent quality; three new scales were derived by this method – Warmth, Uncertainty, and Strictness. Next, items which did not have face validity for the scale into which they nominally fell were also eliminated, leaving the three scales with twelve, five, and five items respectively. (A rotated component matrix for each of these scales and a list of surviving items with their factor loadings are given in Appendices J and K, respectively.) Finally, the Cronbach alpha reliability coefficients for each new scale were calculated. These data are presented in Table 7.6.

Table 7.6: Cronbach alpha coefficients of internal consistency reliability for three derivative scales of the QTI: Warmth, Uncertainty, and Strictness – individual as unit of analysis.

Scale	Items	*N*	Alpha
Warmth	12	189	0.92
Uncertainty	5	192	0.52
Strictness	5	189	0.58

The analysis above indicates that only the Warmth scale demonstrated satisfactory internal consistency reliability. This scale was the only student-reported measure of teacher interpersonal behaviour used in the analyses.

Chapter 8

METHODOLOGY

8.1 Introduction

This chapter covers the practical background to and the processes involved in the fieldwork of this investigation. The following are described: a) ethical clearance for survey activities; b) the participants and teaching context; c) general survey methods; and d) procedures applied to specific instruments.

8.1.1 Ethical Clearance

Once the theoretical background to the study had been established and survey approaches decided upon, a formal submission for ethical clearance was made to Education Queensland and to the Curtin University Ethics Committee. The study presented no special ethical dilemmas and clearance was granted by both parties contingent upon standard stipulations regarding data protection and confidentiality but with an additional requirement that written parental permission be obtained for all students involved.

8.1.2 Participants and Context

The study took place in a large government high school in south-east Queensland, Australia, during the third school term of 2009. At that time, the school hosted 11 Year 8 Science classes taught by nine different teachers. All these teachers were approached in person by the researcher and all volunteered to participate – two for the purposes of the pilot study, and seven for the main study. Of those who participated in the main study, six were male and one female.

The researcher then visited all Year 8 Science classes in the school to introduce them to the objectives of the study and to invite their participation. This was followed up with a letter to parents co-signed by the researcher and the school principal. Parents who did not return the attached permission form were telephoned to ascertain whether their failure to respond was a *de facto* refusal of permission or simply an oversight. Of the 264 students in the cohort, 192 (73%) agreed to participate in the main study and an additional 45 (17%) in the pilot study.

8.1.3 General Preparation

Teachers were individually briefed on the details of survey procedures and, with their assistance, a timetable of observation events was drawn up – first for the pilot survey and then for the main study. In order to constrain the scope of the investigation, only traditional lecture-style (‘chalk-and-talk’) lessons were surveyed. Lessons dedicated to practical activities or work on assessment items were excluded. (As it turned out, a small number of the observed lessons did involve some practical components anyway, but this issue was accounted for during data analysis; see Section 9.1.2).

8.2 General Procedures

8.2.1 Instrument Design and Pilot Survey

Prototypes for the new instruments were developed from pre-existing questionnaires and the theoretical principles discussed in Chapters 3 to 6. Pilot testing and refinement of these prototypes was then undertaken in two ways, each according to the nature of the instrument in question. For the SCIOS, the researcher pilot-surveyed sixteen lessons, during which process the measurement scales were refined and protocols for administration of the Schedule were developed. (The process also helped students grow accustomed to the presence of the researcher and thus reduce the Hawthorne Effect in the main study.) For the two purpose-built questionnaires (i.e., SLIS and ISQ), each was pilot-tested on two classes; feedback was then solicited from student volunteers and adjustments were made to the structure and wording of both. Since the SLIS was the more complex of the two and received the greater number of criticisms, a second version of this questionnaire was also piloted but on a single class only. The validation procedures employed for these instruments have already been treated in Chapter 7.

8.2.2 Main Study – Introduction

Although the students had been introduced to the goals and general procedures of the study during the volunteer solicitation phase, the main study was introduced with a reiteration of these matters. This introduction took some five minutes in each class, after which students were invited to ask questions about the study generally and their responsibilities in it. The two preliminary surveys – the Interest in Science Questionnaire (ISQ) and the Questionnaire on Teacher Interaction (QTI) – were then administered. A total of 193 Interest in Science Questionnaires and 192 Questionnaires on Teacher Interaction were completed. No other data was collected during these introductory lessons.

8.2.3 Main Study – Materials

For observations in the main phase, the researcher was equipped with the following: a laptop computer running the Science Classroom Interest Observation Schedule (SCIOS) in Microsoft Excel; a printed version of the SCIOS Template in case of computer malfunction; a copy of the Teacher Interaction Form (TIF); a class set of blank Science Lesson Interest Survey (SLIS) forms; a stopwatch; a pencil; an eraser; and a field notebook. Extra copies of all paper forms were kept on hand in case of complications.

8.2.4 Main Study – General Procedures

The following general procedures were used during the observations. The researcher entered the classroom 10 minutes before the scheduled start of the lesson and took an unobtrusive position near the back. All the survey equipment was then arranged in a way that made accessibility easy. In particular, a blank copy of the TIF was taped onto the table or bench surface to the immediate right of the computer and the pencil and eraser were placed on top of it. Next, a blank electronic copy of the SCIOS was opened. Administrative data including the date and a unique class identification code were then entered on both the SCIOS Template and the TIF. Finally, the TIF was edited to show only the seating positions actually present in that classroom. For instance, if the classroom had 24 chairs arranged in four rows of six columns, the fifth and sixth rows and the seventh, eighth, and ninth columns on the TIF blank were crossed out, as illustrated in Figure 8.1, below.

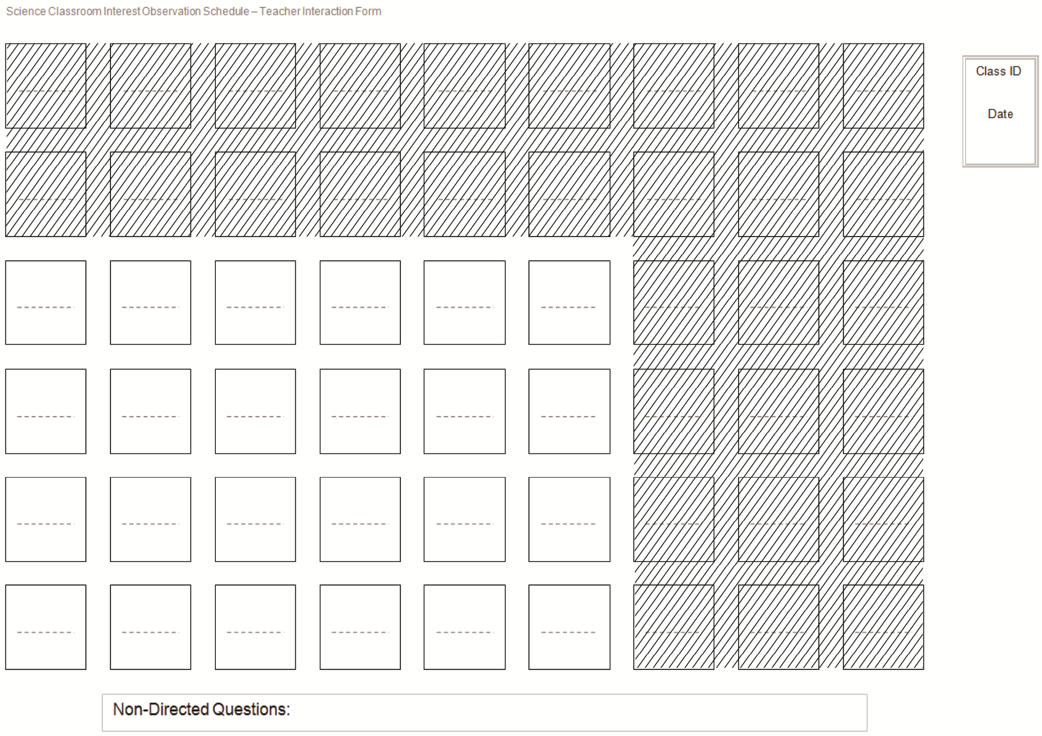


Figure 8.1: An example of a Teacher Interaction Form (TIF) showing the 24 potential seating positions of an actual classroom.

When the students entered the classroom, the researcher made neither eye contact nor conversation with them and aimed instead to give the impression of being absorbed in his task. Once all students were settled, unoccupied seating positions were crossed off the TIF, as in Figure 8.2, leaving only occupied seating position icons for data entry.

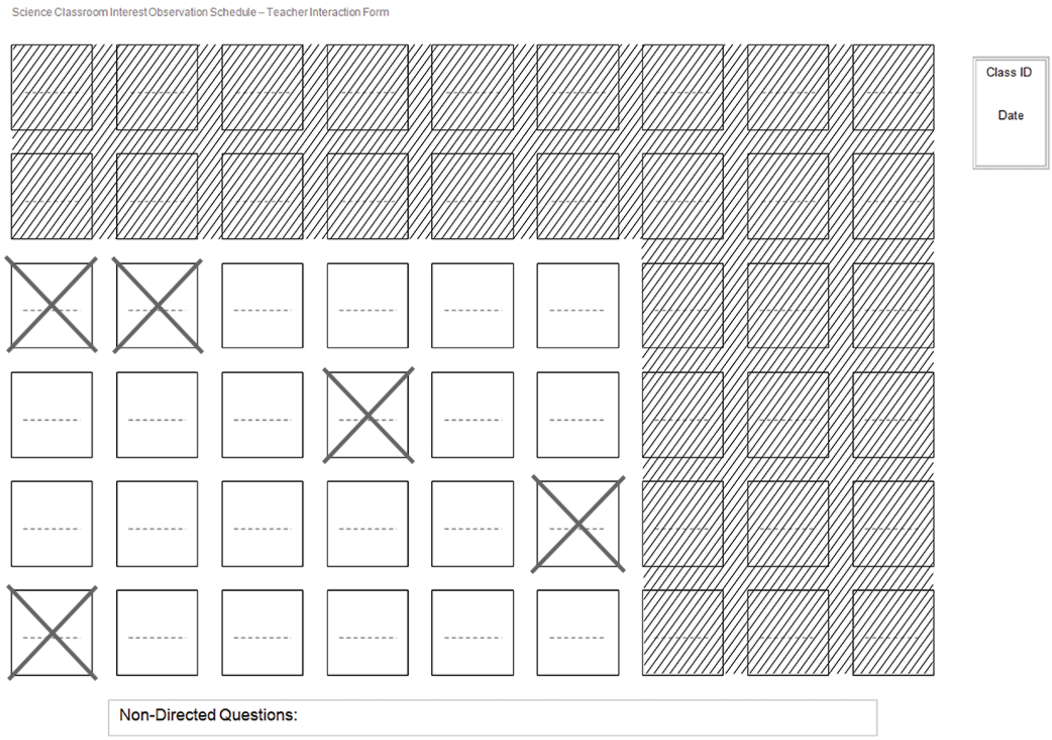


Figure 8.2: An example of a Teacher Interaction Form (TIF) showing a classroom with 24 seats of which 19 were used.

Next, the number of students in attendance was counted and the figure entered in the appropriate cell on the SCIOS Template. No other observations were recorded until the teacher had completed all preliminary administrative tasks (e.g., roll marking, homework collection). At the point when the instruction process actually began, the stopwatch was started and the first observations were recorded on the SCIOS Data Grid. (The broad structure of the SCIOS Template has been covered in Section 7.3; specific details of its use will be covered in Section 8.3.2.)

By agreement with the researcher, each teacher concluded their instruction approximately five minutes before the final lesson bell so that SLIS forms could be administered. Once all these forms had been completed and collected, the class was thanked and then dismissed by the teacher.

A total of 50 lessons were observed in the way just described, with each class being observed on either five or six occasions over a seven week period. Note that two of the teachers taught two Year 8 Science classes and thus were observed more often than the others. Summary details for the main observation phase are presented in Table 8.1.

Table 8.1: Summary statistics for the main observation phase.

Number of lessons surveyed	50
Number of classes involved	9
Number of participating teachers	7
Number of volunteering students	193
Average observed teaching time per lesson (min.)	51

8.2.5 Data Analysis

Data gathered in this study were compiled in Microsoft Excel. Advanced analyses were performed in PASW (formerly SPSS) v.17 for Windows; details of these analyses are given in Chapter 9.

8.3 Instrument-specific Procedures

To complement the structural descriptions of the instruments given in Chapter 7, details of instrument administration and some strategies used to address common challenges are given below, arranged by instrument.

8.3.1 SCIOS – Teacher Interaction Form

The frequency and distribution of teacher-student interactions was recorded on the TIF by entering a tally mark in the respective student seating icon for each such interaction. Tallies were made only when the interactions related directly to lesson content, however. Other interactions (e.g., “Do you need a calculator?” or “Can I please go to the toilet?”) were not taken down. Interactions initiated by the teacher were recorded as a short vertical line in the upper half of the student’s seating icon. Interactions initiated by the student were recorded with a small circle in the lower half of the icon. Generally, teacher-initiated interactions took the form of content-related questions but they also included offers of help. Student-initiated interactions were exclusively questions of various kinds. Questions which the teacher directed to the class as a whole – rather than to a specific pupil – were recorded as Non-Directed Questions at the bottom of the Form. In cases where students moved during a lesson, their interactions were marked in the icons of their original seating position. Teacher-student interactions were not recorded on a cyclic basis but were taken down whenever they occurred.

8.3.2 SCIOS – Main Template

Data entry on the SCIOS Template demanded two distinctive but simultaneous sampling strategies, the first being cyclic and the second opportunistic. Cyclic data sampling addressed a small number of variables which were assessable at all times; these included Student Attention, Visual Object Number, and Physical Intensity. For such variables, data recording began with Student Attention and then progressed through the others in turn, from the top of the Data Table to the bottom. Once all these variables had been measured once, the cycle was concluded with second assessments of Student Attention and Student Behaviour. Opportunistic data sampling, on the other hand, assessed those variables which were not assessable at all times, including Surprise Intensity, Smell Object Pleasurableness, and any variables assessed using a binary measure of presence or absence. These opportunistically-sampled variables were recorded whenever they appeared, regardless of whether the timing coincided with the observer’s cyclic progress through the Data Table. The two strategies – cyclic and opportunistic – were applied simultaneously, with the cyclic measures forming a core structure which the observer followed unless events demanded that opportunistic data be recorded. Note that for all the cyclic measures, once their values were recorded they were not revisited even if they changed later in the cycle. Details of the use of some of the more difficult measures on the SCIOS are discussed below.

Summary Information and the Percentage Calculator

The upper left-hand portion of the SCIOS Template has cells for recording basic administrative information such as the observation date, a school identification code, and class size. It also provides a Percentage Calculator for measuring Student Attention, the use of which deserves further explanation.

Figure 8.3 shows the display from the Percentage Calculator when the total number of students is 23. The left-hand column contains a range of representative percentages; the right-hand column contains the number of students that correspond to those percentages for the class in question.

% Calculator

%	#
5	1
10	2
20	5
30	7
40	9

Figure 8.3: An example of the Percentage Calculator from the SCIOS Template showing specific percentages for a class of 23 pupils.

To estimate the percentage of students attending to lesson tasks, the following procedure was applied. First, a rough mental estimate was made of the overall percentage of task-focused students. If the number constituted an easily estimated percentage of the total class (e.g., 0% or 50%) then that percentage was recorded directly in the appropriate place in the SCIOS Data Grid. If the percentage seemed difficult to estimate but quite small then the task-focused pupils were individually counted, the Calculator consulted, and the respective percentage recorded in the Grid (e.g., seven students in a class of 23 = approximately 30%). If the number of attending students was large, however, then the number of non-task-focused pupils was counted instead, after which the Calculator was consulted, the corresponding percentage was subtracted from 100, and the outcome recorded in the Grid. For instances where the precise number of students counted did not appear on the Calculator, percentage values were estimated by linear extrapolation from the nearest values provided (e.g., six students = approximately 35% of 23).

The only other variable in the upper left-hand region of the Template that requires clarification is Lesson Duration (i.e., cell E10). Lesson Duration is the number of minutes elapsed from the commencement of teaching to the end of the lesson and includes both instructional and non-instructional time. It was calculated after the conclusion of the class from the number of observation cycles recorded. Since each cycle was identified according to the time it started rather than the time it finished, Lesson Duration was calculated as the timing of the last two minute cycle observed plus two minutes. Thus, if the final observation cycle commenced on the 52nd lesson minute (see Template, row 11) then Lesson Duration = 52 + 2 = 54 min.

Division 1: Class Observations

The first behavioral variables to be measured in each cycle were Student Attention and Student Behaviour. The procedures for making these estimates have been described already in Chapter 7, as has the fact that both of these two variables were estimated and recorded a second time once the other observations had been completed. Note, however, that since there was little value in making the final estimate only a few seconds before the commencement of a new cycle, either the 'end' measures of one cycle or the 'start' measures in the next cycle were omitted in instances where less than 10 seconds elapsed between them.

Division 2: Pedagogy

With respect to the Pedagogy division of the SCIOS, all measures therein are binary and no further descriptions of their use are necessary. Only one note needs to be added, that being in regard to Location. In almost all lessons observed, the classroom was the sole instruction location. To reduce unnecessary work, a '>' symbol was placed in the Location row to indicate that all following observation cycles occurred in the same venue. On the sole occasion in this study that the location changed during the course of the lesson, the venue in use was identified in every observation cycle.

Division 3: Sensory Mode Data

For variables in the Sensory Mode Data division, three processes need clarification: a) the assessment of numbers of sensory objects; b) the assessment of object familiarity; and c) the assessment of painful stimuli.

In order to differentiate between the numbers of instructional objects used in a lesson (see Section 7.3.4 for a definition) and the duration for which they were used, the following approach was taken. Each instructional object was identified on the SCIOS with a unique code number as soon as it was presented by the teacher. This code number was recorded for every cycle in which it was used. When a new object was presented, its code replaced the previous one. The SCIOS Summary spreadsheet uses the highest code number entered as the number of objects in that category.

Object familiarity was assessed on a three point scale where ‘1’ = familiar, ‘2’ = unusual, and ‘3’ = bizarre. Since gathering detailed information on individual perceptions of object familiarity was impractical, the assessment of familiarity was by an educated guess on the part of the researcher. This ‘guesstimate’ was based on a combination of the researcher’s own perceptions, his knowledge of the students’ age and experience, and the responses of the students at the time.

While significant physical pain is unlikely to be experienced by students as an educational experience in the course of an ordinary science lesson, it is possible, nevertheless, (e.g., experiencing the discharge from a Van der Graaff generator) and this possibility is accounted for on the SCIOS in the Touch section. Painful tactile sensations would be classified as both intense (on the Intensity scale) and unpleasant (on the Pleasantness scale). No painful events occurred in the lessons measured in the present study, however.

Division 4: Channel Data

The Channel division discriminates stimuli on the basis of their hypothesised ‘channel’ of influence. Some assumptions had to be made in attributing lesson phenomena to each channel, however, and this was especially true in the case of emotional stimuli. To reduce subjectivity, therefore, Emotional Channel measures were assessed in two ways. First, students were observed for any outward signs of emotional responsiveness, such as gasping, laughing, commenting, and so forth. In the absence of such demonstrations, emotional stimuli were assessed on the basis of the teacher’s hypothesised intentions. For instance, if a factual description of cardiac arrest were given in the context of a lesson on the circulatory system, this would have been treated as intellectual input only and would not have been recorded as a Negative Event on the SCIOS. A student whose father had recently suffered from a heart attack, however, might experience emotional distress as a result of this information but no attempt was made to assess highly individualised responses of this kind.

Data Processing and Management

After the conclusion of each lesson, the following procedure was followed for the SCIOS data. First, the teacher-student interaction tallies from the TIF were summed and the results entered into the TIF Table spreadsheet of the SCIOS Workbook. Next, the SCIOS Template was printed out in A3 format and the TIF Table and SCIOS Summary Table worksheets were printed out in A4 format. These three pages were then stapled together and placed in folders containing other documentation from the class in question.

8.3.3 Science Lesson Interest Survey (SLIS)

The SLIS was administered to all volunteering students immediately after the cessation of instruction in each lesson. The students were reminded on each occasion to include their name at the top of the survey. A SLIS form was then distributed to each student and they were given as much time as they wished to complete it. Administration time for a whole class was less than five minutes. No complications arose in connection with the administration of the SLIS but the scoring process deserves brief mention. All SLIS forms were hand scored and the data entered into an Excel spreadsheet for manipulation and analysis. During scoring, it was found that a small number of respondents had provided exactly the same response for all items while others had answered in an unvarying cyclic pattern throughout the whole form. Given that nine SLIS items were reverse scored, it was clear that these students had not responded sincerely; consequently their forms were eliminated from further analysis.

8.3.4 Interest in Science Questionnaire (ISQ)

The ISQ was administered only once, in the introductory lesson of the main study phase. The general approach described above for the administration of the SLIS was also used for the ISQ and, as with that instrument, no difficulties arose in association with its use.

8.3.5 Questionnaire on Teacher Interaction (QTI)

Field work for this study was conducted in the third term of the school year. By that time, most students had been with their respective science teachers for at least six months and had well-developed opinions about them. One teacher, however, had only just taken over his class and it was believed that students could not have developed reliable opinions about him in such a short period. Therefore, the QTI was administered to eight classes at the beginning of the main observation phase but to this ninth class at the end of the study. Although complications arose in the data collected by the QTI (see Section 7.6), no problems were encountered in its administration, nor were special procedures called for. Table 8.2 shows the number of QTIs completed, organised by participating teacher.

