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Student beliefs about learning in religion and science in Catholic schools

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**STUDENT BELIEFS ABOUT LEARNING IN RELIGION AND SCIENCE IN
CATHOLIC SCHOOLS**

by

Philip F. Cox

B. A., Dip.Ed., B. Ed., Post Grad. Dip.Ed. Admin., M. Ed.

**A Thesis submitted in partial fulfilment
of the requirements for the award of
Doctor of Philosophy
in the Faculty of Community Services, Education and Social Sciences,
Edith Cowan University**

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November, 2004

Forward

Religion and science

“And so the discussion goes on. But it always seems to me that there is one question about which everyone is clear: the modern man thinks for himself; the mediaeval man simply accepted things on blind faith; and the prime instance always is that the mediaeval man believed that the sun went round the earth. Yet it should be obvious that he did so, not because the church taught him to, but because he saw the thing happen so! And we believe that the earth goes round the sun, not because we see it, not because, for the most part, we can prove it, but solely on blind faith. So that on this point you get a whole variety of morals; one is that people who go on using this as an illustration of modern freedom of thought as opposed to mediaeval superstition are almost past praying for; they have not enough power of thought to know what their own words mean. Another moral is this: On this particular point the man in the Middle Ages thought for himself and was wrong; we accept something on blind faith, and are right; so there’s something to be said for faith after all. And the third moral is this: That we really have come to a blinder faith in science than men ever had in religion. The thing we are asked to believe goes absolutely against the evidence of our own eyes; we non-scientific people cannot prove it, yet without question we believe it. And it is not unamusing to try to imagine what an uproar there would be if science were silent on the point, and it was the church that asked me to believe it.”

(Sheed, Frank, reference unknown)

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I am exceedingly grateful for the support, assistance and contributions of my supervisor, Dr Russell Waugh. His continued support and encouragement with the conceptualisation, research and writing (re-writing, and re-writing, etc) of this thesis were invaluable.

My thanks are also extended to the Religious Education Co-ordinators from the study schools for their assistance with the survey and my colleagues at the Catholic secondary school where I teach. I would also like to acknowledge all the dedicated teachers of religious education I have worked in Catholic schools with over the last 25 years. Our long discussions regarding how best to teach our subject, has encouraged me to delve more deeply into the processes at work in the religious education classroom and these teachers' dedication and commitment to teaching religious education has inspired me to complete this work.

The support, patience and understanding of my dearest wife Carmen ensured that this project was completed. She managed our five children, a job at a nearby catholic school and me, with care compassion and efficiency.

ABSTRACT

The focus of this study is the impact of student perception of the validity of content on student learning. It is proposed that, if the content of a subject is perceived by students as being different to the content of another subject, a result of this perceived difference is that students will treat their learning in these subjects differently. To test this proposal, student beliefs about items from the content of the religious education course are compared with student responses to items of content of their science course.

A sample of 1418, year 11 students from nine co-educational Catholic secondary schools were asked to respond to a series of outcome statements from the year 10 religious education and science courses. The questionnaire asks two questions; one, can the student recall being taught each item; and two, does the student believe that the item is true. If the students believe that the item is true, they are asked to indicate one of three possible reasons for their belief. One, they believe the item because the teacher had provided them with evidence that convinced them that the item is true; two, they believe the item because they trust the teacher to teach them what is true, or three they believe the item for some other reason such as faith. This study does not deal with the issues of faith formation, catechesis, new evangelisation or evangelisation which are significant *raison d'être* of Catholic schools and are closely linked to the study of religious education in Catholic schools.

Student and staff responses to a number of open-ended questions, and extensive discussions with students in a Reference Group, provide additional insights into the student beliefs regarding the nature of knowledge particularly for the content of their religious education and science courses.

It is proposed that students will find it easy to believe some religious education items and hard to believe other religious education items, and that the students will find it easy to believe some science items and hard to believe other science items. It is also proposed

that there will be a tendency for students to find it generally 'harder' to believe the religious education items than the science items but that the two sets of items will not form two distinct sets of data but rather represent a continuum of difficulty. As a result of student responses to the items, this thesis will develop scales that will allow the model to be tested.

1. The model proposes that students will classify content that represents different levels of plausibility and different types of knowledge and different styles of knowing into different categories. Scales will be developed from the model, based on the hypothesis that content that is perceived as being plausible, easily explained and verifiable by the teacher will be readily accepted by the student and easily learnt – the easy end of the scale. Content that is perceived as lacking plausibility, which cannot be easily explained and verified by the teacher, will be less readily accepted by the student and difficult to learn – the hard end of the scale.
2. The model proposes that students will classify the content of the religious education course differently to the content of the science course. Scales will be developed from the model, based on the hypothesis that the content of the religious education course, in comparison to the content of the science course, is perceived by students as lacking plausibility, is less easily explained and verified by the teacher and represents a different style of knowledge and knowing that make learning in religious education more difficult – the hard end of the scale.

The students' usual religious education teacher administered the questionnaire in school classrooms. The student responses were encoded and analysed, utilising the Simple Logistic Model of Rasch (Andrich, 1988) with the RUMM 2010 program (Andrich, Sheridan, Lyne & Luo, 2000). The analysis utilising the Rasch measurement model was not completely successful, prompting a series of additional analyses to overcome the problem. The results of these analyses provide collaborative evidence that supports the general patterns evident from the imperfect Rasch created scales.

Despite the imperfect Rasch results, the patterns evident from the data indicate that there are major differences between student learning outcomes and belief patterns in science and religious education and within these subjects themselves. The main findings are: one, that students report a higher level of 'recall' and 'belief' of the science content than they report for the religious education content; two, that students tend to believe fewer of the religious education items on the basis of having been provided with evidence that they are true, and fewer on the basis of trusting the teacher to teach what is true and that students tend to believe more of the religious education items on the basis of 'other' reasons than on the basis of evidence or trust. Three, students' responses to the religious education items are more complex and very different to their responses to the science items. The results of this study indicate that the religious education items represent different types of knowledge. Fourthly, a relationship between levels of recall and belief is evident in the data, suggesting that where teachers do provide evidence to prove that an item is true, learning is enhanced.

The study is of importance to teachers of religious education. The evidence indicates that the students find it easier to recall and believe content from the religious education course when the teacher has provided evidence to show that the item is true. Students report that they find it hard to believe the content of their religious education classes on the basis of trust, whereas they report that they find it easy to believe the content of their science classes on this basis.

Student responses to the items indicate that the content of religious education does not represent the same level of knowledge as science, and does not make equal demands on students' acceptance, belief or life experiences. Recognising these differences may also assist teachers of religious education in their task. In addition, the results indicate that there are clear differences in type of content within the religious education course itself. Understanding these differences may allow teachers of religious education to be more effective in their teaching.