Table 8.2: Numbers of lessons and numbers of students contributing data on teacher interaction behavior.

Teacher Id.	Class Id/s	No. Lessons Surveyed	QTIs Completed
Teacher 1	8A & 8G	11	43
Teacher 2	8B & 8D	10	47
Teacher 3	8E	6	24
Teacher 4	8F	5	11
Teacher 5	8H	6	24
Teacher 6	8I	6	24
Teacher 7	8K	6	19

8.4 Methodology Summary

The field work for the present study can be summarised into a preparation phase and a main study phase, each of which can be understood as having two sub-phases.

The preparation phase began with applications for ethical clearance of the project and the solicitation of volunteers. The next phase of preparation was the development of the instruments, a process which involved the construction of instrument prototypes, pilot testing, and instrument refinement and validation.

The main study began with a set of introductory activities, viz.: a reiteration of goals and procedures to all participants, the organisation of an observation timetable, and the administration of both the Interest in Science Questionnaire (ISQ) and the Questionnaire on Teacher Interaction (QTI) to gather student background data. The study proper involved 50 whole-class observations, each consisting of the following elements: completion of the Teacher Interaction Form (TIF), codification of teacher and student behaviours via the Science Classroom Interest Observation Schedule (SCIOS) Template, and administration of the Science Lesson Interest Survey (SLIS) to all pupils.

The data collected by the above procedures was entered into Microsoft Excel for collation and preliminary analysis. More advanced statistical analyses were performed in PASW (formerly SPSS) v.17.

Chapter 9

RESULTS

9.1 Introduction

9.1.1 Overview

This chapter presents the most significant results from the fieldwork, arranged according to themes which emerged during analysis, viz.:

- Academic Involvement and Performance
- Interest vs. Behaviour
- Interest vs. Distraction
- Interest vs. Class Size
- Self-Reported Lesson Experience Variables
- Teaching Strategies – General
- Teaching Strategies – Novelty
- Interest vs. Teacher Interaction Style
- Prior Science Interest

Note that the need themes described in Chapter 5 rarely appear in this chapter since they were not greatly used as measurement parameters. There were a number of reasons for this. First, while needs are considered in the OCI to be essential to the elicitation of interest, they cannot create interest of themselves – a stimulus that might fulfill a need must be present. Second, the main goal of the present study was to identify the actions that elicit interest in science lessons. Thus, the data presented here relate to readily identifiable teacher behaviours and interest-related student responses. An analysis of the data in relation to need themes will be given in Chapter 10, however.

Over 50 variables are discussed below, many of which are closely related to one another in either name or definition or both. To meet the dual objectives of ensuring readability and limiting confusion over terminology, a number of strategies are employed. The first time a variable is mentioned it is fully defined and allocated a short name with each word capitalised. (For instance, students' self-reported prior science interest score is given the name Pupil Prior Interest.) After its first mention, each variable is usually referred to by its short name only. To assist the reader in recognising variables defined earlier, a complete list of all variable names and descriptions is included as Appendix L.

9.1.2 Preliminary Analyses

Preliminary data analysis revealed a number of important overarching data themes. These are outlined here since they inform the later analyses.

Class Size and Lesson Interest

The first such theme pertains to the relationship between class size and lesson interest. A lesson interest score was calculated for each student in each lesson from the Interest scale of the Science Lesson Interest Survey (SLIS); this is referred to as Pupil Lesson Interest. The average interest level for all students in each lesson was then determined, giving the variable Group Lesson Interest. This latter variable was correlated against the number of pupils present (Pupil Number). The results (N=50, r=–0.579, p<0.001) indicated that Pupil Lesson Interest was significantly negatively correlated with class size. The relationship between class size and lesson interest is examined in detail in Section 9.5.2.

Practical Lessons and Video Use

The second theme relates to certain teaching strategies with the potential to disproportionately influence the data. In four of the observed lessons, the teacher screened videos during the final 15 to 20 minutes. Videos score highly on many of the input parameters assessed by the Science Classroom Interest Observation Schedule (SCIOS) including variety (i.e., short-term novelty) and vividness. Further, two lessons involved some laboratory work. Both videos and practical work represent markedly different pedagogies from the 'chalk-and-talk' style of instruction which was the focus of this study. Thus, these six lessons were sometimes removed from the analyses. The 44 ‘chalk-and-talk’ lessons are referred to hereafter as the Ordinary Lessons; the complete set of 50 lessons is referred to as All Lessons.

Prior Interest in Science

The third broad data theme concerns self-reported prior interest in science. This variable – measured using the Interest in Science Questionnaire (ISQ) and labeled Pupil Prior Interest – demonstrated significant correlations with many other variables. It became apparent that science-disinterested students were different in numerous ways and to significant degrees from their higher-interest peers. It was hypothesised that *a priori* interest sub-groups might respond very differently to classroom environment parameters and thus the student cohort was divided into three *a priori* interest strata according to the following method. First, all Pupil Prior Interest scores were standardised [1] using the following formula:

$$Z = (X - \mu) / \sigma$$

Z-score standardising was used on a number of occasions in this study. In the current example, the variables in the equation should be understood as follows:

Z = the student’s standardized Pupil Prior Interest
X = the student’s Pupil Prior Interest (i.e., ISQ score)
μ = the cohort’s Pupil Prior Interest mean
σ = the cohort’s Pupil Prior Interest standard deviation

A Z-score represents the number of standard deviations that a given student is from the cohort mean. In the case of Pupil Prior Interest, students having a Z-score of zero are those who reported a level of prior interest in science exactly equal to the average for the 191-student cohort; students with positive Z-scores reported above average science interest; and students with negative Z-scores reported below average interest. For a standard normal distribution, one third of the population will fall in the region

[1] Z-score standardization requires that the data are distributed normally. Evidence of Pupil Prior Interest normality is provided in Appendix M.

Z≥0.43, one third will fall in the region Z≤–0.43, and one third will lie between these two values. Thus, to stratify the Pupil Prior Interest data, students with Z-scores of 0.43 and above were allocated to the high *a priori* interest stratum, those with Z-scores of – 0.43 and below to the low interest stratum, and the remainder to the mid-interest stratum. The actual numbers of students in each stratum are presented in Table 9.1.

Table 9.1: Numbers of students in each of the three a priori interest strata, as determined from the Interest in Science Questionnaire (ISQ) output variable Pupil Prior Interest.

Number of high prior interest students (Z score ≥0.43)	54
Number of mid prior interest students (Z score <0.43 & >–0.43)	75
Number of low prior interest students (Z score≤ –0.43)	62

Having thus stratified the data, it was possible to calculate statistics within each stratum. Specific findings from these analyses are reported in Section 9.10**.** Note that students in the high *a priori* interest stratum are henceforth referred to simply as High Prior students, those in the middle stratum as Mid Prior students, and so on. This is for the sake of brevity and to avoid confusion with descriptors for lesson event (i.e., situational) interest.

9.2 Academic Involvement and Performance

9.2.1 Introduction

As already discussed in Section 2.1.2, prior interest in a topic is a significant predictor of situational interest and of academic performance. Thus it was hypothesised that students reporting high levels of prior science interest would not only report higher lesson interest generally but also perform better on science-related academic tasks. Similarly, it was predicted that science-interested students would demonstrate better behaviour and greater levels of effort than their less interested peers.

In order to assess these hypotheses, report data for the academic semester preceding the investigation were obtained and compared with results from the Interest in Science Questionnaire (ISQ). The academic reports recorded grades for Achievement, Behaviour, and Effort in each subject the student had undertaken. Achievement grades had been allocated on the basis of marks earned during assessment activities while the Effort and Behaviour grades had been allocated subjectively. All were reported on the scale A to E, with grades of D and E representing failure. Across the cohort it was found that students had participated in a total of 12 subjects during the semester. Only five, however, were common to all, viz.: English, Science, Mathematics, Studies of Society and Environment (SOSE), and Health and Physical Education (HPE). Of these latter, HPE was dropped from further analysis since Achievement results had been allocated partly on the basis of physical – rather than academic – performance. For the remaining four academic subjects, all letter grades were converted to their respective ordinal values: A became 5, B became 4, and so forth. The report data for Science were converted into the variables Science Marks, Science Effort, and Science Behaviour, while results for the three other academic subjects, English, SOSE, and Mathematics were averaged and converted into the variables Non-Science Marks, Non-Science Effort, and Non-Science Behaviour.

9.2.2 Correlations among Report Variables

Correlations among the six report variables are presented in Table 9.2.

Table 9.2: Correlations among the academic report variables Achievement, Effort, and Behaviour for the semester prior to the investigation – individual as unit of analysis.

Variable 1	**Variable 2**	***N***	***r***	***p***
Science Marks	Science Effort	198	0.839	<0.001***
Science Marks	Science Behaviour	198	0.526	<0.001***
Non-Science Marks	Non-Science Effort	196	0.678	<0.001***
Non-Science Marks	Non-Science Behaviour	196	0.518	<0.001***
Science Marks	Non-Science Marks	196	0.632	<0.001***
Science Behaviour	Non-Science Behaviour	197	0.753	<0.001***
Science Effort	Non-Science Effort	197	0.693	<0.001***

$^*p<0.05$, $^{**}p<0.01$, $^{***}p<0.001$

The first significant result here is that Achievement grades were highly correlated with their respective Effort and Behaviour grades. Given the subjective methods used to allocate Effort and Behaviour, it seems likely that they do not, in fact, represent entirely independent aspects of student academic involvement. Thus, Achievement is used as the primary measure of academic performance hereafter. The second significant result is that grades in Science were found to be highly correlated with those in other academic subjects. This suggests that students who perform well in Science demonstrate a general academic aptitude. This result informs the next analysis.

9.2.3 Report Variables vs. Prior Science Interest

To examine the relationship between prior science interest and general academic performance, Achievement scores in each subject were correlated against Pupil Prior Interest values for each student. These results are presented in Table 9.3.

Table 9.3: Correlations between prior science interest (Pupil Prior Interest) and Achievement ratings in four subjects: Science, English, Mathematics, and Studies of Society and Environment (SOSE) – individual as unit of analysis.

Variable 1	Variable 2	*N*	*r*	*p*
Pupil Prior Interest	Science Marks	191	0.227	0.002**
Pupil Prior Interest	English Marks	193	0.203	0.005**
Pupil Prior Interest	Maths Marks	192	0.257	<0.001***
Pupil Prior Interest	SOSE Marks	193	0.248	0.001**

$^{*}p<0.05$, $^{**}p<0.01$, $^{***}p<0.001$

All subject Achievement scores, including English, exhibited highly significant positive correlations with prior science interest levels. Behaviour and Effort grades were then correlated against Pupil Prior Interest for each of the students in the study. These results are presented in Table 9.4.

Table 9.4: Correlations between Pupil Prior Interest and Behaviour and Effort ratings in both Science and Non-Science subjects – individual as unit of analysis.

Variable 1	**Variable 2**	***N***	***r***	***p***
Pupil Prior Interest	Science Behaviour	191	0.197	0.006**
Pupil Prior Interest	Non-Science Behaviour	191	0.287	<0.001***
Pupil Prior Interest	Science Effort	191	0.235	0.001**
Pupil Prior Interest	Non-Science Effort	191	0.267	<0.001***

$^*p<0.05$, $^{**}p<0.01$, $^{***}p<0.001$

Bearing in mind that the Behaviour and Effort scores were subjectively assessed, these results indicate that students' prior science interest levels were predictive of their classroom behaviour, their levels of application in all academic classes, and their overall scholastic performance. That prior science interest correlates with performance in Science classes is in accord with the findings of many earlier studies. That prior science interest is significantly correlated with performance and behaviour in other major academic subjects, including English, suggests a much broader conclusion – that science interest is indicative of general scholastic inclination.

9.2.4 Prior Science Interest vs. Situational Lesson Experience

For each student in each lesson, self-reported lesson interest (Pupil Lesson Interest) was standardised by the Z-score formula given in Section 9.1.2. This generated the variable, Pupil Lesson Interest Z, representing the relative interest level of the individual in a given lesson. A positive Pupil Lesson Interest Z value indicated that the student reported more situational interest than the class average for that lesson, while a negative Pupil Lesson Interest Z value indicated that the student reported lower lesson interest than the average. The individual lesson interest Z-scores were then averaged for each student across all the classes in which they had participated. This yielded a new variable, Pupil Lesson Interest Z Avg., representing the student's overall interest in science lesson experiences relative to his or her peers. Equivalent Z-score averages (i.e., Pupil Lesson Novelty Z Avg. and Pupil Lesson Difficulty Z Avg.) were generated for two other self-reported lesson variables, perceived lesson Novelty and perceived lesson Difficulty.

It is well recognised that persons having a long-standing interest in a topic will experience higher levels of situational interest when presented with stimuli related to that topic than will persons not having such prior interest. Thus, it was hypothesised that Pupil Lesson Interest Z Avg. would exhibit a significant positive correlation with Pupil Prior Interest. No such correlations were predicted for Pupil Lesson Novelty Z Avg. or Pupil Lesson Difficulty Z Avg. The results of these analyses are presented in Table 9.5.

Table 9.5: Correlations between Pupil Prior Interest and Pupil Lesson Interest Z Avg., Pupil Lesson Novelty Z Avg., and Pupil Lesson Difficulty Z Avg. respectively – individual as unit of analysis.

Variable 1	**Variable 2**	***N***	***r***	***p***
Pupil Prior Interest	Pupil Lesson Interest Z. Avg.	191	0.401	<0.001***
Pupil Prior Interest	Pupil Lesson Novelty Z Avg.	191	0.040	0.582
Pupil Prior Interest	Pupil Lesson Difficulty Z Avg.	191	-0.139	0.055

*$p<0.05$, **$p<0.01$, ***$p<0.001$

As anticipated, a highly significant positive association was found between Pupil Lesson Interest Z Avg. and Pupil Prior Interest. This result agrees with the findings of previous research. Pupil Lesson Novelty Z Avg. demonstrated no significant correlation with Pupil Prior Interest, a finding also in accordance with expectations. For Pupil Lesson Difficulty Z Avg., however, the results were ambivalent, bordering on significance at p=0.055. Although not statistically robust, this relationship – that students recording higher prior interest reported lower perceived Difficulty – is in harmony with the earlier finding that prior science interest is indicative of general scholastic aptitude.

9.3 Interest vs. Behaviour

9.3.1 Introduction

In an attempt to corroborate student self-report data with external observations, average student lesson interest (Group Lesson Interest) was correlated against a number of parameters derived from the Science Classroom Interest Observation Schedule (SCIOS). Abbreviations for and descriptions of these variables are provided in Table 9.6. All have plausible theoretical relationships with lesson interest, as discussed in Chapter 7.

Table 9.6: Full descriptions of and abbreviations for potential lesson interest correlates on the Science Classroom Interest Observation Schedule (SCIOS).

Abbreviation	Parameter Description
Attention Avg.	Average percentage of students attending to intended lesson tasks
Attention Max.	Maximum percentage of students attending to intended lesson tasks
Behaviour Avg.	Average behaviour level throughout entire lesson (low scores = better behaviour)
Student Questions 1	Percentage of students asking the teacher one or more content-related questions
Student Questions 2	Percentage of students asking the teacher two or more content-related questions
Correction Number	Number of correction events by teacher during the lesson
Correction Level Avg.	Average intensity of correction events by teacher
Correction Level Max.	Maximum intensity of correction events by teacher

Correlations between the observer-rated parameters in Table 9.6 and Group Lesson Interest are presented in Table 9.7, below.

Table 9.7: Correlations between Group Lesson Interest and eight externally observable, whole-class interest correlates derived from the Science Interest Observation Schedule (SCIOS) – class as unit of analysis, all lesson conditions.

Variable 1	Variable 2	*N*	*r*	*p*
Group Lesson Interest	Attention Avg.	50	0.539	<0.001***
Group Lesson Interest	Attention Max.	50	0.380	0.006**
Group Lesson Interest	Behaviour Avg.	50	-0.363	0.010**
Group Lesson Interest	Student Questions 1	50	-0.140	0.331
Group Lesson Interest	Student Questions 2	50	-0.240	0.093
Group Lesson Interest	Correction Number	50	-0.282	0.047*
Group Lesson Interest	Correction Level Avg.	50	-0.415	0.003**
Group Lesson Interest	Correction Level Max.	50	-0.296	0.037*

*$p<0.05$, **$p<0.01$, ***$p<0.001$

Of the eight variables analysed, all but two – Student Questions 1 and Student Questions 2 – demonstrated significant correlations with Group Lesson Interest. The best correlate with Group Lesson Interest, however, was average attention to the intended instructional tasks (Attention Avg.). A number of the above relationships are discussed below.

9.3.2 Student Interest vs. Student Attention

As is apparent from Table 9.7, Group Lesson Interest demonstrated a highly significant positive correlation with Attention Avg. when all 50 classes were included in the analysis. When this correlation was re-examined for the more conservative Ordinary Lesson data only, the relationship remained highly significant (N=44, r=0.518, p<0.001). These results indicate that student attention can be used as a simple and meaningful index of student interest by classroom teachers and researchers.

9.3.3 Student Interest vs. Teacher Corrections

Table 9.7 shows that all correction measures – Correction Number, Correction Level Avg., and Correction Level Max. – demonstrated significant negative associations with Group Lesson Interest. These results are in accordance with the prediction that higher interest will result in better behaviour and thus in a diminished need for teacher intervention. This hypothesis is further supported by a significant positive correlation between Behaviour Avg. and Correction Number (N=50, r=0.326, p=0.021). When the results for Correction Number were stratified by prior interest level, however, an unexpected detail was revealed (see Table 9.8, below).

The negative relationship between Group Lesson Interest and Correction Number was found to be insignificant for High Prior and Mid Prior students, but significant at p<0.01 for Low Prior students. Several reasons for these results may be postulated. It must be noted, however, that these data give no indication of the mechanisms by which student interest interacted with teacher corrections. Did bored students act up more significantly, prompting greater teacher intervention? Did a more punitive teaching style diminish student interest in the lessons? Were both factors at work simultaneously? Or is there another factor involved? Whatever the answer, the association between Group Lesson Interest and Correction Number suggest that Low Prior students were more sensitive to their classrooms' interest environment.

Table 9.8: Correlations between Group Lesson Interest and Correction Number for the combined data and the three prior interest levels – class as unit of analysis, all lesson conditions.

Variable 1	Variable 2	*N*	*r*	*p*
Combined data:				
Group Lesson Interest	Correction Number	50	-0.282	0.047*
High Prior Interest students:				
Group Lesson Interest	Correction Number	50	-0.140	0.332
Mid Prior Interest students:				
Group Lesson Interest	Correction Number	50	-0.259	0.069
Low Prior Interest students:				
Group Lesson Interest	Correction Number	45	-0.408	0.005**

*$p<0.05$, **$p<0.01$, ***$p<0.001$

9.3.4 Student Interest vs. Student Questioning

The third class of SCIOS variables to return significant correlations with Group Lesson Interest was that relating to student-initiated questions. Each time a student volunteered a question related to lesson content, a mark was recorded on the Teacher Interaction Form (see Section 8.3.1 for procedures). Since the Form identified each student's seating location, the total number of questions volunteered by each student could be determined. The data from each class were analysed to determine the percentage of students that had volunteered one or more content-related questions. This result became the variable Student Questions 1. Also calculated were the number of students who had asked two or more questions (Student Questions 2), four or more questions (Student Questions 4), and six or more questions (Student Questions 6). It was hypothesised that as students' interest increased, the number of questions they volunteered would increase as well.

Ultimately, only eight of the 50 surveyed classes had students who asked four or more questions and only four classes had students who asked six or more. Consequently, the variables Student Questions 4 and Student Questions 6 were eliminated from further analysis. The remaining variables, Student Questions 1 and Student Questions 2 were correlated against Group Lesson Interest yielding correlation coefficients of –0.140 and –0.240 respectively (see Table 9.7). In neither case was a significant relationship detected until the results were examined by prior interest level. The stratified results are presented in Table 9.9.

Table 9.9: Correlations between Group Lesson Interest and Student Questions 1 and Student Questions 2 for all three prior interest levels – class as unit of analysis, all lesson conditions.

Variable 1	**Variable 2**	***N***	***r***	***p***
High Prior Interest students:				
Group Lesson Interest	Student Questions 1	50	-0.039	0.786
	Student Questions 2	50	-0.162	0.260
Mid Prior Interest students:				
Group Lesson Interest	Student Questions 1	50	-0.147	0.310
	Student Questions 2	50	-0.148	0.305
Low Prior Interest students:				
Group Lesson Interest	Student Questions 1	45	-0.348	0.019*
	Student Questions 2	45	-0.354	0.017*

$^{*}p<0.05$, $^{**}p<0.01$, $^{***}p<0.001$

The first noteworthy feature of these results is that the associations are all negative – that is, the percentage of students volunteering content-related questions tended to diminish as lesson interest improved. This result is not statistically significant for most of the data, but deserves mention since the trend is consistent, achieves significance for one of the prior interest levels, and is counter-intuitive. The second interesting feature is that significant correlations existed only for the Low Prior group. Since the identity of questioning students was not tracked, this result does not imply that it was Low Prior students who were asking more questions. A more plausible explanation is that the less science-interested students were simply more sensitive in detecting and reporting the interest climate of the lesson. For more on the matter of interest sensitivity, see Section 9.10.2.