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CHAPTER ONE

INTRODUCTION

Background to the study

This section describes:

- **the situation in which the study occurred in Western Australia;**
- **the structure of the Catholic religious education course used;**
- **the Catholic religious education content taught by all Catholic schools, and**
- **some common content of the science course taught in Catholic schools.**

The Catholic Education Commission of Perth, Western Australia, (C.E.C.W.A.) is responsible for the education of students in system schools within the Perth Archdiocese. A small number of Catholic schools are owned and run by religious brothers and nuns, and while these order-owned schools are generally not the responsibility of the Catholic Education Commission, the administrators of these schools do work co-operatively with the Commission. The Bishops of Western Australia mandate the C.E.C.W.A. to foster the development and improvement of Catholic schools, and to act on behalf of the Catholic community for the benefit of Catholic schools. The Catholic Education Commission is appointed by the Bishops of Western Australia and remains responsible to them. One purpose of the Catholic Education Commission is to generate official state-wide policies and another is to assist individual Bishops with the schools in their own dioceses. To facilitate the efficient running of Catholic schools within the Perth Archdiocese, the Catholic Education Commission established the Catholic Education Office.

Within Western Australia, there are four Catholic dioceses responsible for the education of children. These dioceses are the Archdiocese of Perth and the dioceses of Bunbury, Broome and Geraldton. The Perth Archdiocese includes the Perth metropolitan schools, and those schools located between Rockingham in the south, Moora to the north and those east to Kalgoorlie. Of the 106 schools within the Perth Archdiocese, there are 26 secondary schools teaching over 20,600 secondary school children. There are

seventeen co-educational Catholic colleges teaching approximately 12,350 students from years eight (thirteen year olds) to year twelve (seventeen year olds). The remaining nine secondary schools within the Perth Archdiocese include two girls' secondary colleges (1,500 students), two secondary boys' colleges (1024 students), and five schools that are either co-educational or single sex, teaching students from preschool (five year olds) to year 12 (seventeen year olds) (Annual Report, Catholic Education Commission, 2002).

The Catholic Education Office of Perth, Western Australia, developed a religious education curriculum document entitled the Perth Archdiocesan Guidelines (Catholic Education Office, 1987). From this document, the Perth Archdiocesan Religious Education Course (draft) (Catholic Education Office, 1995) was developed. This document specifies the minimum content for religious education classes in all Catholic schools in Western Australia and the teaching methodology to be used by teachers (thus defining the nature of religious education in Western Australia¹). The Perth Archdiocesan Religious Education Course is written in terms of 'teaching points' (similar to outcome statements) that specify what the teachers are required to cover within their lessons (the teaching points for the Year 10 course, eg A1.1.1, "Identify how people show concern for developing their conscience as intended by God", A1.2.1, "Explain how people are capable of developing their potential for goodness", are listed in Appendix 1). In addition to these teaching points, the document specifies the teaching methodology and a recommended teaching process that has three stages. The three stages include; one, 'reflecting on human experiences', two, 'understanding Catholic faith experiences' and

1. There has been much debate in the literature as to the main purpose of religious education. Various approaches and emphases have been argued in the literature, and practiced in classrooms in Australia and elsewhere. The purpose of religious education in Catholic schools in Western Australia is to teach students what Catholics believe and how they practice their faith. This thesis does not attempt to enter the debate as to the nature of religious education. The focus of the study is also not the effectiveness of evangelisation or catechesis in the religious education class room. A reader interested in exploring the literature concerning the main purpose of religious education may find the following useful: The Australian Catholic Bishops' Committee for Education (1990), Rummery, R.M. (1975), Ryan, M. (1997), Groome, T.H. (1980), Flynn, M. (1979) (1985), Crawford, M. & Rossiter, G. (1988), Moran, G. (1973, 1981, 1983), Fowler (1980, 1981, 1984, 1986, 1993), Boys, M. (1981, 1982, 1984) and Holohan, G. (1999).

three 'relating faith and life' (Figure 1.2). The foci of the religious education course are knowledge and understanding of what Catholics believe and how they practice their faith.

Within Catholic schools, the content of science courses is less uniform than the content of the religious education course. Prior to the early 1980s, the then state education authority, the Board of Secondary Education, did have control over what was taught in Catholic schools. The control over content of science courses in private schools was relinquished for learning programmes up to year 10, and so Catholic schools were then able to develop individual courses for their students. As students who are university bound sit a common university entrance examination at the conclusion of year 12, there is a tendency amongst schools to ensure that their year 10 students are thoroughly prepared for year 11 and 12 courses. As a result, while the science programmes of many Catholic schools are not exactly the same, there are common elements. As a result of differences in course content between schools it was only possible to confirm 37 'content statements' that are common for all nine study schools. Currently, the science curriculum for year 10 is expressed in terms of content that is to be covered by the teacher. This content incorporates content from the disciplines of biology, chemistry, human biology and physics.

Differences between religious education and science

This section describes:

- differences between the content of religious education and science, and differences within the religious education course itself that are evident in the levels of knowledge, in the levels of acceptance of content, in motivation and in student perception and beliefs;
- how students learn differently by treating the content of different subjects differently;
- how the Rasch measurement model allows for a comparison of different learning content on the same scale.

It is recognised that there are differences between the content of religious education and the content of subjects such as science, including differing levels of knowledge, differing levels of acceptance needed by students, the absence of transference of learning between classes, differing levels of motivation between classes, and the students' perceptions of the validity of the content. The degree which these differences influence learning in religious education and science will vary with how students perceive these differences. For example, an item that objectively may be considered as representing a particularly high level of knowledge, and hence may be presumed to be difficult to believe and recall, may be perceived as easily accepted by some students whose life experiences, trust in their teacher or faith allow them to perceive that the item is very plausible and hence easily believed and recalled. The importance of student perception as a factor affecting student learning is therefore significant in that individual perceptions may not correspond to objective views as to the type of knowledge a particular item represents.

One variable, impinging on the effectiveness of learning in religious education classrooms, relates to how students perceive the content of the religious education course. There is anecdotal evidence, communicated to the author by students and teachers, that some students in religious education classrooms in Western Australia, tend to perceive the content of the religious education course as lacking plausibility. One result of the perception that the 'knowable content' presented in the religious education classroom lacks plausibility may be that students tend to treat that content differently to the content presented in other subjects (such as science) where the content is perceived as plausible. This difference in perception therefore may be a factor that contributes to the apparent lack of effort on the part of some students to learn the content of the religious education lesson and the negative attitude some students exhibit toward religious education reported in the literature (Macdonald, 1988, Moore 1991, and Dorman, 1995).

A difference that may impinge on learning in science and religious education is the lack of transference of learning and motivation between classes. A teacher can be teaching science to a group of students in period one, and have those students copying

notes, reading texts, listening to explanations and eventually re-presenting that exact material faithfully in a subsequent examination and not once question the plausibility of the content. That same teacher can then move on to the religious education classroom in period two, with many of the same students, and suddenly find the content challenged, each teaching point questioned and explanations rejected as lacking plausibility. The students' learning style in the two classes appears to be different. Their perception of the plausibility of the content of the two subjects appears to be different. In addition to the anecdotal evidence communicated to the author via teachers who contact the Catholic Education Office, and from personal contact the author has with teachers of religious education, the lack of transference of learning and motivation between classes is supported by student responses to the questionnaire and comments made during detailed discussions with the students in the Reference Group (chapter 5 and 8).

There is also a difference between the level of acceptance needed for the content of subjects such as science and the content of religious education. Some of the material presented in the religious education classroom cannot be measured in a scientific sense, and therefore requires a higher level of acceptance before students will be prepared to believe that it is true. In addition, the lower the level of acceptance necessary for the content of other subjects, such as science, is evident from the observation that students do not challenge teachers to 'prove' that the content of their lessons is valid, as is often the case in the religious education classroom (based on the author's observations of classroom practice and comments from their teachers). The perception that the content of these subjects is plausible manifests itself in the learning style of the students – content that is perceived as plausible is readily accepted as valid, whereas content that is perceived as lacking plausibility is challenged.

This thesis recognises that there are differences in the level of knowledge in the religious education and sciences courses that arise because some students perceive that some science items represent a higher level of knowledge than other science items and some religious education items represent a higher level of knowledge than other religious education items. As a result of the differences in level of knowledge between and within

the religious education and science items some students may tend to find it harder to recall and believe some religious education and science items than others and that there may be a tendency for students to find it harder to recall and believe the religious education items than the science items

The differences between the levels of knowledge may result in students treating the content of religious education and science (and the different 'types' of content evident within the religious education and science courses themselves) differently. Although the content represents different knowledge, the Rasch measurement model allows for different measures to be compared on the same scale and produces a value free score that quantifies the perceived differences. The calibration of the student responses to the items will enable answers to the research question to be made despite the differences evident between the two subjects.

The differences between the content of the religious education and science courses are recognised in this study. Differences in level of knowledge of content, levels of acceptance of content and motivation to learn, have been noted. While recognising that differences exist, at an objective level, the focus of this study is how students perceive the differences between the content of their religious education and science courses, and how the differences in perception impact on learning. The capacity of the Rasch measurement model to provide a value free score of different measures on the same scale allows a comparison of perceived differences of items within and between the content of the religious education and science courses.

The Perth Archdiocesan religious education course

This section describes:

- the structure of the religious education course used in this study;
- how the religious education course is based on the life experiences of the student;
- how sections A and B of the religious education course represent 'knowable content';

- how sections C and D of the religious education course represent content that deals with 'less concrete knowledge'.

The Catholic Education Office developed a religious education course that is mandatory for Catholic schools in the Perth Archdiocese. Figure 1.1 outlines the basic structure of the course that comprises two sections (I and II) and five sub-sections (A, B, C, D and E). The Unit Outcomes (1.0, 2.0 3.2 and so on), which are termed 'Teaching Points', are listed within each sub-section (Appendix 1).

Figure 1.2 illustrates the teaching process to be used in the teaching of the religious education course, and illustrates how the five sub-sections of the content framework (Figure 1.2) are incorporated into the three stages; one, 'reflecting on human experiences', two, 'understanding Catholic faith experiences' and three, 'relating faith and life'. The nine unit outcomes (1.0, 2.0, 3.1, 3.2, 4.1, 4.2, 4.3, 5.0, 6.0 in Figure 1.1) are expanded upon to form the 59 teaching points, listed in Appendix 1, to create the actual 'Teaching Learning Programme' that forms the Perth Archdiocesan religious education course (draft) Year 10 course.

As can be seen from Figures 1.1 and 1.2, the nature of the content in sections A and B is predominantly 'knowable content' reflecting the stated nature of religious education in Western Australia – teaching what Catholics believe and how they practice their faith. The unit outcomes and the specific course outcomes in sections A and B, in particular, are concerned with understanding 'human potential' and 'human weaknesses' (eg. Illustrate how just love leads to peace – Section A, subsection 2.0 see Figure 1.1). The content in this part of the course can be demonstrated to the students because it is based on the students' own experiences of life, and as such, can be shown to be plausible. Through the teaching process, students can be shown that much of what Catholics believe is based on human experiences and represents 'knowable content', and is therefore plausible. The nature of the content in sections C and D (Figure 1.1), to a lesser extent, reflects 'knowable content'. The content of these latter sections is less easily demonstrated

1 Discovering the Human Need for Christian Salvation	
A Discovering Human Potential	
1.0	Recognising our significant human experiences
2.0	Human experiences point towards our human potential
B Accepting Human Weakness	
3.1	Recognising common experiences of human weaknesses
3.2	Appreciating the human yearning for personal freedom
11 Drawing on the Experiences of Christian Salvation	
C Potential Offered by Christian Salvation	
4.1	God offers salvation from human weakness
4.2	Discovering that God values our human potential
4.3	Through Christ, God offers specific gifts
D How Catholics Accept this Potential	
5.0	How Catholics accept the salvation Christ offers
E Making Choices	
6.0	Revision and making choices to be made

Figure 1.1. Content framework of the Perth Archdiocesan religious education course.
Source: Catholic Education Office Archdiocesan Religious Education Course (draft) (1995), Perth Archdiocesan Department of Religious Education, Perth.

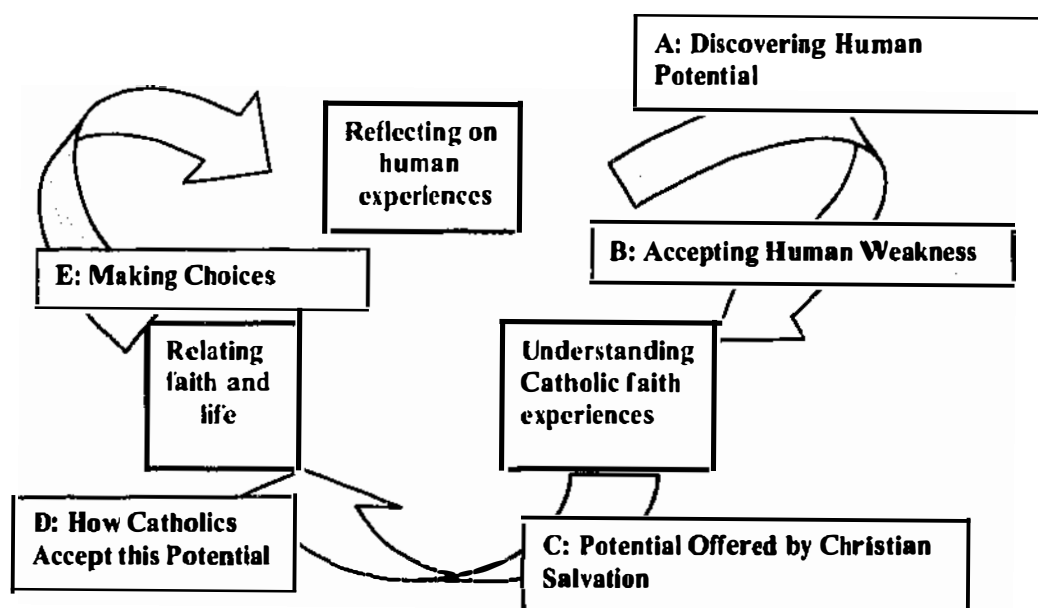


Figure 1.2. The teaching model for the Perth Archdiocesan religious education course.
Catholic Education Office Archdiocesan Religious Education Course (draft) (1995), Perth Archdiocesan Department of Religious Education, Perth.

because many of the teaching points concern God and God's relationship with people (eg 'Explain how God seeks to protect people against behaving unjustly – Section C, subsection 4.3, Figure 1.1), and it is therefore less likely that students who have little experience of God in their lives will find the content in these sections plausible.