9.4 Interest vs. Distraction

9.4.1 Introduction

Interest and attention influence one another in various ways, as described in Sections 2.1.2, 4.2.1, and 5.4.1. It was hypothesised that lesson interest would be diminished where distractions interfered with students' attention to lesson stimuli. This prediction was investigated by gathering both observer-rating and student-report data on distraction variables and correlating these with student interest and behaviour parameters. Externally-observable distracting events were recorded on the SCIOS in the manner described in Section 7.3.4. From this raw data, two summary variables were generated: Disturbance Time (i.e., the time, in minutes, during which external disturbances occurred during the lesson) and Disturbance Max. (i.e., the maximum intensity of external disturbances occurring during the lesson as assessed on a subjective scale of 0 to 3). Maxima, minima, and average values for the variables Disturbance Time and Disturbance Max. are presented in Table 9.10.

Table 9.10: Summary statistics for two externally observed, class level distraction variables, Disturbance Time and Disturbance Max.

Variable	Unit	Min.	Max.	Avg.
Disturbance Time	minutes	0	30	4.8
Disturbance Max.	index	0	3	1.1

Although some classes experienced high levels of external disturbance and some experienced disturbances during as many as 30 minutes of class time, on average the degree of objectively detectable disturbance was insignificant in both duration and intensity.

Students' subjective experiences of distraction were reported on the Science Lesson Interest Survey (SLIS). Students responded to items regarding the following potential distractors: hunger, personal thoughts, temperature, illness, other students, and physical pain. Each distractor was treated as independent of the others and thus, rather than averaging the item scores, they were summed to give a total distraction score for each student in each lesson – Pupil Lesson Distractions. Individual distraction scores were then averaged for all students in each class, yielding a class-level distraction variable, Group Lesson Distractions. A second class-level variable, Total Distraction Reports, was calculated as the number of students who reported any distractions originating from the behaviour of other students. A related class-level variable, High Distraction Reports, was also derived – this being the number of students who reported high levels of distraction from other students.

9.4.2 Student-Reported Distractions vs. Observer-Rated Disturbance

To determine whether there were any associations between observer-rated disturbances and student-reported distractions, the Group Lesson Distractions values were correlated against the observer-rated disturbance measures Disturbance Time and Disturbance Max. for all 50 lessons. The results are presented in Table 9.11, below.

Table 9.11: Correlations between Group Lesson Distractions and two objective disturbance measures: Disturbance Time and Disturbance Max. – class as unit of analysis, all lesson conditions.

Variable 1	**Variable 2**	***N***	***r***	***p***
Group Lesson Distractions	Disturbance Time	50	-0.126	0.385
Group Lesson Distractions	Disturbance Max.	50	-0.223	0.120

*$p<0.05$, **$p<0.01$, ***$p<0.001$

No significant correlations were found between the objective disturbance measures and the subjective distraction scores. It is apparent from these data that the observer ratings were not useful as measures of student distraction experiences. The pairs of variables correlated in Table 9.11 share little commonality in the phenomena they assess, however, so it is unsurprising that associations were not detected. A relationship was anticipated, however, between distractions caused by other students and observer-rated classroom behaviour. Consequently, Total Distraction Reports and High Distraction Reports were correlated against four SCIOS-derived student behaviour variables: average lesson behaviour (Behaviour Avg.), worst lesson behaviour (Behaviour Max.), average intensity of teacher corrections (Correction Level Avg.), and number of teacher corrections (Correction Number). These data are presented in Table 9.12.

Table 9.12: Correlations between the student-reported distraction variables, Total Distraction Reports and High Distraction Reports, and four external measures of student behaviour: Behaviour Avg., Behaviour Max., Correction Level Avg., and Correction Number – class as unit of analysis, all lesson conditions.

Variable 1	**Variable 2**	***N***	***r***	***p***
Total Distraction Reports	Behaviour Avg.	50	0.561	<0.001***
Total Distraction Reports	Behaviour Max.	50	0.246	0.085
Total Distraction Reports	Correction Level Avg.	50	0.168	0.244
Total Distraction Reports	Correction Number	50	0.512	<0.001***
High Distraction Reports	Behaviour Avg.	50	0.282	0.047*
High Distraction Reports	Behaviour Max.	50	-0.006	0.969
High Distraction Reports	Correction Level Avg.	50	-0.119	0.410
High Distraction Reports	Correction Number	50	0.430	0.002**

*p<0.05, **p<0.01, ***p<0.001

Two of the SCIOS behaviour measures – Behaviour Avg., and Correction Number – exhibited significant positive relationships with both of the student-reported distraction variables. Of these latter, however, Total Distraction Reports demonstrated the strongest relationships.

9.4.3 Lesson Distractions vs. Lesson Interest

It was hypothesised that student lesson interest would be negatively correlated with lesson distractions. This prediction was examined by correlating Group Lesson Interest against the student-reported distraction measures and the observer-rated disturbance measures. These data are presented in Table 9.13.

Table 9.13: Correlations between Group Lesson Interest and four distraction/ disturbance measures: Disturbance Time, Disturbance Max., Group Lesson Distractions, and Total Distraction Reports – class as unit of analysis, all lesson conditions.

Variable 1	Variable 2	*N*	*r*	*p*
Group Lesson Interest	Disturbance Time	50	0.220	0.125
Group Lesson Interest	Disturbance Max.	50	0.283	0.047*
Group Lesson Interest	Group Lesson Distractions	50	-0.500	<0.001***
Group Lesson Interest	Total Distraction Reports	50	-0.492	<0.001***

*$p<0.05$, **$p<0.01$, ***$p<0.001$

Group Lesson Interest showed negative correlations with the student-reported distraction variables Group Lesson Distractions and Total Distraction Reports, significant at $p<0.001$ in both instances. In addition, a modestly significant positive correlation was found between Group Lesson Interest and the observer-rated disturbance variable Disturbance Max. The latter is a peculiar result for which no explanation is immediately apparent.

As noted earlier, it was hypothesised that distractions would reduce lesson interest by interfering with students' attention to lesson stimuli. This hypothesis is supported by the data in Table 9.13. There is an alternative explanation for these data, however. Rather than distractions interfering with interest, it may be that the students with low prior interest in science (i.e., students from the Low Prior stratum) were more readily distractible than those from the High Prior stratum. If this were true, Low Prior students would report simultaneous – yet non-causal – low lesson interest and high distraction, resulting in the reported correlations. To examine this possibility, individual Pupil Lesson Distractions scores were standardised for each lesson; these values were then averaged across all lessons that the student had participated in, yielding the variable Pupil Lesson Distractions Z Avg. – the average level of distraction reported by a given student relative to his or her classmates. Negative values for Pupil Lesson Distractions Z Avg. indicate that the student generally reported low levels of classroom distraction, while positive values indicate relatively high levels of reported distraction. This variable was then correlated against each student's prior science interest score (Pupil Prior Interest). The results (N=191, r=–

0.198, p=0.006) indicated that the lower a student's prior interest in science, the more distractions they were prone to perceive. This result supports the hypothesis that Low Prior students are more easily distracted than High Prior students. Such a finding does not necessarily imply, however, that distractions had no causal impact on student lesson interest. Thus, the interest/distraction relationship was analysed again, but controlling for the effect of Pupil Prior Interest. Analyses were performed with both the class and the individual as units of analysis, as presented in Table 9.14.

Table 9.14: Correlations between situational/lesson interest variables (Pupil Lesson Interest and Group Lesson Interest), and Student-perceived distraction variables (Pupil Lesson Distractions and Group Lesson Distractions), controlling for prior interest level (Pupil Prior Interest and Group Prior Interest respectively) – individual and class as units of analysis, all lesson conditions.

Variable 1	Variable 2	*N*	*r*	*p*
Pupil Lesson Interest	Pupil Lesson Distractions	893	-0.359	<0.001***
Group Lesson Interest	Group Lesson Distractions	50	-0.480	<0.001***

*p<0.05, **p<0.01, ***p<0.001

Even after controlling for the influence of prior student interest, student distraction levels continued to demonstrate highly significant negative correlations with self-reported lesson interest. This effect held true whether the unit of analysis was the class or the individual student. These data support the hypothesis that distractions interfere with student interest in lesson experiences.

9.4.4 Lesson Distractions vs. Class Size

Teachers and researchers alike are well aware of the inverse relationship between class size and lesson experience quality. Although this relationship is the consequence of many factors, one such factor may be an increase in student-student interactions as the class population increases. Table 9.15 presents correlation data for the relationship between Pupil Number and two student-report measures of classroom distraction: Group Lesson Distractions and Total Distraction Reports.

Table 9.15: Correlations between Pupil Number and two student-reported measures of distraction: Group Lesson Distractions and Total Distraction Reports – class as unit of analysis, all lesson conditions.

Variable 1	**Variable 2**	***N***	***r***	***p***
Pupil Number	Group Lesson Distractions	50	0.222	0.122
Pupil Number	Total Distraction Reports	50	0.476	<0.001***

*$p<0.05$, **$p<0.01$, ***$p<0.001$

No significant relationship was found between class size and average distraction scores (i.e., Group Lesson Distractions). On the other hand, a highly significant positive association was found between class size and the number of students reporting distractions by other students. Whether this latter result is solely the consequence of increased student-student interactions or whether some other mechanism is responsible cannot be confirmed at this point, however. The issue of class size is treated in more depth in the next section.

9.5 Interest vs. Class Size

9.5.1 Introduction

As already noted, class size is widely known to be inversely proportional to instructional effectiveness. Thus, it was hypothesised that class size would be negatively correlated with student interest and, when analysed, a significant relationship of this nature was found (see Section 9.1.2). Section 9.5.2 investigates this association more thoroughly, while Sections 9.5.3 and 9.5.4 examine other implications of class size.

9.5.2 Class Size vs. Student Interest

Group Lesson Interest was correlated against Pupil Number and a highly significant negative relationship was found (N=50, r=–0.579, p<0.001), in accordance with expectations. The sensitivity of this relationship to class size was then examined using two methods. The first method sought to determine the minimum class size at which the size vs. interest relationship appeared. This was achieved by first performing the above analysis on data from classes of all sizes including the largest – that is classes with 27 pupils – then performing it a second time but using a maximum class size of 26 pupils, and then again with a maximum of 25, and so forth. The results of this procedure are presented in Table 9.16. The second method sought to determine whether there was a maximum class size beyond which the size vs. interest relationship ceased to apply. This latter method was simply the reverse of the former, also involving a systematic elimination of classes from the analysis but starting with the smallest first. The results of this second approach are presented in Table 9.17.

Commencement of the Class Size vs. Student Interest Relationship

Table 9.16: Correlations between Pupil Number and Group Lesson Interest for a range of class size maxima, with the largest classes removed from analysis first – class as unit of analysis, all lesson conditions.

Variable 1	**Variable 2**	***N***	***r***	***p***
Pupil Number (max = 27)	Group Lesson Interest	50	-0.579	<0.001***
Pupil Number (max = 26)	Group Lesson Interest	49	-0.573	<0.001***
Pupil Number (max = 25)	Group Lesson Interest	43	-0.574	<0.001***
Pupil Number (max = 24)	Group Lesson Interest	40	-0.573	<0.001***
Pupil Number (max = 23)	Group Lesson Interest	33	-0.438	0.011*
Pupil Number (max = 22)	Group Lesson Interest	31	-0.436	0.014*
Pupil Number (max = 21)	Group Lesson Interest	29	-0.408	0.028*
Pupil Number (max = 20)	Group Lesson Interest	23	-0.543	0.007**
Pupil Number (max = 19)	Group Lesson Interest	17	-0.683	0.003**
Pupil Number (max = 18)	Group Lesson Interest	12	-0.597	0.040*
Pupil Number (max = 17)	Group Lesson Interest	10	-0.440	0.203
Pupil Number (max = 16)	Group Lesson Interest	7	-0.245	0.597

*$p<0.05$, **$p<0.01$, ***$p<0.001$

With the progressive removal of the largest classes from consideration, the negative relationship between class size and lesson interest remained significant until the class size dropped under 18 pupils. Below this value, the class size vs. interest relationship continued to be negative but ceased to be statistically significant.

Extinction of the Class Size vs. Student Interest Relationship

Table 9.17: Correlations between Pupil Number and Group Lesson Interest for a range of class size maxima, with the smallest classes removed from analysis first – class as unit of analysis, all lesson conditions.

Variable 1	**Variable 2**	***N***	***r***	***p***
Pupil Number (min = 9)	Group Lesson Interest	50	-0.579	<0.001***
Pupil Number (min = 10)	Group Lesson Interest	49	-0.577	<0.001***
Pupil Number (min = 11)	Group Lesson Interest	48	-0.514	<0.001***
Pupil Number (min = 12)	Group Lesson Interest	47	-0.513	<0.001***
Pupil Number (min = 13)	Group Lesson Interest	46	-0.469	0.001**
Pupil Number (min = 16)	Group Lesson Interest	45	-0.460	0.001**
Pupil Number (min = 17)	Group Lesson Interest	43	-0.396	0.009**
Pupil Number (min = 18)	Group Lesson Interest	40	-0.328	0.039*
Pupil Number (min = 19)	Group Lesson Interest	38	-0.379	0.019*
Pupil Number (min = 20)	Group Lesson Interest	33	-0.483	0.004**
Pupil Number (min = 21)	Group Lesson Interest	27	-0.352	0.071
Pupil Number (min = 22)	Group Lesson Interest	21	-0.050	0.829
Pupil Number (min = 23)	Group Lesson Interest	19	0.075	0.761

*$p<0.05$, **$p<0.01$, ***$p<0.001$

When the smallest classes were removed from the analysis first, the relationship between Group Lesson Interest and Pupil Number remained significant up to the point where the minimum class size was 20 pupils. Beyond this, the class size vs. interest relationship terminated quite abruptly. For classes of 22 students or more, no trend was detectable.

Class Size vs. Student Interest by Prior Interest Stratum

In a separate analysis of the class size vs. interest relationship, all class results were first stratified by prior interest level. For this procedure, Group Lesson Interest values were recomputed for each class using data from only those students in each specified prior interest stratum. Thus, three values for Group Lesson Interest were generated for each lesson, each of which was separately entered into the correlation calculation with Pupil Number. The results are presented in Table 9.18, below.

Table 9.18: Correlations between Group Lesson Interest and Pupil Number for combined data and the three prior interest levels – class as unit of analysis, all lesson conditions.

Variable 1	Variable 2	*N*	*r*	*p*
Combined data:				
Group Lesson Interest	Pupil Number	50	-0.579	<0.001***
High Prior Interest students:				
Group Lesson Interest	Pupil Number	50	-0.432	0.002**
Mid Prior Interest students:				
Group Lesson Interest	Pupil Number	50	-0.572	<0.001***
Low Prior Interest students:				
Group Lesson Interest	Pupil Number	45	-0.278	0.064

*$p<0.05$, **$p<0.01$, ***$p<0.001$

The results in Table 9.18 indicate a distinction between Low Prior students and other pupils. For Low Prior students, there was no significant relationship between the size of the class they were in and their level of interest. On the other hand, the class size vs. interest relationship was significant at $p<0.01$ for both of the higher prior interest categories. Thus, students who were *a priori* interested in science experienced more dramatic interest attenuation as a result of increasing class size than did their less science-interested fellows.

9.5.3 Interest Correlates and Class Size Stratum

Prompted by the preceding results, it was hypothesised that certain interest relationships that pertain to classes with relatively few pupils may not hold true for classes with many pupils, and vice versa. To investigate this, two class-size sub-groups were identified on the basis of pupil numbers. The large class size sub-group comprised classes with at least 22 students. This limit was chosen on the basis of the results presented in Table 9.17 (above) wherein class size showed no association at all with student interest for classes of 22 pupils or more. The small class size sub-group comprised those classes having a maximum of 20 students. This lower ceiling of 20 pupils was chosen to allot roughly equal class numbers to each stratum and to omit the transition condition of classes with 21 students. In the second phase of the analysis, correlations between selected classroom environment variables and selected interest variables were calculated, initially for all classes combined and then for the large and small classes separately.

For most of the variables analysed in the manner described, significant associations that were detected for the data as a whole were also found to hold true when the class size distinction was made. All such instances have been reported elsewhere under the relevant topic headings. For one variable, however, student lesson interest showed a highly significant correlation for only one of the class size sub-groups. Table 9.19, below, provides results for the relationship between Group Lesson Interest and Emotion Mode Number for the two sub-groups. (Emotion Mode Number represents the number of types of emotion-based instructional strategy used by the teacher; it is explained in detail in Section 7.3.4.)

Table 9.19: Correlations between Group Lesson Interest and Emotion Mode Number for all data and for the large and small class size groups separately – class as unit of analysis.

Variable 1	Variable 2	*N*	*r*	*p*
Combined data:				
Group Lesson Interest	Emotion Mode Number	50	0.226	0.115
Large classes (Pupil Number > 21):				
Group Lesson Interest	Emotion Mode Number	21[1]	0.609	0.003**
Small classes (Pupil Number < 21):				
Group Lesson Interest	Emotion Mode Number	23[1]	-0.374	0.079

*$p<0.05$, **$p<0.01$, ***$p<0.001$

[1] The six classes having exactly 21 students have been omitted from these analyses.

Although no significant correlation between lesson interest and Emotion Mode Number was detected for the data set as a whole, a highly significant association was found for the large classes (N=21, r=0.609, p=0.003). This finding is in clear contrast to the results for the small class stratum, for which the association (N=23, r=–0.374, p=0.079) is not only insignificant but negative in direction.

9.5.4 Other Class Size Correlates

In addition to the class size correlates examined above, two other variables demonstrated highly significant correlations with class size: average number of students reporting distractions from other students (Total Distraction Reports) and percentage of students with whom the teacher interacted on content matters (Teacher Interaction Level). The first of these relationships has already been covered in Section 9.4.4; the latter will be treated in more detail in Section 9.7.2.

9.6 Self-Reported Lesson Experience Variables

9.6.1 Introduction

The Science Lesson Interest Survey (SLIS) gathered student self-report data on lesson interestingness, novelty, and difficulty. Individual student scores for each of these scales became the variables Pupil Lesson Interest, Pupil Lesson Novelty, and Pupil Lesson Difficulty respectively. On the basis of prior research it was hypothesised that interest would show a significant positive correlation with novelty. Interest vs. difficulty and novelty vs. difficulty were not expected to exhibit significant associations due to the complexity of their interactions. Correlations among these three variables are given in Table 9.20.

Table 9.20: Correlations among three lesson self-report variables: Pupil Lesson Interest, Pupil Lesson Novelty, and Pupil Lesson Difficulty – individual as unit of analysis, all lesson conditions.

Variable 1	**Variable 2**	***N***	***r***	***p***
Pupil Lesson Interest	Pupil Lesson Novelty	893	0.332	<0.001***
Pupil Lesson Novelty	Pupil Lesson Difficulty	893	0.300	<0.001***
Pupil Lesson Interest	Pupil Lesson Difficulty	893	-0.080	0.017*

*$p<0.05$, **$p<0.01$, ***$p<0.001$

9.6.2 Interest vs. Novelty

Table 9.20 shows that Pupil Lesson Interest showed a significant positive correlation with Pupil Lesson Novelty ($p<0.001$). This result is in accord with the findings of earlier research and is unsurprising given that that factor analysis of SLIS survey responses found that three of the Novelty scale items loaded significantly on the Interest scale. Implications of these results are discussed in Section 10.3.3

9.6.3 Novelty vs. Difficulty

The discovery of a significant positive correlation ($p<0.001$) between Pupil Lesson Novelty and Pupil Lesson Difficulty confounded expectations. The most plausible explanation for this result is that new information presents a cognitive challenge to students.

9.6.4 Interest vs. Difficulty

Also contrary to expectation, Pupil Lesson Interest and Pupil Lesson Difficulty were found to be significantly but negatively correlated. The effect size was small ($r=-0.080$), however, and the relationship was therefore re-examined to determine whether any of the prior interest strata had contributed disproportionately to the overall result. The stratified correlation data are presented in Table 9.21.

No significant correlations were demonstrated between perceived lesson interest and difficulty for Mid Prior and High Prior students. The small negative correlation apparent in the combined data was revealed to originate with students who had reported low *a priori* interest in science. Given that prior science interest is correlated with academic aptitude (see Section 9.2.3) and that interest is promoted by optimal challenge (see Section 5.4.3) these data suggest that the cognitive demands of the lessons surveyed were generally beyond the optimal level for the low prior interest (i.e., least able) students.

Table 9.21: Correlations between Pupil Lesson Interest and Pupil Lesson Difficulty for combined data and the three prior interest levels – individual as unit of analysis, all lesson conditions.

Variable 1	Variable 2	*N*	*r*	*p*
Combined data:				
Pupil Lesson Interest	Pupil Lesson Difficulty	893	-0.080	0.017*
High Prior Interest students:				
Pupil Lesson Interest	Pupil Lesson Difficulty	260	0.066	0.292
Mid Prior Interest students:				
Pupil Lesson Interest	Pupil Lesson Difficulty	351	-0.049	0.363
Low Prior Interest students:				
Pupil Lesson Interest	Pupil Lesson Difficulty	282	-0.198	0.001**

*$p<0.05$, **$p<0.01$, ***$p<0.001$

9.6.5 Interest vs. Distractions

Six items regarding lesson distraction experiences were included on the SLIS. The results of this aspect of the study have already been treated in Section 9.4.3.

9.7 Teaching Strategies – General

9.7.1 Introduction

This section begins to address the central question of the study: What is it that teachers do that makes science classes interesting? A number of preliminary comments are necessary before the results are presented. First, no attempt has been made to examine the cognitive processes employed by teachers in the design or administration of lessons. The results that follow pertain only to external lesson event phenomena rather than 'strategies' in the strict sense of the word. Second, a sizeable number of the most noteworthy teaching strategy results relate to lesson novelty. Since there are so many of these, they have been included in a separate section. Third, in the following analyses the value for *N* is not consistent. This is due to the fact that video lessons were sometimes removed from the analysis (for the reasons outlined in Section 9.1.2) or because certain classes did not have representatives of a particular prior interest stratum.