Other related literature in religious education

The focus of this thesis is student perceptions, and the differences in learning that may arise from these perceptions. The focus of the thesis is neither a full analysis of the religious education literature nor a review of the theory and practice of religious education in Australia or elsewhere. Similarly, the section dealing with belief in the literature review is included from the aspect of the relationship between belief (that something is accepted as true) and learning rather than from the Catholic view of faith (a gift from God). This thesis is not concerned with Catholic ministry or faith formation.

The literature that relates to the theory and practice of religious education is extensive. A fuller understanding of the issues associated with the teaching and learning of religious education may be achieved with reference to the following significant literature - the Australian Catholic Bishops' Committee for Education (1990), Rummery (1975), Ryan (1997), Groome (1980), Flynn (1979), (1985), Crawford, & Rossiter (1988), Moran (1973), (1981), (1983), Fowler (1980, 1981, 1984, 1986, 1993), (1984), Boys (1981), (1982), (1984) and Holohan (1999).

The dual nature of religious education

This brief discussion establishes an understanding of the context of the study. It is not a literature review. This section provides background material that describes a particular aspect of religious education – its dual nature – that impinges on how students perceive the content of this course, and hence relates directly to the model.

This section presents evidence supporting the view that:

- the main purpose of the teaching of religious education in Western Australia is to educate young people about what Catholics believe;
- despite its main purpose the nature of religious education entails faith development;
- it is difficult to provide students with evidence to prove the veracity of some of the content of the religious education;
- students perceive that the content of the religious education course lacks veracity; and
- students treat learning in religious education quite differently to learning in other subjects such as science (from anecdotal evidence at catholic schools).

The task of teaching religious education in Catholic schools in Perth, Western Australia, is very different from the pedagogy of teaching secular subjects. Religious education has two aspects that give it a dual nature. One, knowledge education, and two, faith formation. A brief section outlining the dual nature of religious education is necessary to establish the framework for understanding the issues involved in the teaching and learning processes associated with the teaching of religious education. The inclusion of this section will also provide a context for understanding the aims, research questions and the model described later in this chapter.

Carey's (2001) paper regarding knowledge and Catholic education represents a philosophical discussion of the nature of religious education in England. While his work relates specifically to the U.K. situation and lacks statistical validation the basis of his paper that there is a dual reality in the teaching of religious education does echo the Australian reality. Carey (2001) concludes that this dual reality "places religious education in a strange location – having to do with the material world ... it is necessarily concerned with the type of knowledge which empiricism recognises ... but ... it is also concerned with at least some of those realities with which not only metaphysics, but also faith have been traditionally included" (p.13). Byrne (1997), also writing from the U.K. perspective, bases his arguments on Catholic Church documents and also recognises that religious education has a dual nature. He suggests, it is "false to suppose that we are

faced with a straight choice between naturalistic (teaching knowledge) and confessional paradigms (teaching faith), for the teaching of religious education requires both approaches to be successful" (Byrne, 1997, p.339).

While the work of Carey (2001) and Byrne (1997) relates specifically to the English scene and not Australia, church documents clearly indicate that religious education has at its heart educational rigour. As a basic principle, it must be understood that the church hierarchy urges Catholic schools (Congregation for Catholic Education, 1988) to apply careful rigour in the development of a critical sense, maintaining a respect for the autonomy of human knowledge and for the rules and methods proper to each of the disciplines. Maintaining academic rigor within religious education is essential because "Fanatical confessionalism is self-defeating, and raises the suspicion among pupils that Christianity may not be true" (Barnes, 2000, p.318). The Religious Education Guidelines document focuses on knowledge education with the goal of teaching young people about Catholic faith and practices (Watson, 1993, p.24).

To achieve the goal of academic rigour the focus of religious education is "also very much grounded in the here and now, since it is based on the understanding that God is involved in, and participates in, the human condition (Carey, 2001, p.13). It is this human condition that is the starting point of the Religious Education Guidelines document (Figure 1.1), and that provides the bridge between the life experiences of the student and the religious concepts presented in the classroom.

Having established that the focus of teaching religious education in Catholic schools in Western Australia is knowledge, it is also recognised that a purely academic study of religion that provides only the cognitive understanding of the religion studied cannot cater for a greater understanding of the human condition. An approach that not only recognises the importance of the scientific study of religion, but provides the students with ample opportunities to explore and enhance their religious experiences, enables the teacher (and student) to bridge the dual realities knowledge and faith formation present within religious education.

A strong advocate of the need to ensure academic rigour working in religious education in Australia, Rossiter (1999) nevertheless raises a concern regarding the assumption that academic rigour be the sole focus of religious education. Rossiter separates cognitive learning from personal teaching in the specific area of values education, and raises the concern that a large number of variables associated with the individual student, and not the classroom, "enter into personal learning processes" (p.48) and may impact on personal learning. This impact, he suggests, is significant enough to separate personal learning from cognitive learning. Cognitive learning, he believes, is appropriate and effective in dealing with knowledge constructs. Values and faith are constructs that are more effectively taught in the context of personal teaching. In this context the dual nature of the religious education course is very clear.

Rossiter's observations highlight a possible difference between the teaching - learning processes at work in religious education classrooms and other subjects. Dornan (1995), whose research in Australia is extensively based in accepted statistical methods and research technique, also reports - "the distinctive nature of religion classes, compared to other subject classes, seldom has been considered in any classroom research even though many teachers believe that religious education is quite different to other subjects" (p.69). The religious education curriculum contains 'knowable content', but has a significant component of content that relies on faith. The science curriculum, on the other hand, is perhaps dominated by 'knowable content' and is less often noted for its affective content or content that relies on faith.

The particular nature of religious education, which entails a significant proportion of its content in the affective domain, suggests that religious education cannot totally rely on cognitive education processes, and may need to consider practices and methodologies that enhance personal education. The influence of student perceptions and epistemological beliefs regarding religious education can therefore be seen as playing a significant part in the teaching-learning processes at work in religious education.

The dual reality of religious education may create a difficulty for the teachers of religious education. It may be difficult for teachers to provide proof beyond doubt that

the faith (less knowable) aspects of the content of the religious education course are true. If students perceive that aspects of the religious education course lack veracity they may also come to perceive that much of the content of the religious education course lacks veracity – the 'knowable content' as well as the 'less knowable' content. Watson (1993) points out that students may not achieve the outcomes of a religious education programme "if their minds and emotions are already sealed tight" (p.24) against the goals of religious education. His warning points to the importance of students being prepared to learn and participate in a lesson if genuine learning is to occur. If students perceive that the content of religious education does not have a basis in truth, they may not be open to the content being presented in class. The perception that the content of the religious education course lacks veracity may create a difficulty that may need to be addressed by the religious education teacher before effective teaching can occur.

Learning in the religious education classroom

This section presents evidence supporting the view that:

- there is still debate amongst teachers of religious education as to the purpose of religious education;
- the lack of clarity of purpose may negatively impact on the effectiveness of teaching in the religious education classroom.

This section is included in this chapter because it relates more closely to an understanding of the context within which the study occurred than to the literature review. This particular section provides background material that describes the learning processes at work in the religious education classroom and is included for the reader because there are aspects of teaching religious education that are different to teaching in general.