9.7.2 Teacher Involvement with Students

During the lesson observations, a tally mark was recorded on the Teacher Interaction Form each time the teacher had an instructive interaction with a specific student that was emotionally positive in tone (see Section 8.3.1 for further details). Since the Form identified each student's seating location, the percentage of students involved in this way throughout the lesson could be calculated. This involvement percentage became the variable Teacher Interaction Level. Correlation data for the relationship between this variable and Group Lesson Interest are given in Table 9.22. It was hypothesised that the two variables would show significant positive correlations.

Table 9.22: Correlations between Group Lesson Interest and Teacher Interaction Level for combined data and the three prior interest levels – class as unit of analysis, all lesson conditions.

Variable 1	Variable 2	*N*	*r*	*p*
Combined data:				
Group Lesson Interest	Teacher Interaction Level	50	0.343	0.015*
High Prior Interest students:				
Group Lesson Interest	Teacher Interaction Level	50	0.407	0.003**
Mid Prior Interest students:				
Group Lesson Interest	Teacher Interaction Level	50	0.341	0.016*
Low Prior Interest students:				
Group Lesson Interest	Teacher Interaction Level	45	0.071	0.644

*$p<0.05$, **$p<0.01$, ***$p<0.001$

The combined results confirm the predicted relationship between lesson interest and levels of teacher interaction. When the data were analysed according to prior interest level, however, a distinct pattern emerged. The strength of the correlation between lesson interest and teacher interaction diminished from a highly significant correlation – for the High Prior group – to no correlation for the Low Prior group.

Teacher Interaction Level was then correlated against Pupil Number for all observed lessons. The results (N=50, r=–0.477, p<0.001) show that the proportion of the class experiencing individual attention by the teacher diminished significantly as class size grew. This factor may be significant in explaining the inverse relationship between class size and lesson interest.

9.7.3 Vividness – Colour Intensity

Stimulus vividness has been identified by previous researchers as a significant elicitor of interest. Thus, a range of measures were included in the SCIOS to assess the vividness/intensity of sensory phenomena (see Section 7.3.4 for details). For visual stimuli, vividness variables were divided into two categories. The first category assessed vividness according to the number of colours used in presentations or instructional materials. Two variables were generated: average colour vividness, (Colour Variety Avg.) and maximum colour vividness (Colour Variety Max.). The second category assessed the complexity of movement of any mobile demonstration objects. Again, two variables were generated: average movement complexity (Movement Complexity Avg.), and maximum movement complexity (Movement Complexity Max.). Aural vividness/intensity was not assessed. Tactile, olfactory, and gustatory vividness, although allocated measurement scales, did not yield sufficient data for analysis. Of the four visual vividness variables, only Colour Variety Max. demonstrated significant correlations with student lesson interest. The pertinent results are presented in Table 9.23.

In accordance with theoretical principles, the combined student data shows that Group Lesson Interest was significantly positively correlated with the maximum colour vividness (i.e., variety) of visual stimuli used during lessons. When the data was stratified by prior interest level, however, it became apparent that this relationship was actually only significant for the High Prior students.

Table 9.23: Correlations between Group Lesson Interest and Colour Variety Max. for combined data and the three prior interest levels – class as unit of analysis, no video lessons.

Variable 1	Variable 2	*N*	*r*	*p*
Combined data:				
Group Lesson Interest	Colour Variety Max.	46	0.331	0.024*
High Prior Interest students:				
Group Lesson Interest	Colour Variety Max.	46	0.338	0.021*
Mid Prior Interest students:				
Group Lesson Interest	Colour Variety Max.	46	0.258	0.083
Low Prior Interest students:				
Group Lesson Interest	Colour Variety Max.	41	0.235	0.139

*$p<0.05$, **$p<0.01$, ***$p<0.001$

9.7.4 Knowledge Development Duration

At the high school in which this study took place, lessons occupied 70 minute time-slots. For research purposes, however, observations were suspended during roll marking, gear deployment, external interruptions, and so forth. Average actual tuition duration was 51 minutes per lesson. During formal tuition times, note was made of the purpose to which the lesson time was dedicated. Four broad purpose categories were identified: Knowledge development, skill acquisition, experiencing of a phenomenon, and pleasure. Since the great majority of tuition time was spent on knowledge development, two variables were extracted from the observational data: number of lesson minutes spent on knowledge development (Knowledge Time) and percentage of tuition time spent on knowledge development (Knowledge Percentage). Correlations between Group Lesson Interest and these variables are given in Table 9.24.

Table 9.24: Correlations between Group Lesson Interest and two measures of lesson time allocation: Knowledge Percentage and Knowledge Time, for combined data and the three prior interest strata – class as unit of analysis, all lesson conditions.

Variable 1	Variable 2	*N*	*r*	*p*
Combined data:				
Group Lesson Interest	Knowledge Percentage	50	-0.299	0.035*
Group Lesson Interest	Knowledge Time	50	-0.295	0.037*
High Prior Interest students:				
Group Lesson Interest	Knowledge Percentage	50	-0.338	0.016*
Group Lesson Interest	Knowledge Time	50	-0.336	0.017*
Mid Prior Interest students:				
Group Lesson Interest	Knowledge Percentage	50	-0.299	0.035*
Group Lesson Interest	Knowledge Time	50	-0.270	0.058
Low Prior Interest students:				
Group Lesson Interest	Knowledge Percentage	45	-0.148	0.333
Group Lesson Interest	Knowledge Time	45	-0.166	0.276

*$p<0.05$, **$p<0.01$, ***$p<0.001$

Not surprisingly, average student interest showed a significant negative correlation with duration of knowledge development. This result held true for both Knowledge Time and Knowledge Percentage. When the data were analysed by prior interest level, however, the results defied expectations. Of the three strata, it was the High Prior students whose lesson interest demonstrated the strongest negative correlation with knowledge development duration; the Mid Prior students showed a less significant negative association; and the correlation for the Low Prior students, although negative in direction, was not statistically significant at all. Implications of this matter will be discussed in Section 10.3.4.

9.7.5 Hybrid Variables

The foregoing results show how a number of isolated classroom environment parameters were associated with student lesson interest. Attempts were made to derive hybrid variables from the most significant of these but the resultant correlations with Pupil Lesson Interest and Group Lesson Interest were no better than for the best of the single parameter measures.

9.7.6 Failed and Omitted Results

Some mention must also be made of those variables which were expected to show associations with lesson interest but which are not reported here. First in this category are the collative variables. As explained in Section 7.3.2, collative variables other than novelty proved too difficult to assess by the methods employed. Their absence from these results should not be interpreted as evidence of insignificance, therefore. Second, a number of teaching variables with predicted relationships to interest do not appear here simply because they were never employed by teachers during the lessons observed. For instance, the teachers gave no practical demonstrations, presented no samples to students for inspection, and never employed fantasy. Consequently, the influence of such phenomena could not be assessed. Finally, some variables with a known influence on interest were effectively measured but the degree of variation for the lessons observed was so slight as to prevent statistical analysis. For these variables, also, it was impossible to determine their influence on student interest. Of particular note in this regard was teacher interest modelling. All of the participating teachers delivered their lessons in a manner best described as 'professional'; on the whole, there was neither disinterest nor special passion evident in their deliveries.

9.8 Teaching Strategies – Novelty

9.8.1 Introduction

This section is an extension of the preceding one concerning teaching strategies and pertains to a range of novelty-related variables. Novelty is an important predictor of interest and can be categorised as either complete or short-term. Complete novelty is the degree to which a stimulus is novel or unfamiliar when compared to the gamut of an individual's entire life experiences. Short-term novelty, on the other hand, is a measure of the time since last exposure to the stimulus. Since there are many challenges in assessing both of these constructs, short-term novelty is here assessed simply as experiential variety within individual lessons; complete novelty has been operationalised as stimulus familiarity, according to the procedures outlined in Section 7.3.4.

9.8.2 Short-Term Novelty

There are many factors which contribute to the short-term novelty (i.e., variety) of science lesson experiences. Details of the complete suite of such factors assessed in the investigation have been given in Section 7.3.4. Only four of these exhibited significant associations with lesson interest, however, viz.: the number of 'channels' (i.e., mental, physical, and emotional) that students experienced the lesson through (Channel Number); the number of senses students used during lesson experiences (Sense Number); the number of teaching resources used by the teacher (Resources Number); and the number of educational activities employed (Activity Number). Each of these will be considered in turn.

Channel Number

Correlations between Group Lesson Interest and Channel Number – for both combined data and prior interest level data – are presented in Table 9.25.

Table 9.25: Correlations between Group Lesson Interest and Channel Number for combined data and the three prior interest strata – class as unit of analysis, no video lessons.

Variable 1	Variable 2	***N***	***r***	***p***
Combined data:				
Group Lesson Interest	Channel Number	46	0.131	0.387
High Prior Interest students:				
Group Lesson Interest	Channel Number	46	0.153	0.309
Mid Prior Interest students:				
Group Lesson Interest	Channel Number	46	0.068	0.653
Low Prior Interest students:				
Group Lesson Interest	Channel Number	41	0.347	0.026*

*p<0.05, **p<0.01, ***p<0.001

A significant relationship between lesson interest and channel number was only found for the Low Prior students (N=41, r=0.347, p<0.05).

Sense Number

The variable Sense Number refers to the number of senses utilised by students when participating in the intended lesson experiences. Since all 50 lessons surveyed involved seeing and hearing but none involved either taste or smell, this variable effectively measured only the influence of tactile involvement on lesson interest. Further, Sense Number does not measure the number or duration of sensory experiences per lesson, but simply the presence or absence of sensory phenomena. Thus, Sense Number is a binary variable in the current context. Correlation data for relationships between Sense Number and Group Lesson Interest are provided in Table 9.26, below.

Table 9.26: Correlations between Group Lesson Interest and Sense Number for combined data and the three prior interest strata – class as unit of analysis, all lesson conditions.

Variable 1	Variable 2	*N*	*r*	*p*
Combined data:				
Group Lesson Interest	Sense Number	50	0.159	0.271
High Prior Interest students:				
Group Lesson Interest	Sense Number	50	0.202	0.160
Mid Prior Interest students:				
Group Lesson Interest	Sense Number	50	0.017	0.909
Low Prior Interest students:				
Group Lesson Interest	Sense Number	45	0.399	0.007**

*p<0.05, **p<0.01, ***p<0.001

Although no significant associations were found for the combined data or the two upper prior interest strata, the data from the Low Prior students exhibited a highly significant positive correlation between Group Lesson Interest and Sense Number. As noted already, however, Sense Number measured only the presence or absence of tactile stimuli in the present study. Furthermore, all these tactile experiences occurred in the context of practical activities; they were never included for their own sake. Thus, the above result may indicate that Low Prior students' situational interest improved due to an increase in hands-on activities rather than an increase in tactile experience *per se*. This finding has clear parallels with the Channel Number results, in which the interest of Low Prior students improved when the physical channel was used.

Resources Number and Activity Number

Two variables representing explicit aspects of pedagogy were generated from the SCIOS: Resources Number and Activity Number (see Section 7.3.4 for details on the assessment of these parameters). Correlation data for the relationships between these two parameters and Group Lesson Interest are given in Table 9.27. It was hypothesised that Group Lesson Interest would show a significant positive correlation with both of these teaching strategy variables for all prior interest strata.

Table 9.27: Correlations between Group Lesson Interest and two measures of pedagogical variety – Resources Number and Activity Number – for combined data and the three prior interest strata – class as unit of analysis, all lesson conditions.

Variable 1	Variable 2	*N*	*r*	*p*
Combined data:				
Group Lesson Interest	Activity Number	50	0.353	0.012*
Group Lesson Interest	Resources Number	50	0.070	0.627
High Prior Interest students:				
Group Lesson Interest	Activity Number	50	0.344	0.014*
Group Lesson Interest	Resources Number	50	0.193	0.180
Mid Prior Interest students:				
Group Lesson Interest	Activity Number	50	0.390	0.005**
Group Lesson Interest	Resources Number	50	0.008	0.957
Low Prior Interest students:				
Group Lesson Interest	Activity Number	45	0.086	0.575
Group Lesson Interest	Resources Number	45	0.289	0.054*

*p<0.05, **p<0.01, ***p<0.001

Activity Number showed a significant correlation with Group Lesson Interest for both the High and Mid Prior students but not for those in the Low Prior stratum. For Resources Number this trend was reversed, however, with only the Low Prior students' interest levels showing any degree of association with the number of teaching resource objects used. Activity Number showed a stronger influence on lesson interest than Resources Number.

9.8.3 Complete Novelty

Estimates of the complete novelty (i.e. unfamiliarity) of visual, aural, and tactile stimuli were recorded on the SCIOS as per the procedures described in Section 7.3.4. During the lessons observed, however, there were relatively few tactile learning experiences and thus the following analyses pertain to visual and aural phenomena only. Note also that since videos rate highly for aural and visual novelty, and since the present study is concerned with teachers' instructional approaches, video data are excluded from the following analyses.

Aural Stimulus Novelty

Table 9.28 gives the results of correlations between Group Lesson Interest, and two measures of aural stimulus novelty – average aural stimulus novelty (Aural Novelty Avg.), and maximum aural stimulus novelty (Aural Novelty Max.). Interest theory predicts a strong positive association between interest and both of the aural novelty variables.

In accordance with predictions, aural stimulus novelty was found to be significantly correlated with student lesson interest. This result held true for both of the independent variables but not within all prior interest strata. Surprisingly, the strength of the associations between lesson interest and aural novelty variables increased in inverse relation to students' *a priori* science interest scores.

Table 9.28: Correlations between Group Lesson Interest and two measures of aural stimulus novelty – Aural Novelty Avg. and Aural Novelty Max. – for combined data and the three prior interest strata – class as unit of analysis, no video lessons.

Variable 1	**Variable 2**	***N***	***r***	***p***
Combined data:				
Group Lesson Interest	Aural Novelty Avg.	46	0.373	0.011*
Group Lesson Interest	Aural Novelty Max.	46	0.381	0.009**
High Prior Interest students:				
Group Lesson Interest	Aural Novelty Avg.	46	0.245	0.101
Group Lesson Interest	Aural Novelty Max.	46	0.259	0.082
Mid Prior Interest students:				
Group Lesson Interest	Aural Novelty Avg.	46	0.304	0.040*
Group Lesson Interest	Aural Novelty Max.	46	0.331	0.024*
Low Prior Interest students:				
Group Lesson Interest	Aural Novelty Avg.	41	0.437	0.004**
Group Lesson Interest	Aural Novelty Max.	41	0.428	0.005**

*$p<0.05$, **$p<0.01$, ***$p<0.001$

Visual Stimulus Novelty

Table 9.29 presents the results of correlations between Group Lesson Interest and two measures of visual stimulus novelty – average visual stimulus novelty (Visual Novelty Avg.) and maximum visual stimulus novelty (Visual Novelty Max.). A strong positive association between Group Lesson Interest and both of these variables was predicted.

Visual stimulus novelty was found to be correlated with student lesson interest but only when Visual Novelty Avg. was used as the predictor variable. Unlike the aural novelty data, there was no variation in correlation strength between prior interest strata. It is noteworthy that of all the teacher strategy variables measured in this study, Visual Novelty Avg. demonstrated the strongest correlation with Group Lesson Interest.

Table 9.29: Correlations between Group Lesson Interest and two measures of visual stimulus novelty – Visual Novelty Avg. and Visual Novelty Max. – for combined data and the three prior interest strata – class as unit of analysis, no video lessons.

Variable 1	**Variable 2**	***N***	***r***	***p***
Combined data:				
Group Lesson Interest	Visual Novelty Avg.	46	0.404	0.005**
Group Lesson Interest	Visual Novelty Max.	46	0.180	0.230
High Prior Interest students:				
Group Lesson Interest	Visual Novelty Avg.	46	0.323	0.029*
Group Lesson Interest	Visual Novelty Max.	46	0.224	0.134
Mid Prior Interest students:				
Group Lesson Interest	Visual Novelty Avg.	46	0.350	0.017*
Group Lesson Interest	Visual Novelty Max.	46	0.163	0.280
Low Prior Interest students:				
Group Lesson Interest	Visual Novelty Avg.	41	0.347	0.026*
Group Lesson Interest	Visual Novelty Max.	41	0.005	0.974

*$p<0.05$, **$p<0.01$, ***$p<0.001$

9.8.4 Student-Report vs. Observer-Rated Measures

The preceding analyses concerned relationships between student-reported lesson interest and various aspects of teaching novelty. Relationships between student-reported (subjective) novelty scores and observer-rated (objective) novelty measures have not yet been treated, however. Table 9.30 presents correlation data for Pupil Lesson Novelty and four complete novelty measures. Table 9.31 presents correlation data for Pupil Lesson Novelty and nine short-term novelty measures.

Table 9.30: Correlations between Pupil Lesson Novelty and four observer-rated measures of lesson complete novelty – Visual Novelty Avg., Visual Novelty Max., Aural Novelty Avg.) and Aural Novelty Max. – class as unit of analysis, all lessons.

Variable 1	**Variable 2**	***N***	***r***	***p***
Pupil Lesson Novelty	Visual Novelty Avg.	50	0.283	0.046*
Pupil Lesson Novelty	Visual Novelty Max.	50	0.145	0.314
Pupil Lesson Novelty	Aural Novelty Avg.	50	0.068	0.637
Pupil Lesson Novelty	Aural Novelty Max.	50	0.157	0.276

*$p<0.05$, **$p<0.01$, ***$p<0.001$

Table 9.30 shows that of the four most significant complete novelty measures recorded on the SCIOS, only Visual Novelty Avg. demonstrated any significant correlation with student-reported lesson novelty (r=0.283, p<0.05).

Table 9.31: Correlations between Pupil Lesson Novelty and nine observer-rated measures of lesson short-term novelty – Activity Number, Resources Number, Visual Object Number, Aural Object Number, Tactile Object Number, Stimulus Object Number, Sense Number, Emotion Mode Number and Channel Number – class as unit of analysis, all lessons.

Variable 1	**Variable 2**	***N***	***r***	***p***
Pupil Lesson Novelty	Activity Number	50	0.520	<0.001***
Pupil Lesson Novelty	Resources Number	50	0.255	0.073
Pupil Lesson Novelty	Visual Object Number	50	0.066	0.650
Pupil Lesson Novelty	Aural Object Number	50	0.110	0.446
Pupil Lesson Novelty	Tactile Object Number	50	0.262	0.066
Pupil Lesson Novelty	Stimulus Object Number	50	0.132	0.361
Pupil Lesson Novelty	Sense Number	50	0.262	0.066
Pupil Lesson Novelty	Emotion Mode Number	50	0.253	0.076
Pupil Lesson Novelty	Channel Number	50	0.270	0.058

*p<0.05, **p<0.01, ***p<0.001

Table 9.31 shows that of nine short-term novelty measures recorded on the SCIOS, only Activity Number demonstrated any significant correlation with Pupil Lesson Novelty (r=0.520, p<0.001). This association is stronger than the relationship between Activity Number and Group Lesson Interest (r=0.353, p=0.012, see Section 9.8.2, above). This latter result suggests that the SLIS Novelty scale may be measuring short-term novelty rather than complete novelty – a conclusion contrary to the one drawn in Section 9.8.3 and also contrary to the intentions of the instrument's design. This matter is reviewed in detail in Section 10.3.3.

9.9 Interest vs. Teacher Interaction Style

9.9.1 Introduction

The Questionnaire on Teacher Interaction (QTI) was administered to participating students as per the procedures described in Section 8.3.1. The instrument did not perform as expected, however, and a significant amount of data manipulation was necessary in order to arrive at meaningful conclusions. The manipulations, the reasons for them, and the data ultimately extracted were described in Section 7.6. Only one scale, Warmth, offered robust statistical properties for correlation against other data in this study.

9.9.2 Interest vs. Warmth

The values of all items in the Warmth scale were averaged for each student; all such student scores were then averaged for each teacher. This produced the variable Teacher Warmth Avg. which was then correlated against student-response parameters from both the SCIOS observation schedule and the SLIS questionnaire. Significant associations were found between Teacher Warmth Avg. and two teacher-level variables: overall correction intensity (Correction Level Avg.; N=7, r=–0.759, p=0.048) and overall student-reported lesson interestingness (Teacher Interest Avg.; N=7, r=0.904, p=0.005).

9.10 Prior Science Interest

9.10.1 Summary of Previous Data

It is evident from the results above that students' *a priori* interest levels influenced their lesson experiences in complex ways. Table 9.32 summarises the most significant results in this regard.

*Table 9.32: Correlation p-values for 10 interest variables arranged according to prior interest stratum; (*N *and* r *values are not included; see previous tables for these data).*

Variable 1	Variable 2	Trd.[1]	High	Mid	Low
Group Lesson Interest	Channel Number	+	0.309	0.653	0.026*
Group Lesson Interest	Sense Number	+	0.160	0.909	0.007**
Group Lesson Interest	Aural Novelty Max.	+	0.082	0.024*	0.005**
Pupil Lesson Interest	Pupil Lesson Difficulty	-	0.292	0.363	0.001**
Group Lesson Interest	Correction Number	-	0.332	0.069	0.005**
Group Lesson Interest	Student Questions 1	-	0.786	0.310	0.017*
Group Lesson Interest	Activity Number	+	0.014*	0.005**	0.575
Group Lesson Interest	Teacher Interaction Level	+	0.003**	0.016*	0.644
Group Lesson Interest	Pupil Number	-	0.002**	<0.001***	0.064
Group Lesson Interest	Knowledge Percentage	-	0.016*	0.035*	0.333

$*p<0.05$, $**p<0.01$, $***p<0.001$

[1] Trend of relationship

It was originally hypothesised that the influence of prior science interest on lesson experiences would be linear in nature. The data in Table 9.32, however, show that in many cases this supposition was incorrect. In particular, it is clear that Low Prior students responded to stimuli in ways distinctly different from those who reported moderate or high prior science interest. With respect to some class environment stimuli, Low Prior students responded more sensitively, while to others they responded less sensitively. What was consistent, however, was that they appeared to behave as a sub-group which was qualitatively distinct from their Mid and High Prior interest peers.