The dual nature of teaching religious education has throughout the 1980s and 1990s generated much debate within the literature regarding the central purpose of the teaching of religious education (Engebretson, Fleming, & Rymarez, 2002, Lovat, 2002). Many

saw, and may still see (Lovat, 2000), the teaching of religious education in terms of academic learning that should best be taught utilising standard teaching procedures. Others are equally convinced that the central task of the religious education teacher is faith development and catechesis, and that academic study in religious education classroom is less important. This debate should have been resolved in Western Australia with the publication by the Catholic Education Office of Perth, of the Religious Education Guidelines document, and the release of the General Directory for Catechesis (2000) but the literature (Engebretson, Fleming, & Rymarez, 2002, Lovat, 2002) and anecdotal evidence, communicated to the author from religious education teachers and from the staff responsible for professional development of religious education teachers, suggests that the debate still continues at the teacher level.

The outcome of the debate within the literature regarding the central purpose of the teaching of religious education is that religious education is seen as having a dual nature with the emphasis of knowledge and academic rigor (Rossiter, 1999) laying the foundations for effective catechesis and new evangelisation (Holohan, 1999). There is evidence, though, within the literature (Engebretson, Fleming, & Rymarez, 2002, Lovat, 2002), as well as anecdotal evidence, that suggests that individual teachers may still be uncertain as to their purpose as religious education teachers, or continue to hold differing views as to the purpose of religious education. If teachers of religious education are not able to clearly state what is to count as religious education (Wilson, 1982, p.60 – working in England and Holohan, 1999 – writing specifically from the Western Australian perspective) teaching of religious education in terms of the stated aims of the religious education course in Western Australia may be less affective. Those teachers who advocate faith formation as the central aim of religious education may have difficulty achieving their goals, given that many students in Catholic schools in Perth have limited faith experiences upon which to develop a stronger faith (Holohan, 1999). Faith development cannot occur where no faith is initially present. Equally, those teachers who advocate a purely knowledge based approach may enhance their students' knowledge of Catholic faith, but fail to engender any belief that the content has validity.

Complicating the issue is the expectation from some within the Catholic community who "expect the school to increase attendance at mass, and nurture other aspects of a students' faith" (Ryan & Malone, 1996, p.142) and are greatly concerned with a crisis of values that is perceived to be afflicting young people. This vocal sector of the Catholic community actively calls for the focus of religious education to be faith formation bringing pressure to bear on religious education teachers to focus their teaching on catechesis.

It would seem that despite the clear statements within the religious education curriculum documents as to the purpose of religious education in Catholic high schools in Western Australia the subject religious education continues to be seen as having two separate functions. Writing from the Australian perspective, Elliott (1988) highlights the importance of enhancing of students' understanding of the subject (p.26). Elliott's paper, while lacking an empirical basis, represents an extensively referenced philosophical discussion about learning in religious education. While he emphasises the importance of *understanding* in religious education he also recognises that religious education has a second aspect - faith development. No other subject in high schools seems to be seen in this light. Other subjects are recognised as having values embedded within their core objectives, but the overwhelming core purpose of such subjects revolves around knowledge, skills and understanding. Values are usually seen as an adjunct to the main purpose for teaching. If the purpose of religious education remains unclear, teacher effectiveness may continue to be affected. The possible lack of a clearly defined and widely recognised purpose may impinge on effective teaching and learning in the religious education classroom. Without effective teaching strategies that provide evidence that the content of the religious education course is plausible and valid, it is possible that students may perceive that the content of the religious education course lacks veracity and therefore does not take an important place in their study regime. This study seeks to investigate how students perceive the content of their religious education course and in so doing develop a model that may assist more effective teaching in the religious education classroom.

Religious literacy

This section continues the argument that the effective teaching of religious education is built upon knowledge and understanding. This section argues that:

- religious literacy is an essential tool for students' religious education;
- religious literacy provides students with the skills, knowledge and understanding necessary to deal with the religious; and
- religious education is educative but is more than learning about the Catholic religion.

There is recognition within the literature from England and Australia (Doherty, 1997, Cush, 1999, Barry and Rush, 1999, and Morse, 1999) that it is a mistake to over-emphasise the development of faith as a task within the religious education classroom and, as a result, the emphasis within the literature, and now within religious education curricula (Figure 1.2), seems to be more recently focusing on the development of religious literacy. Doherty (1997), Cush (1999), Barry and Rush (1999) and Morse (1999) reiterate the importance of religious literacy to the aims of religious education, and define it as the "ability which a student progressively acquires, to interrelate and synthesise, through a range of genre, and within cultural and social contexts, knowledge, processes, communication, attitudes and values, in the light of the Catholic tradition" (Morse, 1999, p.35). This broad description of religious literacy clearly states that religious literacy develops as a result of support from a community and cannot develop as a result of the intervention of the school alone.

The development of religious literacy enables students to communicate effectively about religious issues, and provides them with the knowledge needed to respond effectively to the "ultimate questions that religions ask" (Cush, 1999, p.139). The significance of religious literacy is emphasised by the findings of Brennan (2000) and Barry (1997) and in the 'Catechism of the Catholic Church' (1994) where it is clearly stated that the principal aim of religious education in Catholic schools is religious literacy rather than an emphasis on faith sharing activities.

Helm (2001) in a philosophical work suggests that religion is a “way of constructing human reality” (p.81) and, in doing so, introduces the problem of connecting beliefs (about reality) to reality itself. His in-depth reflection on faith, belief and religion points to the importance of building bridges between these two aspects of reality describes the education process (Figures 1.1 and 1.2) in the religious education classroom in that the starting point is the students’ experiences of the world. Radford (1999), in a similar vein, suggests that the task of religious educators is to “introduce the learner to the geography of the religious descriptors and explanations, to locate the conceptual relationships and spaces, and to equip the learner to explore and establish her own tentative approaches to filling them” (p.168). Donnan’s (1995) research into the learning environment of religious education and science classrooms shows “religion classes to be remarkably similar to science classes” (p.10) for six classroom environment scales, suggesting that teachers may be approaching the two subjects in a similar manner in an attempt to provide the students in the religious education classes with the academic skills necessary to effectively learn in the religious education classroom. The development of students’ religious literacy may provide the students with the intellectual tools necessary to deal with religious questions.

The main function of religious education is therefore educative, in that the students develop skills, knowledge and understanding about the Catholic faith. This approach to teaching religious education is at odds with the approach to teaching religious education that focuses on faith formation and catechesis. By educating students about a religion, students can learn about and understand their faith giving them the religious literacy to “articulate the spiritual dimension to human experience” (Radford, 1999, p.170). This enables students to participate in

an objective debate about their shared experiences and to understand what they feel to be true and why the church and their teachers believe what they do.

The implications of current teaching pedagogy to religious education

Much of the content of religious education represents different forms of knowledge and as such suggests that perhaps a different teaching-learning process may benefit teaching in the religious education classroom. While this may be true, effective teaching in the religious education classroom may also be enhanced by understanding current teaching pedagogy and by applying the best and most recent research to teaching religious education. Further refinements may be necessary, as teaching techniques are adapted to the special task of teaching religious education, but it is nevertheless important that good teaching techniques and procedures be the starting point of an investigation of teaching and learning in religious education.

Aims of the study

The aims of this study arise from an understanding of the complexities of the teaching and learning processes at work within the religious education classroom, and the goal of gaining a better insight into these processes. It is recognised that there are differences between religious education and other subjects, such as science, in the level of knowledge and acceptance, and in the students' epistemological beliefs. A result of these differences may be that student learning behaviour in religious education differs from the learning behaviour in a subject such as science. The aims of this thesis, therefore, seek to test the veracity of these observations and, in so doing, gain a better insight into the teaching-learning processes at work within the religious education classroom.

The specific aims of this study are to:

1. Measure student belief of the content of their religious education course;

2. Develop a model of student belief of sets of ordered items for the four central teaching themes (A – Discovering Human potential, B – Accepting Human Weakness, C – The Potential Offered by Christian salvation and D – How Catholics Accept this Potential) of the Year 10 religious education programme used in Perth, Western Australia;
3. Test the model using the RUMM computer program (Andrich, Sheridan, Lyne & Luo, 2000), and to compare the results of this analysis with other measures;
4. Analyse the psychometric characteristics of student belief of the content of their religious education course;
5. Measure student belief in the content of their science course;
6. Develop a model of student belief of ordered items for the content of the Year 10 science course;
7. Test the model using the RUMM computer program (Andrich, Sheridan, Lyne & Luo, 2000), and to compare the results of this analysis with other measures, and
8. Analyse the psychometric characteristics of student belief in the content of their science course.

Research questions

This study seeks to answer the following research questions for a sample of 1418 Catholic secondary school children from nine Catholic secondary co-educational schools in Perth, Western Australia.

1. What 'knowable content' from the religious education course do students recollect being taught?
2. What 'knowable content' from the religious education course do students believe on the basis of evidence?
3. What 'knowable content' from the religious education course do students believe on the basis of faith?

4. What 'knowable content' from the science course do students recollect being taught?
5. What 'knowable content' from the science course do students believe on the basis of evidence?
6. What 'knowable content' from the science course do students believe on the basis of faith?
7. Can students' recollection of 'knowable content' from the religious education course, their beliefs of this content as based on evidence, and their beliefs of this content as based on faith, be modelled and aligned on a scale from easy to hard, using a Rasch Measurement Model?
8. Can students' recollections of 'knowable content' from the science course, their beliefs of this content as based on evidence, and their beliefs of this content as based on faith be modelled and aligned on the same scale as that in 7 above, from easy to hard, using a Rasch Measurement Model?
9. Can the difficulties of the items relating to the 'knowable content' of the religious education and science courses be modelled and aligned on a scale from easy to hard and calibrated on the same scale as in 7 above, using a Rasch Measurement Model?
10. Can a model be devised to explain students' beliefs of the 'knowable content' of the religious and sciences courses, based on what students recollect being taught in class, what they believe on the basis of evidence, and what they believe on the basis of faith.

The significance of the study

Unique aspects

The significance of this study lies in the utilisation of the Rasch measurement model in the context of learning in religious education. While the use of the religious education curriculum and practice in Catholic schools in Western Australia may not have relevance to a global context, the use of the Rasch measurement model in the context of

learning in religious education does have global implications. The ability of the Rasch measurement model to provide a value-free 'score', and thus compare disparate items on a single scale, provides an opportunity to compare very different learning situations and to provide a unique insight into student beliefs about learning in the religious education and science classrooms.

There are four unique aspects of this present study. The first unique aspect is the development of a learning model that considers the influence of student perceptions of the veracity of content of learning outcomes in science and religious education. Within the context of this model, this study indicates that the teaching and learning processes at work in the religious education classroom seem to be affected by the students' beliefs regarding the veracity of the content of the religious education course. Students tend to perceive that the content of the religious education course lacks veracity, and that evidence cannot be provided to show that the content is true. In addition, some students indicated that they do not trust their teachers to teach them what is true. These perceptions are shown to affect, not only student learning in the religious education classroom, but also the students' perceptions of the importance of religious education in their lives.

Within the context of the learning model, this study indicates that the teaching and learning processes at work in the science classroom are also affected by the students' beliefs that the content of the science classroom is valid and concrete, irrespective of the true status of the content. Scientific theories, hypotheses, and propositions are perceived as representing concrete, factual knowledge. These perceptions are shown to enhance student learning in science and also increase the students' perceptions of the importance of science as a subject.

The second unique aspect of this study arises from the use of the Rasch measurement model in comparing different aspects of the religious education curriculum. The Rasch analysis indicates that there are different groups or types of content in the religious education course where the importance of experience, evidence and other knowledge varies. The analysis indicates that not all parts of the religious education curriculum are

equal or make equal demands on students' acceptance, belief or life experiences. These results are significant for all religious education teachers and curriculum writers.

The third unique aspect of this study is the use of the Rasch measurement model to compare the level of difficulty of items from religious education and science on a single scale. Despite extensive efforts to achieve a top quality scale, the various test-of-fit statistics from twenty two analyses indicate that a top quality scale is not possible. While the Rasch analysis indicates the absence of a top quality scale, the generalised patterns evident from the Rasch analyses, corroborated by substantial additional data, provides evidence to allow generalised conclusions regarding the students' perceptions of the level of difficulty of the content of their science and religious education classrooms. These conclusions provide a unique opportunity to compare student perceptions, and learning beliefs and practices, for two very different subjects and for different forms of knowledge within the two subjects. The inability to achieve a top quality scale also indicates that the use of Rasch modeling for analysing student belief patterns in religious education may not be useful for advancing knowledge in this field. Researchers may therefore need to look elsewhere to more fully understand the complex relationship between students' perceptions, beliefs and learning in religious education.

The fourth unique aspect of this study relates to the possible benefits of this research to curriculum designers, teachers of religious education and administrators in Catholic schools. Understanding that student perceptions of the plausibility of the content of religious education affects not only the teaching learning processes at work within the religious education classroom, but also, the students' perception of the importance of religious education as a subject itself can enable curriculum designers and administrators of Catholic schools to rethink course design and teacher training and inservice programmes. Teachers of religious education too, may incorporate this new understanding in their teaching methodology by being more conscious of the need to provide their students with plausible reasons for believing that the content is true and in creating a more trusting learning environment. Therefore, as a result of this study, further

refinement of the Draft Western Australian Religious Education Programme will be possible, as well as other religious education programmes around the world.

The testing of belief

Belief, in this study, is based on the general meaning given in the Concise Oxford Dictionary (1993) and Chambers Dictionary (1996) (expanded in Chapter 4). Student belief, that the items are true are based on three reasons: one, the teacher provided evidence that the item is true; two, the students trust the teacher to teach what is true, and three, students believe the item for some other reason, will provide the necessary basis to model the item difficulties of the scale. The development of these scales allows a model of belief and a scale to be tested. Belief, in the context of this thesis, can be based upon grounds insufficient to afford positive knowledge, but can also be just 'believe to be true' and may incorporate a possible rationale for accepting the veracity of something, such as persuasion, trust or evidence.