9.10.2 Interest Sensitivity

Table 9.32 raises a significant question: Which, if any, of the three interest strata shows the greatest responsiveness to teacher input? This matter was investigated by comparing the average degree of variation in lesson interest for students in each prior interest stratum. The following approach was taken. First, students who had participated in less than four lessons were eliminated from consideration on the basis of insufficient information. Second, students of the three least-interesting teachers (i.e., those with the lowest Teacher Interest Avg. values) were also eliminated since it was assumed that teachers who did not provide stimulating lessons would not give sufficient opportunity for their students to experience (and thus report) a wide range of interest. The application of the above constraints reduced the assessable cohort to 81 students. For each of these remaining pupils, their lowest and highest lesson interest scores were determined; the former was then subtracted from the latter to derive an individual interest range value. Finally, the individual interest range values were averaged according to prior interest level. These averages are given in Table 9.33.

Table 9.33: Average interest range values for students who attended four or more lessons with teachers rated as having above average levels of lesson interestingness – data arranged by prior interest stratum.

Interest Stratum	Range Avg.	*N*
High Prior Interest	1.0	27
Mid Prior Interest	1.0	30
Low Prior Interest	1.4	24

When the range averages were analysed using Student's t-test, it was found that the High and Mid Prior averages were not significantly different (p=0.927) but that the Low Prior average was significantly above both of the others (Low vs. High, p=0.049; Low vs. Mid, p=0.033). These results suggest that students with a low prior interest in science may be significantly more responsive to their class environments than their more initially-interested classmates. This idea is in accord with the findings reported in Sections 9.3.3 and 9.3.4. It also fits with the results in Table

9.32, which show that Low Prior students were significantly affected – both positively and negatively – by a greater number of classroom environment variables.

Chapter 10

DISCUSSION

10.1 Introduction

It is hoped that findings from the present work will contribute to the retention of students in the study of the sciences and the improvement of educational outcomes for the students so retained. This final chapter is written with such objectives in mind. Before commencing any discussion of these matters, however, it is appropriate to review the study's original objectives. Initially cited in Section 1.3, these objectives were divided into two hierarchies – research questions and instrumental goals – and are reproduced below.

Core research question: What factors affect student interest in the science classroom?

Question 1	What teacher behaviours are important in determining student interest in science classes?
Sub-question 1a	*What are the most important of the known interest-inducing factors?*
Sub-question 1b	*Do teacher inter-personal behaviours influence the development of classroom interest?*
Question 2	How does student *a priori* interest affect the elicitation of student lesson interest?
Question 3	How do classroom distractions influence student interest?

Instrumental goal: To refine the theoretical and practical tools of interest research in order to answer the research questions.

Goal 1	To facilitate more effective science classroom research generally
Sub-goal 1a	*To locate/create a theoretical model that explains how the gamut of teacher actions induce interest*
Sub-goal 1b	*To determine – from amongst the range of available options – the most practical means of assessing interest in natural, classroom settings*
Goal 2	To locate/create survey instruments to attain the research goals
Sub-goal 2a	*To locate/create a survey instrument that measures lesson interest as a dependent variable*
Sub-goal 2b	*To locate/create an observation schedule that records teacher behaviours in terms of known interest-inducing factors*
Sub-goal 2c	*To locate/create a survey instrument that measures teacher inter-personal behaviour*
Sub-goal 2d	*To locate/create a survey instrument that measures student* a priori *interest in science*

The following discussion addresses the above matters but does not proceed in the same order as the list above. In particular, the discussion of theoretical matters precedes that of practical implications.

10.2 Theoretical Implications

10.2.1 Review of the OCI as a Definition of Interest

Although interest is a relatively neglected phenomenon, there exist in the relevant literatures a number of models that aim to describe or explain it. Some of these models have been proposed by dedicated interest researchers, others by workers in the fields of motivation and vocation psychology, and yet others by emotions scholars. In seeking a theoretical framework for the present study, however, it became apparent that there were significant problems with all the previous approaches. These problems may be summarised as: a) failure to identify feature/s that make interest qualitatively distinct from related phenomena; b) lack of model parsimony; c) lack of clarity regarding terms and underlying constructs; and/or d) failure of the models to explain important examples or aspects of interest. Such weaknesses explain – at least in part – why there exists to date no universally accepted definition or theory of interest.

It was my original intention to find and apply an existing definition. The problems identified above necessitated a novel approach, however, and the product – the Opportunity Concept of Interest – represents a significant outcome of this work and one largely independent of the empirical research. Yet the OCI is not new in any absolute sense. The lack of theoretical unanimity amongst interest researchers tends to obscure the fact that scholars have consistently – and often independently – described a cluster of phenomena with which interest seems inextricably linked. These phenomena constitute a zone of convergence which has been synthesised here as the OCI. Earlier chapters have defended this synthesis, applying data and ideas from a wide range of researchers and demonstrating that the weaknesses in prior models can be resolved by the new conception. Nevertheless, it is evident that the OCI might be criticised on a number of grounds.

First, this study offers no empirical support for the OCI. This weakness is acknowledged. The purpose of this work was never to gather evidence regarding the OCI's validity. The concept is inferred and its support drawn from the data reported by others. Consequently, the ideas are set forth speculatively.

A second potential criticism concerns the scope of the concept itself. For instance, in Section 5.2.3 a number of interest-eliciting and -enhancing phenomena were explained using the OCI as a framework. There, it was postulated that hands-on activities are commonly experienced as interesting because they provide opportunities for the fulfillment of any of a number of needs, including stimulation, autonomy, affiliation, or competence. The interestingness of other classroom phenomena was similarly explained by reference to their capacity to provide for any of a diversity of needs or because they enhance perceptions of need-fulfillment opportunities. In proposing that interest in a single classroom strategy might be the outcome of any of such a range of factors, the OCI may be open to the charge of being too general. Ignoring for the moment the extensive defense of the OCI's tenets presented in earlier chapters, a few comments may be made regarding such a criticism. In particular, it is suggested here that theorists and educators alike ought to expand their understanding of the prevalence and importance of interest. Perhaps the reason that existing concepts have failed to explain the interest 'laundry lists' is not merely because the models themselves are too limited, but because the virtually ubiquitous presence and influence of interest is insufficiently appreciated. Comments to this effect by major theorists have already been cited. To these we might add that of Piaget, who opined: "Every intelligent activity is founded upon an interest" (1974, p. 31, cited Krapp & Fink, 1992).

10.2.2 Other Theoretical Issues

This study touches on a number of other significant theoretical issues. The first of these is the proposition that situational interest should be considered an emotion while individual interest should be considered a motivation. Not only does this proposal economically differentiate the two terms, but it suggests research directions for investigating the conversion of momentary interest in classroom events into long-term interest in science topics. (The issue of interest development is treated in more detail in Section 10.3.5, below.)

Another important outcome of the present research has been to highlight the role of student needs in educational transactions. Schools must, of necessity, deliver content for which pupils often perceive little or no personal need. Further, the exigencies of daily school life frequently oblige teachers to deliver lessons in a manner which falls far short of the ideals suggested by scholars – even those ideals to which the teachers, themselves, subscribe. Nevertheless, the present findings suggest that an educational process which fails to understand and respond to student needs, and thus interest, is bound to run up against significant – perhaps even intractable – obstacles.

That teaching is often administered without formal explication of student need dynamics does not contradict this statement. Rather, it illustrates how frequently student needs coincide with educational provisions anyway and how often teachers recognise and cater to such needs. However, in the same way that a technical understanding of nutrition can enhance physical wellbeing, so also a technical understanding of student needs and interest ought to enhance teaching effectiveness.

The current study has also drawn attention to a number of neglected need categories. Of particular significance is the need for stimulation in all its forms: physical, emotional, and mental. Despite a large body of evidence demonstrating that stimulation is essential for healthy physical and mental development, stimulation rarely features in need taxonomies and when it does, it does not attain prominence. While the notion of stimulation as a need is not essential to the OCI *per se* it does, however, appear to be necessary for the satisfactory explanation of a number of interest-related phenomena. It is beyond the scope of this discussion to do more than suggest that researchers consider this a topic of importance.

A final theoretical matter worthy of mention is novelty. Novelty was found to have diverse and complex relationships with interest, both theoretically and empirically. Novelty is closely related to stimulation and has figured prominently in the work of such interest theorists as Silvia and Berlyne. Nevertheless, the volume of empirical data on the relationship between novelty and interest is not commensurate with its significance. The relationship between novelty and interest is treated again in Section 10.3.4.

10.3 Practical Implications and Applications

10.3.1 Introduction

The remainder of this chapter treats some practical implications of the study findings. First, some general limitations of the research methods will be addressed in acknowledgment that they constrain any subsequent conclusions. Second, the survey instruments will be discussed individually, highlighting some weaknesses and suggesting directions for future work. Third, those findings from the classroom observations that appear most salient to teaching practice will be reviewed using the OCI as a discussion framework. And finally, some general education policy implications will be briefly treated.

10.3.2 Study Limitations

As previously noted, there have been only a small number of investigations of situational interest in natural educational settings. Studies of this type in science classes have been very few, indeed. Consequently, the present investigation was essentially exploratory and surveyed a very wide range of variables in order to generate a broad picture of the science class interest environment. Not all the variables identified at the outset were equally amenable to measurement by the methods employed, however. The major failures in this regard have already been identified in Chapter 6, with collative variables being prominent among them.

Other notable limitations of the current study include: exclusive focus on a single, middle school year level; emphasis on the lecture-style mode of instruction; and the participation of female teaching staff in only one of the nine classes surveyed. These factors are not methodological failures but they must be taken into account in any attempts to generalise current findings. Another important limitation to inference arises from the absence of any measure of academic performance. It has been assumed, on the basis of much previous research, that interest is positively associated with learning, yet no attempt was made to measure the level of learning that took place over the course of this study. Finally, it should be remembered that the focus in the investigation was situational interest. Although individual interest in science was measured, it was only measured in order to assess its influence on situational interest levels.

10.3.3 Study Implications for Researchers

General Issues

In Chapter 9 the implications of some of the empirical results were briefly noted. Of these, one of the most prominent was the highly significant correlation between student attention to lesson tasks and self-reported interest levels. This result suggests that attention might be used by researchers and teachers alike as an effective index of student interest.

Only one other issue of general research interest will be treated here. This problem was most evident in the results from the Questionnaire on Teacher Interaction (QTI) but also appeared in conjunction with the Science Lesson Interest Survey (SLIS). Details of the original QTI problem and its resolution have been described in Section 7.9 but the problem may be summarised as follows: More than half of the QTI items were found to load on a single factor. In order to derive meaningful results for present purposes, a new scale was extracted from the survey data. This new scale was termed Warmth; it yielded a Cronbach alpha reliability coefficient of 0.916 and was found to be significantly correlated with lesson interest levels. While a useful scale was ultimately derived from the data collected, a fundamental issue remains unresolved: the QTI did not perform with the discrimination its authors and earlier users reported.

A plausible explanation for this problem is that the students did not pay attention to the nuances of individual item wording. Rather, they appear to have given generic responses according to the positivity or negativity implied in each. Since the respondents were relatively young (12 to 13 years) and the survey quite long (48 items), it would not be surprising if the forms were completed with less than the anticipated levels of diligence. If this is the case, then the QTI effectively served as a popularity survey. This does not entirely invalidate the information gathered, however. Teacher popularity is closely related to such qualities as described by the items of the Warmth scale, i.e.: friendliness, approachability, humour, and patience. The conservative conclusions drawn in this study regarding teacher-student interactions and interest are not compromised by the problems noted.

This generic response issue seems not to have been limited to the QTI, however. When reviewing responses to the SLIS, it became apparent that many students reported high levels of interest during lessons that were, from an objective point of view, quite lacking in interesting features. This observation cannot be confirmed here with numerical data but I report it anecdotally, having formally surveyed over 50 lessons for interestingness using the SCIOS. A reasonable explanation for this observation is that a positive classroom environment – especially one created by a popular teacher – may foster an ‘interest momentum,’ that is, a habit of expectation and perception which can override minor troughs in individual lesson interestingness. This idea is offered speculatively but may have significant implications for interest development and will be discussed further Section 10.3.5.

Science Classroom Interest Observation Schedule (SCIOS)

The SCIOS was the sole instrument used for examining the pedagogical strategies of teachers. As already discussed, it was purpose-built for this study, was exploratory in nature, and addressed a large number of variables hypothesised or previously reported to have a bearing on student interest. One of its major weaknesses was heavy reliance on previously untested, subjective scales. As discussed in Section 7.3, this was a necessity given the scope of the survey and the paucity of previous research. A related issue was the very short duration of attention given to the assessment of individual parameters during each observation cycle.

Given the above issues, there is considerable scope for improving the validity and reliability of many SCIOS measures, especially those pertaining to the more abstract variables, such as Anticipation, and some of the stimulation variables, such as Pleasurableness.

Science Lesson Interest Survey (SLIS)

The Science Lesson Interest Survey (SLIS) was also constructed expressly for this study. Like the SCIOS, this survey was designed to be exploratory in nature and was never intended to assess orthogonal dimensions of a single phenomenon. Instead, it surveyed four distinct lesson experience variables, viz.: Interest, Novelty, Difficulty, and Distraction. The first three of these variables were assessed on single scales of six items each, each of which demonstrated satisfactory internal consistency reliability. The fourth variable, Distraction, surveyed a range of plausible distraction phenomena including pain, personal thoughts, and interference from other students. Since these phenomena are essentially unrelated, internal consistency reliability was not a relevant statistic for Distraction.

For the purposes of research improvement, the most striking result from the SLIS was the peculiar nature of responses to the Novelty scale. This scale was designed to measure complete novelty and representative items included: *I had new experiences in this science lesson*, and, *The facts we learned today were new to me*. Despite such unambiguous wording, Novelty scale scores correlated significantly (r=0.520, p<0.001) with Activity Number – a short-term novelty (i.e., variety) variable. The interpretation of this result is problematic. A possible explanation is that students responded somewhat carelessly to Novelty scale items and treated them as referring to short-term novelty. Such a hypothesis is refuted, however, by the relationship between Novelty and Difficulty data. These two scales were found to be positively correlated with a significance level of $p<0.001$, which would be surprising if the Novelty scale had been treated as a measure of temporal variety. In short, then, the interpretation of the SLIS Novelty scale data presents some difficulties for which no obvious solution is apparent.

A final curiosity of the SLIS was that during factor analysis, half of the Novelty items were found to load significantly on the Interest scale. Indeed, two Novelty items – *I had new experiences in this science lesson*, and, *I learned how to do new things in science today* – loaded more heavily on Interest than on their intended scale. Since the wording of the items in both scales is unambiguous and since the Novelty scale is a measurement of input from a teacher while the Interest scale is a measurement of emotional response by a student, this result is especially odd. It is hypothesised here that the result is not a matter of instrument error or even student reporting carelessness, but that interest and novelty are associated in ways more significant than hitherto recognised. Certainly this matter warrants closer empirical scrutiny.

Questionnaire on Teacher Interaction (QTI)

The QTI was the instrument with which the greatest problems arose. These problems have already been treated at length and shall not be revisited. Since the instrument has a fine pedigree and has been used widely since its original design in 1991, it is assumed that the problems that arose in the present context can be traced largely to the youth of the students to whom the survey was administered.

10.3.4 Study Implications for Classroom Teachers

The key question guiding this study has been simply: What is it that teachers do that makes their students interested in science lessons? Having discussed the various theoretical matters, it is now possible to summarise the empirical findings as principles that are applicable to teaching practice. Before commencing such a summary, however, it is worth briefly reviewing the problem that these suggestions are intended to alleviate – student boredom.

Is school boring? In respect of specific days and particular events there are plenty of students who would answer this question in the negative, as data from this study has shown. Nevertheless, research indicates that there are many others who would argue that schooling is often drudgery. Larson (2000), for instance, found consistently low levels of intrinsic motivation among high school students during classroom experiences. Hidi and Berndorff (1998) have reported that interest deficiencies are especially evident in mathematics and the sciences, while others (e.g., Cordova & Lepper, 1996; Hidi, 2000; Gentry, Gable, & Rizza, 2002) have observed that such problems become worse in the later years. Indeed, some scholars have gone so far as to conclude that the schooling process actually undermines children's innate motivation to learn (e.g., Lepper, Greene, & Nisbett, 1973) and Travers (1978, p. 128) has even provocatively stated that, "school is more likely to be a killer of interest than the developer". Nevertheless, most researchers would agree with Brophy (1983) that while these problems are real and challenging, they can also be ameliorated.

Thus, there exists on the one hand a real and very significant interest deficit in schools – a lack which is especially evident in secondary science classes. On the other hand, this problem has causes which can be identified and, in some measure, corrected. These two contrasting factors constitute both context and rationale for the remaining discussion and, indeed, for the study as a whole.

The causes of the educational interest deficit are many and, though schools and teachers may be responsible in part for problems with learning motivation, other factors certainly play a significant role. Hidi (2000) has summarised a number of such factors pertaining to high school students, including an increase in the level of difficulty of academic task demands and increasing competition for the energies of students between goals of an academic nature and those of a social nature. Improving the academic interest levels of school children will require a better theoretical understanding of motivational dynamics, greater knowledge of corrective strategies, and a sober recognition of those conative variables which are within the control of educators and those which are not. The present study aims to contribute to the first two of these matters.

What is suggested in the final sections below pertains entirely to the category of corrective strategies. In this regard, Bergin (1999) has made the charge that:

> Theories of interest and motivation give little specific advice to teachers regarding curriculum decisions about how to attract interest in classroom activities. (p. 88)

It is to correct this problem that the suggestions below are given. They are not given because they are necessarily unique, however; some are quite well established from other research. Rather, the conclusions are presented on the basis of relevance to the present study and are considered to be but a small contribution to the momentous task of better motivating students.

Prior Interest in Science

For the classes observed in this study, prior/individual interest in science correlated with average situational interest in science lessons at a significance level of $p<0.001$ (see Section 9.2.4). This means that pupils' interest levels were significantly influenced by factors that pre-dated the class and were thus beyond the teacher's immediate control. It also suggests that a teacher who instructs a low-interest science class will have to work harder to attain, maintain, and improve interest than will a teacher with a high-interest class, *ceteris paribus*. This result is unsurprising and accords with a large body of earlier research.

A less predictable finding was that *a priori* science interest levels divided students into two qualitatively distinct sub-groups. Students who reported moderate levels of science interest responded to lesson stimuli in a manner that was qualitatively equivalent to the responses of high interest students. Those students whose *a priori* interest in science was in the lowest third of the distribution, however, responded to science lesson stimuli in distinctively different ways to their more interested peers (see Sections 7.1 and 7.10 for details). Three general differences were evident between the low interest and higher interest groups: a) low prior interest students showed statistically significant responses to a greater number of lesson environment variables; b) low prior interest students showed a significantly greater range in the magnitude of their interest responses; and c) the two groups showed marked differences in the types of lesson environment variables to which they responded. Two conclusions of practical relevance can be drawn from these results. First, low prior interest students appear to be more sensitive to instructional quality than their higher interest peers. Second, different strategies are needed to manage the interest of low interest students compared to high interest ones.

The latter conclusion directs our attention to those class environment variables with the most significant interest correlations. Channel Number and Sense Number are important examples; they were both found to be positively correlated with interest for the low interest students but not for the higher interest ones (see Section 9.8.2). Does this mean that low interest students are those who are more kinaesthetically-oriented in their learning styles? If so, this result suggests that more tactile and practical activities ought to be used to reach such students. Alternatively, since *a priori* science interest levels are *de facto* capability levels, it might be argued that beyond a certain age level students should be streamed into science classes according to preference and/or aptitude. This matter is taken up again in Section 10.3.6.

Other classroom variables showed an entirely different trend. Knowledge Time and Activity Number were significantly correlated with the interest levels of higher prior interest students only – the former variable being negatively associated with lesson interest and the latter positively (see Sections 9.7.4 and 9.8.2). A plausible explanation for these results is related to the capabilities of the higher interest students. The more interested and capable students are likely to attend more closely to appointed tasks and to strive more diligently to achieve. They are thus more likely to become fatigued as lessons progress and be more likely to derive benefit from activity changes. This hypothesis suggests that teachers should: a) be careful not to exhaust the energy and enthusiasm of their best students; and b) use breaks and activity changes to avoid student fatigue and associated interest deterioration.

Distractions

It was predicted at the beginning of this study that distractions – whether external or internal – would diminish lesson interest. In fact, the relationship between distractions and interest was found to be quite complex. Perceived levels of distraction were found to be associated with students' prior science interest levels, with low prior interest students being more readily distracted than their higher interest peers. Despite this complication, when *a priori* interest was statistically controlled, distraction levels were still found to be negatively correlated with lesson interest, as originally hypothesised.