The model proposes that students will classify the content of the religious education and science classrooms into different categories that relate to the type of knowledge represented by the items and the plausibility of that content. These different categories will include 'knowable content' – content that is perceived as having a basis of proof, and is therefore perceived as plausible and content that is perceived as lacking proof, and hence can only be accepted on the basis of faith. The model suggests that students filter the content of their lessons according to their perceptions of the plausibility of that content. The content of the lesson is filtered according to a measure of plausibility that may vary according a range of variables. These variables include: one, the students' perception of the veracity of any evidence presented in the classroom as proof that the content is factual; two, their acceptance of the content because of faith in an authority such as a teacher, significant other or textbook; three, the acceptance of the content based on personal faith; four, the acceptance of the content without any personal commitment to that content and five, the students' perception that the content of the lesson has relevance for their future, an undefined personal relevance or relevance as a consequence of an

imminent final grade. The model proposes that, as the content of the science course is perceived as representing different knowledge to the content of the religious education course, students will form a different level of belief for the content in the two courses. The different treatment of items representing different knowledge will also be apparent for items within each of the two courses. While it is recognised that the items from the science and religious education courses represent different knowledge and that within the religious education course there are also different levels of knowledge, the Rasch measurement model allows the two to be compared on the same scale.

The scale that will be developed from the model is based on the hypothesis that content that can be easily explained and verified for the student will be easily learnt, because the student will be readily able to accept the plausibility of the content – easy end of the scale. Content that cannot be easily explained or verified is, as a result, difficult to learn and difficult to believe because such content is perceived as lacking plausibility – hard end of the scale. Learning of the hard items may require a higher level of faith or belief than that required for the easy items. A fuller explanation of the model occurs in Chapter 4.

Limitations

A primary limitation of this thesis is associated with the attempt to gain an insight into the students' belief structures. Belief structures tend to operate at a very personal level, and so some students may not be prepared to respond to the surveys as honestly as they may respond to a less personal questionnaire. It is expected that this limitation can be partially overcome by providing each student with a high degree of anonymity and a strong request to 'tell us how they truly think'. However, we cannot be sure of this.

In addition to the privacy issue, another limitation associated with attempting to survey beliefs arises because beliefs and values are often aspects of a person that lie deeply within the consciousness of an individual. Some individuals may have difficulty being aware of their true beliefs or values when presented with a questionnaire. It is

believed that the students in the target population have been regularly exposed to activities associated with appraising, discussing, debating and reflecting on their beliefs and values. Given that the item wording of the surveys reflects the teaching points of their religious education course, it is expected that the students will be able to respond with a high degree of certainty, so that their responses do indeed reflect their actual beliefs. However, we can never be absolutely sure of this. To increase the degree of certainty, the questionnaire has been extensively trialled (and this is reported later) with over 100 students who reported to the researcher that they were able to provide their true beliefs about the science and religious education course content. The use of terms such as 'accept' or 'trust' in place of 'believe' was therefore deemed unnecessary. The use of such terms, while possibly having a less 'religious' feel, particularly when used in the context of the religious education items, may have resulted in levels of confusion similar to those that may have arisen from the use of the term 'belief' – students may have wondered what does 'accept' and 'trust' mean. (The word 'trust' is also an important descriptor in the third item – I believe this item because I trust my teacher to teach what is true and so it is not possible that it be used as a significant word in the items.) The results of the trials suggest that the term 'belief' (as defined in the instrument) is understood by the students and therefore produces reliable responses.

This study is limited to co-educational Catholic schools within the Perth metropolitan area and, as the sample is limited to these schools, strictly speaking, the results can only be generalised to similar Catholic schools within Perth. Although the results cannot be strictly generalised to other religious schools, and other Catholic schools, within Australia and overseas where environmental and educational factors are similar, some application of the results may be possible. (While this limitation may be perceived as a significant limiting factor in this study, the significance of this study lies in the use of the Rasch measurement model in the context of religious education. The applicability of this instrument to other regions within Australia and overseas is in itself significant and establishes a precedence that other regions copy.)

Another limitation relates to the size of the study. Given that the study incorporates nine schools, there are over 50 different teachers taking religious education classes in these schools. The variation in teaching expertise, and approach to teaching, between these 50 teachers may impact on the results of this study. Similarly, within the study population itself, a wide variation in religious commitment, faith experiences and attitude to learning in religious education classrooms may also impact on the results of this study.

An additional limitation is associated with the use of items with two or more ideas. The structure of the questionnaire is contrary to the usual procedures in Classical Test Theory where researchers are advised to focus each item on one idea. The items in the present study are conceptually ordered from easy to hard in sub-aspects, by making some 'harder' items have two or more ideas. While the trialling indicates that students understand this conceptual structure and respond accordingly, it could be argued that we are not sure to which idea in some items the students are responding.

Structure of the thesis

Chapter two describes the relevant literature that relates specifically to the factors that impinge on students' beliefs regarding the plausibility of the content being taught in the classroom, and how these beliefs then impact on student learning. The main factors highlighted in the literature - epistemological and ontological beliefs and metacognition - are discussed, as is the linkage between beliefs and student learning.

Chapter three draws together the major theoretical and philosophical assumptions outlined in the literature review to describe a model that outlines the teaching and learning processes at work in the religious education classroom. A general model of learning is briefly described indicating the complexity of the interaction of the variables at work within the classroom. While this thesis recognises the complexity of this array of variables and their complex interaction within the general model, the focus of this thesis utilises the theoretical and philosophical basis of the general model to develop a specific model that is directly relevant to this thesis. This specific model of learning forms the

theoretical framework for this study and describes the specific variables relevant in this thesis. It is this specific model that will be tested in this study (Figure 3.2).

Chapter four outlines the basic principles of the Rasch Measurement Model and the conceptual ordering of the research items. The phases of the data analysis are explained. The first, in chapter five, uses descriptive statistics to provide an overview of the data and to gain an impression of the patterns evident in the data. This phase of the data analysis provides evidence that enables a response to the first six research questions. The second phase (chapters 5, 6 and 7), describes the results of the RUMM 2010 Program. The results of this analysis deal specifically with the research questions associated with the development of a measurement model that can describe the association between recall levels and belief patterns for religious education and science items.

The evidence indicating that students are not responding to the items in an ordered manner suggests that a further enquiry into the students' perceptions and thinking is necessary. To respond to this need, a Reference Group was established to discuss in detail their responses to the items, their beliefs and values, and their reasoning behind their responses to the items. The results of these discussions, presented in chapter 8, provide a valuable insight into student epistemology, metacognition and ontology, adding considerably to the results of the statistical analysis of the student responses.

Finally, chapter 9 summarises the main findings and conclusions evident from the study and outlines implications for educationalists, theorists and classroom teachers. To respond directly to the research questions established at the beginning of this study, the research questions themselves form the first section of this chapter.

CHAPTER TWO

REVIEW OF LITERATURE

The learning and teaching processes at work in secondary school classrooms are complex, and are influenced by a broad array of factors. A review of the literature that is most relevant to this thesis occurs within the context of good educational practice and suggests that there are two main groups of factors directly impacting on student learning in religious education secondary school classrooms. One, factors that are associated with students' beliefs and perceptions – discussed in Part A. As an aspect of this thesis relates to students' belief, a brief section (Part B) is included. Part C of this chapter outlines how students' beliefs impact on the teaching-learning processes at work in the classroom. A summary of the main findings from the literature review is set out as Part D.