This relationship may be interpreted in either of two ways. First, distractions may diminish lesson interest by interfering with students' perceptions of and engagement with lesson stimuli. This is the relationship originally envisaged. Alternatively, unstimulating lesson material may actually be responsible for increases in reported distractions via one or both of two mechanisms: a) disengaged students may perform off-task behaviours as a means of need-fulfillment, incidentally distracting their classmates in the process; or b) disengaged students may become more keenly aware of the distracting phenomena already impinging upon them. It is proposed here that all of the above processes have a role to play and should be taken into account by teachers. Thus, on the one hand, the elimination of distractors – especially student misbehavior – ought to enhance interest, regardless of the quality of lesson content. On the other hand, improvements in lesson interestingness ought to improve behaviour due to heightened student engagement, regardless of the quality of behaviour management.

Perception

The OCI posits that interest is initiated by the appraisal of an object. Therefore, whatever is capable of influencing object appraisals is capable of influencing interest and thus both sensory and cognitive perceptions have roles in interest induction (see Section 4.1.1). These relationships are significant to classroom interest management in a number of ways.

The first and most obvious perception issue relates to lesson material clarity. In their analysis of teacher effectiveness, Kyriakides, Campbell, and Christofidou (2002) reported a range of results leading to the unsurprising conclusion that effective teachers use clear content presentation. A more specific finding in the same vein was reported by Wade, Buxton, and Kelly (1999). They found that the text features responsible for making reading material uninteresting were problems relating to comprehension, such as poor explanations, inadequate background information, difficult vocabulary, and lack of textual coherence. Their study linked textual clarity directly to student interest, a finding in harmony with the predictions of the OCI.

In the case of the present study, aspects of visual and aural vividness/clarity were measured but no significant correlation with lesson interest was found. This result may have been due, at least in part, to the high degree of uniformity in vividness/ clarity levels during the lessons surveyed, however. If there had been greater variability in the vividness of teaching materials, a correlation may have been detected. With respect to conceptual clarity (i.e., ease of comprehension), no attempt was made to assess this parameter. Nevertheless, on the basis of prior research and theoretical principles one simple practical conclusion is evident: effort expended on improving conceptual clarity contributes significantly to student situational interest. This is an outcome distinct from any consequential improvements in recall or performance.

A second recommendation relating to perception is the clear explication of connections between lesson content and student needs. As has been said earlier, human need-fulfillment behaviours do not necessarily demonstrate wisdom. People often seek stimuli which are actually harmful and fail to recognise or even ignore stimuli which are beneficial. It follows that teachers can promote student interest in lesson material by specifying connections to authentic needs, since such connections may not be evident to their pupils. An allied matter is goal proximity. Bandura and Schunk (1981) have shown that greater student motivation is achieved when goals are proximal rather than distal – that is, when less time must pass before the satisfaction of the need. In this regard, teachers have a role, not just in managing the size and timing of tasks, but in managing students' perceptions of those tasks and of goal proximity.

The third practical recommendation relates to student-student interactions. It has already been suggested that distractions influence interest by interfering with students' perceptions of and engagement with lesson objects. Since a major source of student distraction is the off-task actions of classmates, effective behaviour management is an important mechanism by which the perception of lesson objects might be enhanced and interest improved.

Teacher Warmth

The problems associated with the QTI have been discussed already. Despite the failure of this instrument to perform as expected, one useable scale was extracted from the data. This scale, labelled Warmth, was found to have a highly significant positive correlation with lesson interest. The finding that positive teacher-student interactions improve student schooling experiences has been reported by many researchers. It is a fact also reflected in Ryans' (1960) teacher effectiveness dimension, X_o (understanding, friendly vs. aloof, restricted behaviour; see Section 1.1.3). The finding of the present study – that warm teacher-student relations improve science lesson interest levels – was, therefore, not surprising. Certainly, the current results only serve to reinforce the prevailing wisdom that teachers will improve the quality of their instruction by improving their relationships with students.

Growth and Challenge

The OCI explains the correlation between prior interest in science and situational interest in science lessons as follows: science lessons provide those students who have a general interest in the topic with greater need-fulfillment opportunities than those without such an interest. Such an explanation implies that the very nature of science lessons meets certain need types more than others. These needs deserve some discussion.

The human need most clearly and deliberately catered for in the conventional science classroom is the need for personal growth – specifically, intellectual development. While it is assumed that all people have a need for intellectual growth, individuals have different capacities for growth, preferred rates of growth, and varied domains in which they wish to experience and express growth. Thus, some students will never show a high degree of interest in the fundamental nature of science – that is, in the abstractions by which the universe is explored and explained. They may develop an interest in science – even a strong one – for other reasons, but it will not lead to a high level of performance in scientific disciplines. Thus, teachers ought to differentiate their instruction according to the inherent interest levels of their pupils.

Before addressing provisions for the growth of the two broad types of science students (i.e high prior interest and low prior interest students) separately, some general comments regarding growth needs are germane. The suggestions made below regarding growth are focused on two themes: maintenance of optimal challenge and provision for autonomy. With regard to optimal challenge, it is important to recognise that the need being provided for is the student's sense of competence. Interest is not stimulated by challenge *per se* but by the opportunity – made available via challenge completion – to improve competence. With respect to autonomy, it should be noted that opportunities for even the relatively trivial personalisation of learning experiences have the potential to improve lesson interest. Cordova and Lepper (1996) have opined that such manipulations tend to increase the self-relevance of tasks. Thus, both optimal challenge and provision for autonomy are generally applicable to all classroom contexts. What follows are suggestions specific to the two interest groups previously defined.

In line with the results reported in Section 9.2.3, it is here assumed that higher interest students are usually those with higher ability. For this group, the task facing the teacher is usually to maintain interest rather than create it. High interest/ability students will usually require levels of challenge considerably above their peers and a significant investment of time and thought may be required to find or create resources which meaningfully engage and extend these students. Such higher level students may also be particularly responsive to autonomous research tasks since these provide the opportunity to pursue issues to a depth of which others are incapable or else to pursue aspects of a topic which others find dull.

The low interest group presents rather different challenges to the science teacher. For such students, managing the level of task demand (i.e., challenge) is perhaps even more important than for high interest students. There are at least two task demand factors relevant to pupils who have low interest in science. As has already been noted, people tend to prefer to tasks that present a moderate level of difficulty. The optimal difficulty level varies from person to person and activity to activity, however. Thus, tasks which are optimally challenging for the majority will tend to discourage rather than motivate the least capable students as the difficulty may be too great to cultivate the sought-after sense of competence. This hypothesis was supported by data from the present study: Interest was significantly negatively correlated with Difficulty for the low prior interest students ($r=-0.198$, $p=0.001$; see Section 9.6.4) while the other interest strata did not show any significant associations for these two variables. This finding argues for teachers to pay careful attention to the differentiation of task difficulty levels.

The second matter relates to the nature of the task. As noted in an earlier chapter, Abuhamdeh and Csikszentmihalyi (2012) have reported that the preference for optimal challenge is only demonstrated when the activity in question is intrinsically motivated (see Section 5.4.3). When the task is performed merely as an obligation, however, the preference is for minimal effort expenditure. It is here assumed that most students cannot learn or perform well in science classes on minimal effort – yet low levels of exertion are all too common. Thus, the findings of Abuhamdeh and Csikszentmihalyi reinforce how important it is for educators to maximise the degree to which students identify learning activities as personally significant.

The preceding discussion has been based on the generalisation that students fall into two simple categories: those with higher ability and higher interest and those who are low in both. Clearly, not all students can be so characterised; there are students who are capable but not interested and vice versa. Nevertheless, the high/low generalization has broad utility and the principles of action applicable to the generic interest categories can be modified to account for the more unusual cases.

Stimulation

In Section 5.1.4, the notion of arousal – those changes in organismic functioning associated with the desynchronisation of brain voltage cycles – was discussed. Pfaff (2006) has suggested that arousal in any one system of the organism can induce arousal – and hence, heightened performance – in the other systems. For instance, physical activity can improve mental functioning. This notion of generalised arousal was presented earlier along with a wide variety of other evidences in support of the contention that stimulation is an important human need yet one neglected in the research literature on needs.

Since stimulation is a need, the OCI suggests that opportunities for stimulation should elicit interest. A number of measures of stimulation were made in this study, of which two – Emotional Mode Number and Max. Colour Vividness – demonstrated significant correlations with lesson interest. Emotional Mode Number was a measure of the number of pedagogies employed which might stimulate an emotional response in students. Examples included humour, stories, surprise, and positive encouragement. Emotional Mode Number was highly positively correlated with interest for classes of 22 students or more, but not for smaller classes. As for Max. Colour Vividness, this variable was found to be positively correlated with interest for high prior interest students only. Unfortunately, these two results appear to have rather limited practical value. This does not mean, however, that stimulation is an insignificant factor in science lesson interest but that the present study provided insufficient data upon which to found far-reaching conclusions. This failure can be attributed, in part, to: a) the preliminary nature of the observation instruments; and b) the limited range of stimulation pedagogies employed by teachers in the lessons observed. Future research might attend to these issues.

Another variable with a potentially important stimulation role is novelty. Since novelty has many effects on interest, it is treated separately, below.

Novelty

It is widely acknowledged by practitioners and theoreticians alike that novelty is effective in piquing student interest. This mild observation belies the complexity of the interactions between novelty and interest in the classroom, however. First, different types of novelty (e.g., complete novelty and short-term novelty) have different effects on interest. Second, novelty is positively associated with task difficulty. And third, novelty appears to have a role in the elicitation of all emotions, not just interest. Each of these relationships has a bearing on interest management in science lessons and has been treated in depth in earlier sections. What follows is a summary of the most pertinent findings and their implications for science teaching practice.

The complete novelty variable most significantly correlated with lesson interest was Visual Novelty Avg. – that is, the average level of unusualness of visual stimuli employed by the teacher. This variable was found to be significantly correlated with interest for all interest sub-groups and it suggests that teachers might significantly improve lesson interest simply by using visual materials that show the unfamiliar and the bizarre. Aural Novelty Max. was also found to correlate positively and significantly with lesson interest, although the degree of significance varied in inverse proportion to the students' prior interest levels (see Section 9.8.3). This result also has clear implications for the improvement of science lesson interest.

Short-term novelty is a measure of experiential variety in a given time frame. Of the short-term novelty variables measured, two variables – Knowledge Time and Activity Number – proved to have the most significant influence on interest in the lessons measured, although these effects were only detected for students with higher prior interest (see Sections 9.7.4 and 9.8.2). It is hypothesised here that these results were largely due to the greater expenditure of effort by these students, and the consequent increases in mental fatigue and the need for rest. Lower interest students would likely demonstrate similar associations if they were more thoroughly engaged in lesson experiences. This calls for the judicious management of instructional activity sequencing.

The second factor with a broad relationship to novelty is challenge, measured in this study by the Difficulty scale of the SLIS. Since the relationships between these variables have already been extensively discussed, no further comment is needed at this point except to reiterate that teachers ought to attend to the amount of novel material they present in case their less-capable students disengage.

The third aspect of the novelty-interest relationship derives from emotion theory. As discussed in Chapter 4, some researchers have proposed that novelty is an essential factor in the elicitation of all emotion. Assuming this to be so, there should be a positive correlation between the degree of novelty experienced in science classes and the general affective stimulation of the students. Assuming, further, that: a) humans have a basic need for stimulation; and b) the stimulation of any organismic system promotes arousal and enhanced functioning in all other systems, it follows that increased lesson novelty will improve the general quality of student lesson experiences – at least up to some ceiling level.

Interactions between Teacher Behaviour Dimensions

Early design decisions in this study were significantly influenced by Ryans' (1960) three teacher-behaviour dimensions: X_o – understanding, friendly vs. aloof, restricted behaviour; Y_o – businesslike, systematic vs. unplanned, slipshod behaviour; and Z_o – stimulating, imaginative vs. dull, routine behaviour (see Section 1.1.3). Although these dimensions were originally identified as independent aspects of teacher behaviour, Ryans noted that they tend to overlap and be positively correlated with one another.

Results from the present study are in agreement with Ryans' observations. Although dimension Z_o – stimulating vs. dull behaviour – was the focus of the present work, aspects of dimension X_o and dimension Y_o were also investigated. And, despite some difficulty in determining the direction of causation in the relationships, it was nevertheless apparent that student lesson interest was related to such X_o-type factors as the quality of teacher-student interpersonal relationships, and such Y_o-type factors as the orderly administration of the classroom and the clarity with which content was presented. The number and diversity of these relationships and their reciprocity illustrate how lesson interest must be understood as a product of the entire teaching process, not just a few isolated ‘interesting’ actions.

10.3.5 The Development of Long-term Interest in Science

Although the principal focus of this study is situational interest, it necessarily touches on individual interest. One important matter in this regard is the conversion of the former into the latter.

The acquisition of an abiding interest in science is clearly of greater educational import than a transient experience of enthusiasm during a single lesson. While some students need little or no assistance from teachers in this regard, the development of an affinity for scientific disciplines is clearly not guaranteed. What follows, therefore, are suggestions by various scholars plus some observations derived from the present investigation regarding the enhancement of this process.

Over a century ago, John Dewey (1913) made a distinction between catching students’ interest and holding their interest. Since then, numerous attempts have been made to describe how this process occurs and how teachers might assist it (e.g., Hidi & Renninger, 2006; Todt & Schreiber, 1998). Krapp and Lewalter (2001) summarised various such models into three phases of interest development: 1) the triggering of situational interest by external stimuli for the first time; 2) the maintenance of situational interest throughout a particular learning phase; and 3) the onset of an enduring predisposition to engage with the specified class of objects/stimuli. Clearly, this description is an abstraction of the more fluid reality, but it provides a useful framework for discussion. Equally clearly, these matters are practically relevant only to those students who have not already acquired an interest in science and thus must be led to it during schooling.

The first phase – the initial triggering of interest – is quite readily achieved by teachers and the techniques can be broadly summarised as strategies that have their effect by appealing to universal and quickly satisfied needs, especially the needs for physical or emotional stimulation. Thus, jokes, explosions, chocolate rewards, and footage of two-headed crocodiles eating baby antelopes can reasonably be expected to catch student interest. Dewey, however, made a scathing criticism of such techniques:

> When things have to be made interesting, it is because interest itself is wanting. Moreover, the phrase is a misnomer. The thing, the object, is no more interesting than it was before. The appeal is simply made to the child's love of something else. He is excited in a given direction, with the hope that somehow or other during this excitation he will assimilate something otherwise repulsive. (p.11)

To some extent, he made a valid point. Teachers might set off nitroglycerine, ignite balloons of pure hydrogen – even set themselves alight – and yet elicit not the slightest interest from students in the underlying combustion equations. An allied problem arising in the context of science textbooks is that of seductive details – those snippets of information which are intriguing but irrelevant to the central concept being explicated. Considerable research has been undertaken into this topic (e.g., Garner, Gillingham, & White, 1989; Wade & Adams, 1990; Harp & Mayer, 1998; Schraw, 1998) and scholars hold a variety of opinions on the matter. While the intricacies of the debate cannot be covered here, it is the author's opinion that an extreme position on seductive details – and other interest triggers – is unwarranted since they represent the entirety of neither the interest development problem nor its solution. Catching student interest is an essential strategy but it must be recognised as only one contribution to the overall interest development process.

What, then, is needed for interest to develop to the second phase and beyond? The OCI suggests that interest will develop a more enduring character whenever a person identifies an object/topic as having the potential to fulfill needs that are more enduring or recurrent. Thus, the transition from 'catch' to 'hold' in science lessons implies a shift in the nature of the needs being fulfilled.

As discussed earlier, science classes most readily afford opportunities for intellectual growth. Growth needs are not only fulfilled in a different way and at a slower rate to the stimulation needs, but it is often more difficult for students to perceive a connection between the stimulus and the need fulfillment. For these reasons, strategies which maintain interest are not only different to those which trigger interest, they are more difficult for teachers to manage and less guaranteed of success. Thus, if there is benefit for science educators in advice on catching interest, there is even greater benefit in advice on scaffolding interest from trigger to maintenance. Some suggestions for achieving the latter are provided below. They are presented in summary form only and include reiterations of suggestions made in earlier sections. Note that no attempt is made here to suggest how to promote Krapp and Lewalter's third phase – the transition from temporarily held interest to individual interest. This final phase is the one least within the teacher's control and the least certain of attainment. Nevertheless, one would expect a positive correlation between success in promoting the first two phases and attainment of the third.

So, how can student interest in science be maintained? First, improving students' perceptions of the personal relevance of tasks tends to improve interest, as does improving goal proximity. Second, teachers ought to differentiate task difficulty levels to ensure that each student is undertaking work at an optimal level of challenge. Third, teachers can capitalise on circumstantial interest opportunities – in particular, student questions prompted by their exposure to new concepts. And fourth, teachers can themselves create 'needs' by building anticipation for answers, results, and solutions within the context of class discussions and investigations. The clarification and development of such strategies would seem to be a profitable – if not, indeed, vital – direction for future research.

The suggestions above represent devices for scaffolding interest in core science lesson content – that is, the material about which education is primarily concerned yet in which students are prone to experience little or no interest. Such recommendations would likely gain the approbation of John Dewey and of those contemporary scholars who fear that seductive details and related interest triggers are damaging. And yet it is suggested here that they represent only half the story. The findings of the present study indicate that science lesson interest is an outcome not simply of a small set of specific teacher actions but of a holistic educational experience. Indeed, some of the evidence reported here indicates the existence of an ‘interest momentum’ by which students who have previously had positive experiences in science lessons – or with a particular teacher – interpret current lessons as interesting regardless of any objective interestingness. This notion finds support from Schiefele and Csikszentmihalyi (1994) who reported a number of studies which found that positive affective experiences during learning episodes strengthened the students’ motivation to learn in future.

If we assume this ‘interest momentum’ principle to be valid, then a whole range of classroom environment phenomena become relevant to interest maintenance. For instance, we must review the role of the ‘catch’ strategies, since things which elicit momentary interest have beneficial effects beyond their obvious value for grabbing attention. Carefully timed ‘catch’ events can provide a break in the classroom routine and thus stave off boredom arising from extended note-taking or problem-solving episodes. ‘Catch’ events are also capable of fulfilling various stimulation needs. Thus, the strategic use of interest triggers can cultivate in students the expectation that science lessons are not monotonous marathons of concentration but dynamic and diverse experiences. Similarly, the results of the present study show that student lesson interest is negatively correlated with the level of intra-student distraction. This implies that effective behaviour management will foster within students positive expectations regarding the lesson environment and so enhance their positivity toward science as a subject. Finally, efforts expended by teachers to develop positive relationships with students will also pay dividends in improved science lesson interest.

Overall then, the scaffolding of student interest from ‘catch’ to ‘hold’ involves a diverse range of strategies and skills. It is not something that can be achieved by a single tactic, nor by isolated events, nor even by individual excellent lessons. Rather, it requires a sustained process of high-quality instruction which addresses a wide range of classroom environment variables. Given that interest in science tends to decline in the later years of schooling, the importance of interest management increases with student age.

10.3.6 Implications for Administrators

In the previous section it was argued that interest in science classes is not simply the product of a small set of discrete strategies but is influenced by the entire classroom experience. And classroom experiences, in turn, are not simply the product of one teacher's pedagogical repertoire but are influenced by decisions arising from diverse places in the educational hierarchy. While it is not possible to address all such matters here, the findings of the present study point to some issues that deserve attention by administrators.

The first of these is philosophical in nature and relates to the purposes for which science education – and, indeed, education in general – is intended. Numerous authors have observed that academic performance should not be the only goal of schooling. Schiefele and Csikszentmihalyi (1994), for instance, have commented that "the quality of students' experience is an outcome measure in its own right" (p. 253). In the present study, substantial evidence has been presented to indicate that there exists a significant positive correlation between lesson experience quality (as reflected in lesson interest) and scholastic performance. Thus, actions which enhance the former also enhanced the latter – a classic win/win situation. Unfortunately, however, not all policy decisions support this harmonious relationship and some, in fact, may undermine it.

A prime example of an interest-impairing policy is a heavily prescribed curriculum. Two factors are relevant in this regard: a) subject matter flexibility; and b) time flexibility. An inflexible curriculum limits the degree to which teachers can tailor learning experiences to their students. To some extent, this problem can be ameliorated if time is available to implement strategies such as those previously discussed. If, however, the mandated curriculum is very extensive – or the teaching time very constrained – teachers will almost inevitably adopt a 'content cramming' style of instruction which is most detrimental to the nurturing of interest.

A related issue implied by the current findings concerns the time made available to teachers for lesson preparation. The interest-enhancing strategies suggested in this chapter all demand that teachers invest time in lesson design and resource development. In some cases, the additional time investment is relatively large while in other instances it is only small. Cumulatively, however, the creation of a comprehensive set of lesson resources which achieves sustained student interest throughout a unit of work entails a very substantial time cost. Thus, when teachers are obliged to spend the majority of their non-contact time on administrative tasks or when they must repeatedly construct new units – or even entire terms and years of work – to respond to systemic curriculum revisions, lesson quality and student interest inevitably suffer.

A third matter relates to curriculum content. A complaint made frequently by students and taken up by numerous education scholars (e.g., Dillon, 2009; Gilbert, 2006) is that science curricula lack relevance. As noted in Section 2.2.2, Stuckey et al. (2013) addressed this problem by first clarifying the nature of the word relevance. They identified five meanings, including: relevance as connoting students' perception of personal meaningfulness, and relevance as connoting significance for society as a whole. It is not practical to discuss here the range of issues raised by these authors but one matter is salient in the present context. According to the principles of the OCI, relevance – in the sense meant by students – is entirely a matter of personal meaningfulness; it is always in the eye of the beholder. What is perceived as relevant by politicians, educators, practicing scientists, and employers may elicit little or no interest in teenage science pupils, no matter how significant or urgent it may be from an 'objective' point of view. Thus, inasmuch as the problem of relevance relates to the motivational value of curriculum content, the solution can be obtained in part by the efforts of teachers to explicate connections between science lesson content and real-world applications. Some share of the responsibility, however, must lie with the administrators of curricula. Teachers will have difficulty clarifying the connection between lessons and life if those links are feeble or non-existent.

A final issue for administrators to consider in regard to student interest is class composition. Two factors are relevant in this regard, the first being class size and the second being student aptitude. In the present study, a significant negative correlation was found between class size and student interest. Assuming that the present findings apply more broadly, it is clear that reductions in science class sizes will pay dividends in the form of improved student interest and consequent performance in the subject. As for the second factor, the present study found that prior interest in science was significantly correlated with general academic aptitude and that the least interested – and usually least adept – students responded to class environment variables in ways distinctly different to their more interested peers. Notwithstanding the many valid arguments to the contrary, these results speak in favour of science class streaming in the middle school years, with highly interested students participating in theoretical work and the least interested students participating in a more practically-based curriculum.

10.4 Conclusion

The late Jacob Gould Shurman, erstwhile professor of philosophy and president of Cornell University, once commented that, "Interest is the most important word in education" (cited in DeGarmo, 1904). The present study has furnished evidence for a related, if more modest, conclusion regarding science education: interest is the most important *neglected* word. The data gathered here has shown that interest is a key factor in learning and yet science teachers and researchers alike have consistently under-rated its significance. Thus, we see widespread boredom amongst students of science yet an almost complete absence of research into interest in actual science classrooms.

Psychology scholar Mihaly Csikszentmihalyi has written on the general matter of educational motivation as follows:

> the chief impediments to learning are not cognitive. It is not that students cannot learn; it is that they do not wish to. If educators invest a fraction of the energy they now spend trying to transmit information in trying to stimulate the students' enjoyment of learning, we could achieve much better results. (1990b, p. 115)

Csikszentmihalyi's comments echo findings of the current work. Interest is more than merely relevant to learning, it is critical. Consequently, if science educators are to correct the interest deficit so apparent in the later years of schooling they must do more than acknowledge the significance of interest, they must make student interest an explicit goal.

Such an assertion presents a problem, however. At every level of educational decision-making there already exists a multitude of weighty issues clamouring for attention and a surfeit of strategies offering to address them. The suggestion that interest be added to an already bottomless improvement agenda is unlikely to inspire enthusiasm among reform-fatigued educators. And, even if interest were to be made an educational focus for a school, a region, a state, or a country, success could not be achieved by any single edict or program. As has been shown, significant advances in student interest require the improvement of a suite of pedagogical practices, many of which are quite different from one another and some of which are in tension. Indeed, rather than interest being just another box to be ticked or hole to be plugged, it demands no less than the re-prioritising of an entire dimension of pedagogy.

Given these challenges, successful solutions to the science interest deficit should not be expected from simplistic or formulaic strategies. Meaningful improvements in this area will be the product of integrated approaches which address the whole fabric of scholastic instruction and which ultimately produce conscious awareness and the manifest improvement of interest in every science class every day. The teachers and administrators who will be most successful in this endeavour will be those having not only well-developed knowledge of conventional instructional techniques but those also possessing a thorough knowledge of motivational dynamics, the capacity to think innovatively, and high levels of personal motivation. In short, improvements in science lesson interest will require novel solutions from creative people.

And thus, this study comes full circle. It was my original goal to investigate in detail the nature and role of creativity in the teaching of science. While this goal was abandoned, aspects of science teaching to which creativity might apply have been clarified nevertheless, and the need for teacher creativity has become even more apparent. Future work on student science interest should not merely focus on the phenomenon of interest *per se*, but also on the identification, development, and deployment of those teacher attributes best suited to eliciting it.

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Appendices

Appendix A: Ford and Nichol's taxonomy of human goals (Source: Ford, 1992)

DESIRED WITHIN-PERSON CONSEQUENCES	
Affective Goals	
Entertainment	Experiencing excitement or heightened arousal; Avoiding boredom or stressful inactivity
Tranquility	Feeling relaxed and at ease; Avoiding stressful over-arousal
Happiness	Experiencing feelings of joy, satisfaction, or well-being; Avoiding feelings of emotional distress or dissatisfaction
Bodily Sensations	Experiencing pleasure associated with physical sensations, physical movement, or bodily contact; Avoiding unpleasant or uncomfortable bodily sensations
Physical Well-Being	Feeling healthy, energetic, or physically robust; Avoiding feelings of lethargy, weakness, or ill-health
Cognitive Goals	
Exploration	Satisfying one's own curiosity about personally meaningful events; Avoiding a sense of being uniformed or not knowing what's going on
Understanding	Gaining knowledge or making sense out of something; Avoiding misconceptions, erroneous beliefs, or feelings of confusion
Intellectual Creativity	Engaging in activities involving original thinking or novel or interesting ideas; Avoiding mindless or familiar ways of thinking
Positive Self-Evaluations	Maintaining a sense of self-confidence, pride, or self-worth; Avoiding feelings of failure, guilt, or incompetence
Subjective Organization Goals	
Unity	Experiencing a profound or spiritual sense of connectedness, harmony or oneness with people, nature, or a greater power; Avoiding feelings of psychological disunity or disorganization
Transcendence	Experiencing optimal or extraordinary states of functioning; Avoiding feeling trapped within the boundaries of ordinary experience

DESIRED PERSON-ENVIRONMENT CONSEQUENCES	
Self-Assertive Social Relationship Goals	
Individuality	Feeling unique, special, or different; Avoiding similarity or conformity with others
Self-Determination	Experiencing a sense of freedom to act or make choices; Avoiding the feeling of being pressured, constrained, or coerced
Superiority	Comparing favorably to others in terms of winning, status, or success; Avoiding unfavorable comparisons with others
Resource Acquisition	Obtaining approval, support, assistance, or validation from others; Avoiding social disapproval or rejection
Integrative Social Relationship Goals	
Belongingness	Building of maintaining attachments, friendships, intimacy, or a sense of community; Avoiding feelings of social isolation or separateness
Social Responsibility	Keeping interpersonal commitments, meeting social role obligations, and conforming to social and moral rules; Avoiding social transgressions and unethical or illegal conduct
Equity	Promoting fairness, justice, reciprocity, or equality; Avoiding unfair or unjust actions
Resource Provision	Giving approval, support, assistance, advice, or validation to others; Avoiding selfish or uncaring behavior
Task Goals	
Mastery	Meeting a challenging standard of achievement or improvement; Avoiding incompetence, mediocrity, or decrements in performance
Task Creativity	Engaging in activities involving artistic expression or creativity; Avoiding tasks that do not provide opportunities for creative action
Management	Maintaining order, organization, or productivity in daily life tasks; Avoiding sloppiness, inefficiency, or disorganization
Safety	Being unharmed, physically secure, and free from risk; Avoiding threatening, depriving, or harmful circumstances

Appendix B: Science Classroom Interest Observation Schedule – Teacher Interaction Form

Science Classroom Interest Observation Schedule – Teacher Interaction Form

Class ID

Date

Non-Directed Questions:

Science Classroom Interest Observation Schedule

Sheet 1: Observation Template

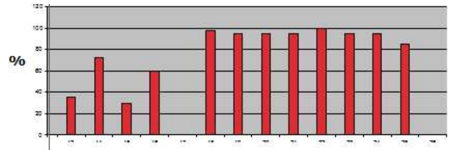
Version 5.10

Password: zx

School Code	MSHS
Class Code	8A
Date	4-Aug-09
Observn. No.	1
No. in class	16
Class Duration	50

% Calculator

%	#
5	1
10	2
20	3
30	5
40	6



Missed observations = 'X' >

					24	26	28	30	32	34	36	38	40	42	44	46	48	50	Avg.	Tot.1	Tot.2	Max	Min	Nov.	Dis.
1. Class Obs.	Interest Responses	Student Attention	% of class focussed on lesson activity: Start	%	40	90	40	65		100	95		95	100	95	95	80		82						
			% of class focussed on lesson activity: End	%	30	55	20	55		95	95	95			95	95	90		75						
			Average	%	35	73	30	60		98	95	95	95	100	95	95	85		79			100	20		
		Student Behaviour	Worst behaviour: Start	0-5	2	1	3	0		1	0		0	0	0	0	0		0.80						
			Worst behaviour: End	0-5	2	2.5	2	1		0	0	0			0	0	0		0.90						
			Average	0-5	2.0	1.8	2.5	0.5		0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.85			3			
		Correction Intensity	Level teacher correction intensity	0-4	1	0	3	2	0	1	0	0	0	0	0	0	0		1.86	7		3			
	Disruptions		Level non-student distractions	1-3		2														5		2			

					24	26	28	30	32	34	36	38	40	42	44	46	48	50	Avg.	Tot.1	Tot.2	Max	Min	Nov.	Dis.
Location		Classroom	Present/ absent	x/ blank																2					
		Sports hall	Present/ absent	x/ blank																x					
		School grounds	Present/ absent	x/ blank																x					
		Other <id here>	Present/ absent	x/ blank																x					
																				1					
Resources Used	Items	Black/ whiteboard	Present/ absent	x/ blank																x					
		OHP	Present/ absent	x/ blank																x					
		Slideshow	Present/ absent	x/ blank																8					
		Handouts	Present/ absent	x/ blank	x	x	x	x	x											9					
		Printed visual	Present/ absent	x/ blank																x					
		Video	Present/ absent	x/ blank						x	x	x	x	x	x	x	x			8					
		Smartboard	Present/ absent	x/ blank																x					
		Physical model	Present/ absent	x/ blank																x					
		Computer simulation	Present/ absent	x/ blank																x					
		Sci apparatus <id here>	Present/ absent	x/ blank																x					
		Sample - non living <id>	Present/ absent	x/ blank																x					
		Sample - living <id here>	Present/ absent	x/ blank																x					
		Audio player	Present/ absent	x/ blank																x					
		Other 1 <id here>	Present/ absent	x/ blank																x					
		Other 2 <id here>	Present/ absent	x/ blank																x					
	Object Proximity	Objects	No. objects displayed (total #)	#																					
			No. objects handled (max. #)	#																					
		Students	No. students handling (max. %)	%																					
																				3					

Appendix C: Science Classroom Interest Observation Schedule – Template; Rows 49-94

2. Pedagogy

					24	26	28	30	32	34	36	38	40	42	44	46	48	50	Avg.	Tot.1	Tot.2	Max	Min	Nov.	Dis.
Teaching Actions	Teacher activity	Lecture w/out interaction	Present/ absent	x/ blank																					
		Class discussion	Present/ absent	x/ blank		x	x	x												5					
		Writing on board	Present/ absent	x/ blank																					
		Activity explanation	Present/ absent	x/ blank																					
		Reading to class	Present/ absent	x/ blank																					
		Supervise work (passive)	Present/ absent	x/ blank	x					x	x	x	x	x	x	x	x								
		Supervise work (active)	Present/ absent	x/ blank																x					
		Demo 1 <id here>	Present/ absent	x/ blank																					
		Demo 2 <id here>	Present/ absent	x/ blank																					
		Other 1 <id here>	Present/ absent	x/ blank																					
		Other 2 <id here>	Present/ absent	x/ blank																					
	Modelling		Apparent level of teacher interest	1-3		2	2	2											2.00	12		2			
																				5					
Learning Focus	Activity Type	Listening/ watching only	Present/ absent	x/ blank					x	x	x	x	x	x	x	x	x			11	44				
		Class discussion	Present/ absent	x/ blank		x	x	x												5	20				
		Copying notes	Present/ absent	x/ blank																7	28				
		Written problem solving	Present/ absent	x/ blank	x															3	12				
		Reading text (to self)	Present/ absent	x/ blank																x	x				
		Reading text (out loud)	Present/ absent	x/ blank																2	8				
		Gp. Discuss. (w/out teacher)	Present/ absent	x/ blank																x	x				
		Create/ design <id here>	Present/ absent	x/ blank																x	x				
		Other 1 <id here>	Present/ absent	x/ blank																x	x				
		Other 2 <id here>	Present/ absent	x/ blank																x	x				
																				5					
					24	26	28	30	32	34	36	38	40	42	44	46	48	50	Avg.	Tot.1	Tot.2	Max	Min	Nov.	Dis.
	Activity Purpose	Acquire new knowledge	Present/ absent	x/ blank																10	10				
		Revise/ reinforce knowledge	Present/ absent	x/ blank	x	x	x	x	x											7	7				
		Acquire a new skill	Present/ absent	x/ blank																x	0				
		Practise a new skill	Present/ absent	x/ blank																x	0				
		Preparatory activity	Present/ absent	x/ blank																x	0				
		Experience phenom <id here>	Present/ absent	x/ blank						x	x	x	x	x	x	x	x			8	8				
		Entertain./ play <id here>	Present/ absent	x/ blank																x	0				
		Other 1 <id here>	Present/ absent	x/ blank																x	0				
		Other 2 <id here>	Present/ absent	x/ blank																x	0				
																				3					
Other Actions		Admin activity (non-break)	Present/ absent	x/ blank																1					
		Venue shift (break)	Present/ absent	x/ blank																	x				
		Gear deployment (break)	Present/ absent	x/ blank					x												1				
		Teacher absent (break)	Present/ absent	x/ blank																	x				
		Deliberate break time (break)	Present/ absent	x/ blank																	x				
		Discipline event (non-break)	Present/ absent	x/ blank																x					
		Other 1 - break <id here>	Present/ absent	x/ blank																1	1				
		Other 2 - non-break <id here>	Present/ absent	x/ blank																x	x				
																				1	2				

Mode	Category	Sub-category	Item	Description	Scale	24	26	28	30	32	34	36	38	40	42	44	46	48	50	Avg.	Tot.1	Tot.2	Max	Min	Nov.	Dis.
3. Sensory mode [1]	Sight	Type - object	Number	No. of sight objects used (a)	#	5	5	5	5	6	6	6	6	6	6	6	6	6					6			
			Familiarity	Familiarity level	1-3	1	1	1	1	1	1	1	1	1	1	1	1	1		1.04	25		2			
		Movt. - object	Complexity	Level of complexity	1-3					2	2	2	2	2	2	2	2	2		2.00	9		2			
		Vividness	Colour variety	Number of colours used	1-3	1	1	1	1	3	3	3	3	3	3	3	3	3		2.04	25		3			
			Intensity	Level of visual clarity	1-3	2	2	2	2	2	2	1.5	2	2	2	2	2	2		2.06	25		3			2.06
																									4	0.06
	Sound	Type	Number	No. of aural objects used (b)	#		1	1	1	3	3	3	3	3	3	3	3	3					3			
			Familiarity	Familiarity level	1-3		1	1	1	1	1	1	1	1	1	1	1	1		1.00	22		1			
		Intensity		Level of sound intensity	1-3		2	2	2	2	2	2	2	2	2	2	2	2		1.95	22		2			1.95
																									2	-0.05
	Touch	Type	Number	No. of tactile objects/ object sets used	#																		x			
			Involvement	Degree of user involvement	1-3															x	x		x			
			Familiarity	Familiarity level	1-3															x	x		x			
		Pleasurableness		Level of pleasantness	1-3															x	x		x			
		Intensity		Level of experience intensity	1-3															x	x		x			
																									x	
	Smell	Type	Number	No. of smell sense objects used	#																		x			
			Familiarity	Familiarity level	1-3															x	x		x			
		Pleasurableness		Level of pleasantness	1-3															x	x		x			
		Intensity		Level of experience intensity	1-3															x	x		x			
																									x	
	Taste	Type	Number	No. of taste objsects used	#																		x			
			Familiarity	Familiarity level	1-3															x	x		x			
		Pleasureableness		Level of pleasantness	1-3															x	x		x			
		Intensity		Level of taste intensity	1-3															x	x		x			
																									x	

Appendix C: Science Classroom Interest Observation Schedule – Template; Rows 131-152

4. Channel [2]

Dimension	Category	Item	Description	Scale	24	26	28	30	32	34	36	38	40	42	44	46	48	50	Avg.	Tot.1	Tot.2	Max	Min	Nov.	Dis.
Mental	Challenge	Not assessed on SCIOS; see SLIS																							
Physical	Intensity		Level of activity demand (max.)	1-3	1	1	1	1	1	1	1	1	1	1	1	1	1		1.00	25		1		0	
																								0	
Emotional	Stories	**Told by teacher**	Present/ absent	x/ blank					x	x	x	x	x	x	x	x	x			10					
		Told by a student	Present/ absent	x/ blank																0					
	Modes	**Negative Events**	Level of student response to stimulus	1-3					2	2	1		2	1	1	1	1		1.44	9	1	2			
		Humour	Level of student response to stimulus	1-3															x	x	x	x			
		Surprise	Level of student response to stimulus	1-3								1							1.00	1	1	1			
		Positive Events	Level of stimulus positivity	1-3															x	x	x	x			
		Conflict	Level of interpersonal conflict	1-3															x	x	x	x			
		Anticipation Events	Presence/ absence	x/ blank						x	x	x	x	x	x	x	x			8	1				
																			1.22	2	2	2		1	
	Global Themes	**Scandal/ crime**	Level of student response to stimulus	1-3						2	1		1				1		1.25	4		2			
		Danger	Level of student response to stimulus	1-3										1	1	1			1.00	3		1			
		Injury/ violence	Level of student response to stimulus	1-3									1						1.00	1		1			
		Death	Level of student response to stimulus	1-3					2	2	1		1						1.60	5		2			
		Power	Level of student response to stimulus	1-3															x	x		x			
		Sex	Level of student response to stimulus	1-3															x	x		x			

Appendix D: Science Classroom Interest Observation Schedule – Summary Sheet; Rows 1-43

Science Classroom Interest Observation Schedule

Sheet 3: Results Summary

Version 5.10

Password: zx

Category		Variable	Name	Result	Units	Type	
General		No. students (#)	STU.NUM	**16**	#		
		Class duration	CLS.TIM	**50**	min		
		Lesson Time	LSN.TIM	**46**	min		

Category		Variable	Name	Result	Units	Type	
Outcomes	**Attentiveness**	Attentiveness (avg.)	ATT.AVG	**79**	%	< Interest	I
		Attentiveness (max.)	ATT.MAX	**100**	%	< Interest	I
		Attentiveness (min.)	ATT.MIN	**20**	%	< Interest	I
		Interest peaks (no.)	PKS.NUM	**2**	#		
	Behaviour	Behaviour (wtd. avg.)	BEH.AVG	**0.85**	0-5	< Interest	I
		Behaviour (max.)	BEH.MAX	**3**	0-5	< Interest	I
	Participation	% Students volunteering (>0)	STU0.PER	**6**	%	< Interest	I
		% Students volunteering (>2)	STU2.PER	**0**	%	< Interest	I
		% Students volunteering (>4)	STU4.PER	**0**	%	< Interest	I
		% Students volunteering (>6)	STU6.PER	**0**	%	< Interest	I
	Class Involvement	No. Teacher/ student interaction (total)	QUN.NUM	**14**	#	< Interest	I
		% Students actively involved in class	STU.PER	**38**	%	< Interest	I

Category		Variable	Name	Result	Units	Type	
Distractions	**Behaviour**	Behaviour (wtd. avg.)	BEH.AVG	**0.85**	0-5	< Distractions	D
		Behaviour (max.)	BEH.MAX	**3**	0-5	< Distractions	D
	Corrections	Correction events (total)	COR.NUM	**7**	#		
		Correction intensity (wtd. avg.)	COR.AVG	**1.86**	0-4		
		Correction intensity (max.)	COR.MAX	**3**	0-4		
	Other Distractions	Classroom distractions (total)	DIS.TIM	**10**	min	< Distractions	D
		Classroom distractions (max.)	DIS.MAX	**2**	1-3	< Distractions	D
	Inadequate Intensity	Visual difficulties	VIS.VAR	**0.06**	-1 > 1	< Distractions	D
		Aural difficulties	AUR.VAR	**-0.05**	-1 > 1	< Distractions	D

Appendix D: Science Classroom Interest Observation Schedule – Summary Sheet; Rows 44-119

Category		Variable	Name	Result	Units	Type	
Inputs	**Resources**	Teaching resources variety (total)	RES.NUM	3	#	< Novelty	N
		Student activities variety (total)	ACT.NUM	5	#	< Novelty	N
		Strategy variety (total)	STR.NUM	8	#	< Novelty	N
	Input Type Durations	New knowledge (total)	KNO.TIM	74	% min	< Growth (Competence)	G
		New skills (total)	SKL.TIM	0	% min	< Growth (Competence)	G
		Stimulation events (total)	STIM.TIM	0	% min	< Stimulation	S
		Pleasure events (total)	PLE.TIM	0	% min	< Stimulation	S
		Discrete breaks (total)	BRK.NUM	3	#		
		Breaks (total)	BRK.TIM	4	min		
		Stories (total)	STO.TIM	20	min		
	Sensory Impact	Familiarity of visual stimuli (wtd. avg.)	V.FAM.AVG	1.04	1-3	< Novelty	N
		Familiarity of visual stimuli (max.)	V.FAM.MAX	2	1-3	< Novelty	N
		No. of visual stimuli (total)	V.NUM	6	#	< Novelty	N
		Variety of colour (wtd. avg.)	V.COL.AVG	2.04	1-3	< Stimulation	S
		Variety of colour (max.)	V.COL.MAX	3	1-3	< Stimulation	S
		Vividness of movement (wtd. avg.)	V.MOV.AVG	2.00	1-3	< Stimulation	S
		Vividness of movement (max.)	V.MOV.MAX	2	1-3	< Stimulation	S
		Familiarity of aural stimuli (wtd. avg.)	A.FAM.AVG	1.00	1-3	< Novelty	N
		Familiarity of aural stimuli (max.)	A.FAM.MAX	1	1-3	< Novelty	N
		No. of aural stimuli (total)	A.NUM	3	#	< Novelty	N
		Familiarity of tactile stimuli (wtd. avg.)	T.FAM.AVG	x	1-3	< Novelty	N
		Familiarity of tactile stimuli (max.)	T.FAM.MAX	x	1-3	< Novelty	N
		No. of tactile stimuli (total)	T.NUM	x	#	< Novelty	N
		Vividness of tactile stimuli (wtd. avg.)	T.VIV.AVG	x	1-3	< Stimulation	S
		Vividness of tactile stimuli (max.)	T.VIV.MAX	x	1-3	< Stimulation	S
		Pleasurableness of tactile stimuli (wtd. avg.)	T.PLE.AVG	x	1-3	< Stimulation	S
		Pleasurableness of tactile stimuli (max.)	T.PLE.MAX	x	1-3	< Stimulation	S
		Familiarity of olfactory stimuli (wtd. avg.)	O.FAM.AVG	x	1-3	< Novelty	N
		Familiarity of olfactory stimuli (max.)	O.FAM.MAX	x	1-3	< Novelty	N
		No. of olfactory stimuli (total)	O.NUM	x	#	< Novelty	N
		Vividness of olfactory stimuli (wtd. avg.)	O.VIV.AVG	x	1-3	< Stimulation	S
		Vividness of olfactory stimuli (max.)	O.VIV.MAX	x	1-3	< Stimulation	S
		Pleasurableness of olfactory stimuli (wtd. avg.)	O.PLE.AVG	x	1-3	< Stimulation	S
		Pleasurableness of olfactory stimuli (max.)	O.PLE.MAX	x	1-3	< Stimulation	S
		Familiarity of gustatory stimuli (wtd. avg.)	G.FAM.AVG	x	1-3	< Novelty	N
		Familiarity of gustatory stimuli (max.)	G.FAM.MAX	x	1-3	< Novelty	N
		No. of gustatory stimuli (total)	G.NUM	x	#	< Novelty	N
		Vividness of gustatory stimuli (wtd. avg.)	G.VIV.AVG	x	1-3	< Stimulation	S
		Vividness of gustatory stimuli (max.)	G.VIV.MAX	x	1-3	< Stimulation	S
		Pleasurableness of gustatory stimuli (wtd. avg.)	G.PLE.AVG	x	1-3	< Stimulation	S
		Pleasurableness of gustatory stimuli (max.)	G.PLE.MAX	x	1-3	< Stimulation	S
		Sensory mode variety (total)	MODE.NUM	2	1-5	< Novelty	N
		Sensory input variety (total)	INPUT.NUM	9	#	< Novelty	N
	Involvement Levels	Intensity of tactile involvement (wtd. avg.)	T.INT.AVG	x	1-3	< Stimulation	S
		Intensity of tactile involvement (max.)	T.INT.MAX	x	1-3	< Stimulation	S
		Intensity of physical involvement (wtd. avg.)	P.INT.AVG	1.00	1-3	< Stimulation	S
		Intensity of physical involvement (max.)	P.INT.MAX	1	1-3	< Stimulation	S
		Intensity of emotional involvement (all - wtd avg.)	E.INT.AVG	1.22	1-3	< Stimulation	S
		Intensity of emotional involvement (all - max.)	E.INT.MAX	2	1-3	< Stimulation	S
		No. of emotional types (total)	E.NUM	2	#	< Novelty	N
		No. of emotional involvement (total)	E.TIM	10	#	< Stimulation	S
		No. of high level emotional events (total)	E.NUM	0	#	< Stimulation	
		No. of 'channels' involved (total)	CHN.NUM	2	#	< Novelty	N
	Affiliation	Modelled interest (wtd. avg.)	MODEL.AVG	2.00		< Affiliation	A
		Modelled interest (max.)	MODEL.MAX	2.00		< Affiliation	A
		Teacher interaction (total)	TQ.TIM	10	min	< Affiliation	A
		No. Teacher requests (total)	TQ.NUM	15	#	< Affiliation	A
		% Students requested	TQ.PER	38	%	< Affiliation	A
		Deliberate anticipation events (total)	ANT.TIM	8	#		P

Appendix E: Science Classroom Interest Observation Schedule – Teacher Interaction Form Data Table

Science Classroom Interest Observation Schedule

Sheet 2: Teacher Interaction Form Data

Version 5.10

Password: zx

Student No.	From Teacher	From Student	Total
1	0	0	0
2	0	0	0
3	0	0	0
4	4	0	4
5	2	1	3
6	0	0	0
7	0	0	0
8	0	0	0
9	0	0	0
10	0	0	0
11	0	0	0
12	2	0	2
13	0	0	0
14	2	0	2
15	1	0	1
16	2	0	2
17			
18			
19			
20			
21			
22			
23			
24			
25			
26			
27			
28			
29			
30			
Qun Totals >	13	1	14
# Volunteering (>0) >	6	1	6
# Volunteering (>2) >		0	
# Volunteering (>4) >		0	
# Volunteering (>6) >		0	

MSHS	School Code
8A	Class Code
4-Aug-09	Date
1	Observn. No.
16	No. in class

Non-Directed Qus
2

Summary Data	
Input measures:	
No. Teacher Requests (total)	15
% Students Requested	38
Output measures:	
% Students Volunteering (>0)	6
% Students Volunteering (>2)	0
% Students Volunteering (>4)	0
% Students Volunteering (>6)	0
Overall involvement:	
No. Interactions (total)	14
% Students Involved (total)	38

Appendix F: Science Lesson Interest Survey

Science Lesson Interest Survey

Curtin University of Technology

Name: ____________________

		Disagree		Agree	
		SD	D	A	SA
1	Today's science lesson seemed to go fast.				
2	I found the work was easy to do. *				
3	I noticed that I was hungry throughout this lesson.				
4	The facts we learned today were new to me.				
5	This science class was boring. *				
6	The work we did in this lesson challenged my abilities.				
7	Other things I was thinking about made it difficult for me to concentrate.				
8	I had new experiences in this science lesson.				
9	I would like to have more science lessons like this one.				
10	I had some difficulty doing today's work.				
11	The temperature in class made me uncomfortable.				
12	The activities we did in this lesson I have done before. *				

		Disagree		Agree	
		SD	D	A	SA
13	Today's class didn't hold my attention. *				
14	What we did in science today was not hard to do. *				
15	I felt sick throughout this lesson.				
16	Everything we did in class today was familiar to me. *				
17	I did not enjoy our science class today. *				
18	Today's work was quite complicated.				
19	Other students distracted me in class today.				
20	The information given today was well-known to me. *				
21	This was an interesting science lesson.				
22	The work we did today was simple. *				
23	I was in pain during this class.				
24	I learned how to do new things in science today.				

Interest in Science Questionnaire

Curtin University of Technology

Name: ______________________

		Disagree SD	D	Agree A	SA	Office Use Only	
1	Sometimes I do science activities in my spare time, just for the fun of it.						
2	Doing science activities puts me in a good mood.						
3	I don't usually discuss science unless I have to.						O
4	Even before high school, science was something I thought about a lot.						
5	Studying science is not a valuable part of my school life.						O
6	When I am on the internet or in a library, I like to look up information about science.						
7	I would prefer not to study science in future years at school.						O
8	It is important to me to study science.						
9	To be honest, I just don't care about science.						O

Appendix H: Questionnaire on Teacher Interaction [2]

Curtin University of Technology

Questionnaire on Teacher Interaction

Name: ______________________

		Never				Always
1	This teacher talks enthusiastically about her/his subject.	0	1	2	3	4
2	This teacher trusts us.	0	1	2	3	4
3	This teacher seems uncertain.	0	1	2	3	4
4	This teacher gets angry unexpectedly.	0	1	2	3	4
5	This teacher explains things clearly.	0	1	2	3	4
6	If we don't agree with this teacher, we can talk about it.	0	1	2	3	4
7	This teacher is hesitant.	0	1	2	3	4
8	This teacher gets angry quickly.	0	1	2	3	4
9	This teacher holds our attention.	0	1	2	3	4
10	This teacher is willing to explain things again.	0	1	2	3	4
11	This teacher acts as if she/he does not know what to do.	0	1	2	3	4
12	This teacher is too quick to correct us when we break a rule	0	1	2	3	4
13	This teacher knows everything that goes on in the classroom.	0	1	2	3	4
14	If we have something to say, this teacher will listen.	0	1	2	3	4
15	This teacher lets us boss her/him around.	0	1	2	3	4
16	This teacher is impatient.	0	1	2	3	4
17	This teacher is a good leader.	0	1	2	3	4
18	This teacher realises when we don't understand.	0	1	2	3	4
19	This teacher is not sure what to do when we fool around.	0	1	2	3	4
20	It is easy to pick a fight with this teacher.	0	1	2	3	4
21	This teacher acts confidently.	0	1	2	3	4
22	This teacher is patient.	0	1	2	3	4
23	It's easy to make this teacher appear unsure.	0	1	2	3	4
24	This teacher makes sarcastic comments about us.	0	1	2	3	4

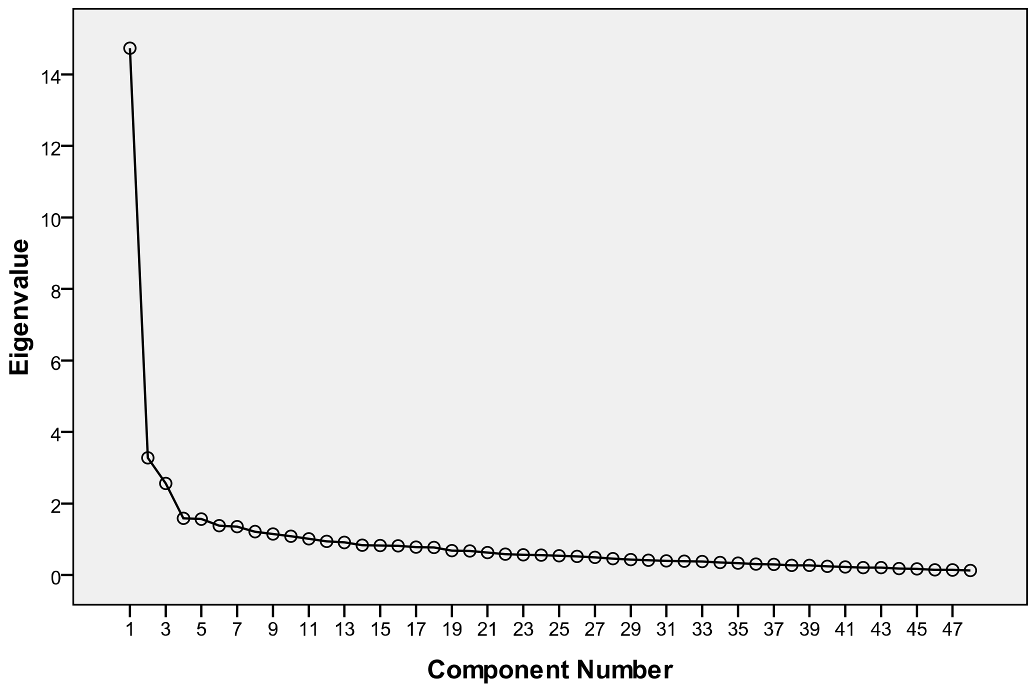
		Never				Always
25	This teacher helps us with our work.	0	1	2	3	4
26	We can decide some things in this teacher's class.	0	1	2	3	4
27	This teacher thinks that we cheat.	0	1	2	3	4
28	This teacher is strict.	0	1	2	3	4
29	This teacher is friendly.	0	1	2	3	4
30	We can influence this teacher.	0	1	2	3	4
31	This teacher thinks that we don't know anything.	0	1	2	3	4
32	We have to be silent in this teacher's class.	0	1	2	3	4
33	This teacher is someone we can depend on.	0	1	2	3	4
34	This teacher lets us decide when we will do the work in class.	0	1	2	3	4
35	This teacher puts us down.	0	1	2	3	4
36	This teacher's tests are hard.	0	1	2	3	4
37	This teacher has a sense of humour.	0	1	2	3	4
38	This teacher lets us get away with a lot in class.	0	1	2	3	4
39	This teacher thinks that we can't do things well.	0	1	2	3	4
40	This teacher's standards are very high.	0	1	2	3	4
41	This teacher can take a joke.	0	1	2	3	4
42	This teacher gives us a lot of free time in class.	0	1	2	3	4
43	This teacher seems dissatisfied.	0	1	2	3	4
44	This teacher is severe when marking papers.	0	1	2	3	4
45	This teacher's class is pleasant.	0	1	2	3	4
46	This teacher is relaxed about the rules.	0	1	2	3	4
47	This teacher is suspicious.	0	1	2	3	4
48	We are afraid of this teacher.	0	1	2	3	4

Lea ____ **Und** ____ **Unc** ____ **Adm** ____

HFr ____ **SRe** ____ **Dis** ____ **Str** ____

[2] Source: Dr Darrell Fisher, Curtin University of Technology. Used with permission.

Appendix I: Scree plot for the 48 items of the QTI indicating three significant components



Appendix J: Rotated component matrix for QTI results – principal components analysis; varimax rotation; three factors specified

Item	Component			Item	Component		
	1	2	3		1	2	3
Lea.1	0.587	-0.132	-0.085	HFr.1	0.686	-0.242	-0.090
Lea.2	0.593	-0.170	0.030	HFr.2	0.712	-0.175	-0.334
Lea.3	0.608	-0.233	0.107	HFr.3	0.787	-0.113	-0.175
Lea.4	0.570	-0.288	0.048	HFr.4	0.716	-0.010	-0.189
Lea.5	0.714	-0.168	-0.234	HFr.5	0.649	0.126	-0.279
Lea.6	0.674	-0.272	0.031	HFr.6	0.672	-0.151	-0.221
Und.1	0.731	-0.111	-0.097	SRe.1	0.356	0.061	-0.295
Und.2	0.700	-0.051	-0.097	SRe.2	0.382	0.369	0.107
Und.3	0.708	-0.075	0.017	SRe.3	0.169	0.416	0.059
Und.4	0.722	-0.206	-0.083	SRe.4	0.184	0.635	-0.291
Und.5	0.720	-0.020	-0.059	SRe.5	0.442	0.305	-0.334
Und.6	0.634	0.004	-0.294	SRe.6	0.504	0.254	-0.286
Unc.1	-0.281	0.514	0.227	Dis.1	-0.243	0.531	0.153
Unc.2	-0.199	0.350	0.207	Dis.2	-0.628	0.380	0.133
Unc.3	-0.319	0.320	0.056	Dis.3	-0.499	0.355	0.471
Unc.4	-0.119	0.537	-0.084	Dis.4	-0.308	0.460	0.249
Unc.5	-0.422	0.383	0.014	Dis.5	-0.438	0.367	0.312
Unc.6	-0.367	0.479	0.182	Dis.6	-0.300	0.347	0.588
Adm.1	-0.302	0.288	0.588	Str.1	-0.334	-0.100	0.629
Adm.2	-0.451	0.191	0.524	Str.2	0.082	-0.085	0.542
Adm.3	-0.131	0.229	0.486	Str.3	0.052	0.152	0.472
Adm.4	-0.454	0.319	0.401	Str.4	0.125	0.059	0.511
Adm.5	-0.435	0.451	0.321	Str.5	-0.117	0.363	0.302
Adm.6	-0.076	0.472	0.127	Str.6	-0.510	0.205	0.311

Appendix K: Factor loadings of surviving QTI items on three new scales: Warmth, Uncertainty, and Strictness

Item Id.	Factor Warmth	Uncertainty	Strictness	Items
HFr.1	0.686			This teacher helps us with our work.
HFr.2	0.712		-0.334	This teacher is friendly.
HFr.3	0.787			This teacher is someone we can depend on.
HFr.4	0.716			This teacher has a sense of humour.
HFr.5	0.649			This teacher can take a joke.
HFr.6	0.672			This teacher's class is pleasant.
Str.6	-0.510			We are afraid of this teacher.
Und.1	0.731			This teacher trusts us.
Und.2	0.700			If we don't agree with this teacher, we can talk about it.
Und.3	0.708			This teacher is willing to explain things again.
Und.4	0.722			If we have something to say, this teacher will listen.
Und.6	0.634			This teacher is patient.
SRe.3		0.416		This teacher lets us decide when we will do the work in class.
SRe.4		0.635		This teacher lets us get away with a lot in class.
Unc.1		0.514		This teacher seems uncertain.
Unc.2		0.350		This teacher is hesitant.
Unc.4		0.537		This teacher lets us boss her/him around.
Adm.3			0.486	This teacher is too quick to correct us when we break a rule
Str.1	-0.334		0.629	This teacher is strict.
Str.2			0.542	We have to be silent in this teacher's class.
Str.3			0.472	This teacher's tests are hard.
Str.4			0.511	This teacher's standards are very high.

Appendix L: Names and descriptions for all variables discussed in Chapter 9

Variable Name	Variable Description
Activity Number	No. distinctly different activities the students were expected to participate in
Attention Avg.	Avg. percentage of students attending to intended lesson tasks
Attention Max.	Max. percentage of students attending to intended lesson tasks
Aural Novelty Avg.	Avg. aural stimulus novelty
Aural Novelty Max.	Max. aural stimulus novelty
Aural Object Number	No. of instructionally-intended aural objects used during the lesson
Behaviour Avg.	Avg. behaviour level throughout entire lesson (low scores = better behaviour)
Behaviour Max.	Worst behaviour level of entire lesson (low scores = better behaviour)
Channel Number	No. channels used in the teaching process
Colour Variety Avg.	Avg. number of colours used per 2 minute cycle
Colour Variety Max.	Max. number of colours used in any 2 minute cycle
Correction Level Avg.	Avg. intensity of correction events by teacher
Correction Level Max.	Max. intensity of correction events by teacher in whole lesson
Correction Number	No. of correction events by teacher during the lesson
Disturbance Max.	Max. intensity of external distraction events
Disturbance Time	Duration of external distraction events
Emotion Mode Number	No. of emotion-based instructional strategies used in whole lesson
English Marks	Pupil's previous semester marks in English as recorded on their academic report
Group Lesson Distractions	Class average of student-reported lesson distractions scores
Group Lesson Interest	Class average of student-reported lesson interest scores
Group Prior Interest	Class average of student-reported prior interest scores
High Distraction Reports	No. of students reporting high levels of distraction from other students
Knowledge Percentage	Percentage of tuition time spent on knowledge development
Knowledge Time	No. lesson minutes spent on knowledge development
Maths Marks	Pupil's previous semester marks in mathematics as recorded on their academic report
Movement Complexity Avg.	Avg. complexity of movement
Movement Complexity Max.	Max. complexity of movement
Non-Science Behaviour	Avg. previous semester behaviour for three non-science subjects, as recorded on their academic report
Non-Science Effort	Avg. previous semester effort for three non-science subjects, as recorded on their academic report
Non-Science Marks	Avg. previous semester marks for three non-science subjects, as recorded on their academic report

Variable Name	Variable Description
Pupil Lesson Difficulty	Pupil's self-reported lesson difficulty score
Pupil Lesson Difficulty Z Avg.	Avg. of pupil's standardised self-reported lesson difficulty scores
Pupil Lesson Distractions	Pupil's self-reported total lesson distractions score
Pupil Lesson Distractions Z Avg.	Avg. of pupil's standardised total lesson distractions scores
Pupil Lesson Interest	Pupil's self-reported lesson interest score
Pupil Lesson Interest Z	Pupil's standardised lesson interest score
Pupil Lesson Interest Z Avg.	Avg. of pupil's standardised self-reported lesson interest scores
Pupil Lesson Novelty	Pupil's self-reported lesson novelty score
Pupil Lesson Novelty Z Avg.	Avg. of pupil's standardised self-reported lesson novelty scores
Pupil Number	Number of students in the class
Pupil Prior Interest	Pupil's prior interest score
Resources Number	No. teacher's resource objects employed in the lesson
Science Behaviour	Pupil's previous semester behaviour in Science as recorded on their academic report
Science Effort	Pupil's previous semester effort in Science as recorded on their academic report
Science Marks	Pupil's previous semester marks in Science as recorded on their academic report
Sense Number	No. senses utilised by students when participating in the intended lesson experiences
SOSE Marks	Pupil's previous semester marks in SOSE as recorded on their academic report
Stimulus Object Number	Total number of objects intended as direct student stimuli
Student Questions 1	Percentage of students asking the teacher one or more content-related questions
Student Questions 2	Percentage of students asking the teacher two or more content-related questions
Tactile Object Number	No. tactile stimulus objects
Teacher Correction Avg.	Teacher's correction intensity, averaged across all lessons surveyed
Teacher Interaction Level	Percentage of students with whom the teacher interacted on content matters
Teacher Interest Avg.	Teacher's interestingness as judged by student self-reports, averaged across all lessons surveyed
Teacher Warmth Avg.	Teacher's personal warmth, averaged across all students surveyed
Total Distraction Reports	No. of students who reported any distractions from other students
Visual Novelty Avg.	Avg. visual stimulus novelty
Visual Novelty Max.	Max. visual stimulus novelty
Visual Object Number	No. of instructionally-intended visual objects used during the lesson

Appendix M: Distribution of Pupil Prior Interest results for all students who completed the ISQ; N = 191