PART A

BELIEF FACTORS AFFECTING STUDENT LEARNING

The teaching-learning processes

This section provides evidence supporting the view that:

- teaching and learning are two processes that while being inter-related are nevertheless quite separate processes

Research by (Barry & King, 1993) in Australia indicates that teaching and learning are two distinct processes that are never the less closely linked. The differences between the two processes of teaching and learning have been indicated by Barry and King (1993) and Cox (1996) who reported that teaching does not necessarily result in learning. The results of their research indicate that, even in good teaching environments, students who have demonstrated learning ability within normal ranges do not necessarily learn the content they are presented with in class. It would seem from this research that students choose what they are prepared to learn selecting content that they perceive as being important enough to invest time and energy to learn. The teaching environment may be excellent but learning may not occur.

The proposal that the teaching and learning processes are two processes is also supported by extensive research in Australian religious education classrooms by Macdonald (1988) and Donnan (1995) who found that students choose not to learn content from the religious education class room that the students perceive as lacking relevance in their lives. These studies suggest that students consciously evaluate the value of the content with which they are presented in class and, as a result of their perceptions, vary their learning activity. The research (Macdonald 1988, Moore, 1991, and Donnan, 1995) indicates that many students relate the importance of their subjects and the content of those subjects to the existence of examinations. It has been shown that, if a subject is examined, many students increase their efforts in that subject, and vice versa. Teachers often report the occurrence of the question – “Is this in the exam?” as an indicator of students seeking prompts from their teachers, as to the importance of an item of content. Subjects that not examined, and content that is not examined from a subject that is normally examined, are often not perceived as being important by students, and as a result, the content is often not learnt. The proposal that learning is a separate process to teaching is therefore evident.

Learning processes

This section provides evidence supporting the view that;

- student beliefs (perception) affect student learning;
- students exhibit differing levels of commitment to learning;
- student motivation to learn is influenced by student beliefs;
- the religious is perceived as having less relevance in the community;
- students perceive that religious education has little relevance to them and so their motivation to learn is low
- effective teaching requires good communication. Good communication is based on trust. If students do not trust their religious education teachers, learning in the religious education classroom may not be effective

- students' cognitive constructs may not mirror the teachers constructs and hence communication may not be effective.

It is the contention of this study that student perceptions impinge on the students' commitment to learn and thus affect the learning process itself. Biggs (1987), Marsh (1996) and Hergenhahn and Olson (1997) suggest that students exhibit a range of differing levels of commitment to learning. The varying levels of student response to the teaching process, can be related to student perceptions of a subject, and can impact on learning. At the lowest level, for example, a student may initially receive the content being taught. Having received the content, a student may be aware of the material being taught, but learning proceeds no further. No real learning has occurred. The student may not have perceived that the content warranted an investment of time and effort to learn. Marsh's (1996) extensive work in the Australian setting suggests that at a deeper level the student may respond to the teaching and so may reveal "a new behaviour as a result of the experience" (Marsh, 1996, p.95). At a still deeper level, a student may value what has been taught and may show some commitment to the content of the lesson and may as a result, "integrate a new value" (p.95) into their own value system. The content may have been perceived as important enough to warrant a significant investment of time and effort to learn, accept and incorporate the content into their lives. Each of the levels of learning, described by Marsh (1996), requires a response on the part of the student. A negative response such as "I don't believe that", "this is boring" or "why do we have to learn this?" may result in little or no learning actually taking place and the level of learning may be quite low (shallow learning). It would seem then, that the level of response by the student to teaching may, in part, be determined by the particular student's perceptions of that subject.

Research by Biggs (1987), Marsh (1996) and Hergenhahn and Olson (1997) suggest that students exhibit a range of differing levels of commitment to learning and that the commitment to learning can vary with the perception of the relevance of the content to the students. The same conclusion is evident in regards the content of the

religious education class room. Ozorak (1989) and Reich (1997) indicated that some people no longer find fulfilment in the religious. While Reich's (1997) research is based in Switzerland and does not strictly apply to the Australian situation his general conclusions can assist with our understanding of student learning. His empirical study relates the movement away from the religious to the lack of religious commitment of the significant others in the person's life, and the lack of religious engagement during childhood (p.15 –22). Reich's findings describe a culture that is increasingly less open to religious thought and becoming increasingly isolated from the religious. If the family no longer supports the religious education of the children, the expectation that "parents are the first educators of their children and that Catholic schools have been established to support the role of parents in the religious education of their children (Ryan & Malone, 1996, p.157, Doherty, 1997, p.42) cannot be fulfilled. Where religious values are not nurtured within the family, young people may not come to appreciate those values. Consequently their motivation to learn the content of the religious education class room maybe low and so learning in this subject may not be effective.

The low status of religious education amongst students is confirmed in studies in Finland, New Zealand and Australia. Puolimatka and Tirri (2000) found that the neutral attitude of grade three to six Finnish students to religious education became quite negative in higher years, when religious education is "regarded as the most irrelevant subject" (p.38) the students experienced. In New Zealand, Stollenwerk (1999) found that students do not consider religious education worthy of serious study (p.144) and Baker and Moroz (1997) found that religious education is "last out of thirteen for teachers and students" (p.23). In Australia, the National Catholic Education Commission (NCEC) (1991) similarly reported that "almost a third of the group are negative about the value of their religious education program" (p.4). The teaching environment of the religious education classroom may well be excellent, and yet the students' perception of religious education as lacking relevance and value, may impact on the effectiveness of student learning. Student learning therefore may be affected by factors other than the teaching environment. It could therefore be concluded that as teaching and learning are quite

different processes and that students have been shown to select what is to be learnt and what is not, then for a subject such as religious education that appears to have a low status in the eyes of the students it is quite possible that student learning in this subject may be poor.

The teaching– learning processes are very much associated with communication. As communication entails both talking and listening and is based on a relationship between teacher and student, effective communication within the classroom may be influenced by student beliefs. According to Biggs (1987) and Maish (1996), communication involves the phase in which 'explaining' requires an open and trusting environment with ample opportunities for communication by all students, and the teacher" (Marsh, 1996, p 118). If students do not believe that they can trust their teacher, effective communication (teaching and learning) may not occur.

While the effectiveness of teaching may be influenced by students' beliefs regarding the level of trust within the classroom, poor communication on the part of the teacher has been cited as one of the causes of ineffective teaching. This poor level of communication results from teachers not understanding the significance of student perceptions of the relevance of the content, student epistemological beliefs and metacognition and student perceptions of the meaning and purpose of the learning activities. Nipkow, Schweitzer, Faust and Krupka (1996) carried out extensive empirical studies of the teaching learning process and have observed that teachers 'do not seem to be aware of the children's own interpretative activities in terms of cognitive structures' (p.119), and that the interplay between teachers and students is not so much an interaction, but rather 'an acting on two separate levels' (Nipkow, Schweitzer, Faust & Krupka, 1996, p.119). Individual students may come into a classroom with differing conceptual models resulting in a lack of connection between teacher and student. Hendry & King's (1994) extensive review of the literature relating to the theory of learning give credence to the conclusion that effective communication is not actually present and so a teacher cannot expect "all children to learn the same thing at the same time" (p.235).

It would therefore appear that differing student perceptions regarding the learning environment and the level of communication within the classroom may have an impact on the teaching– learning processes. This being the case one would expect that a similar situation would be in evidence within the religious education classroom. Students who do not perceive that there is genuine communication within the religious education classroom may not learn effectively.

Three memory systems in processing input: Biggs' model

This section provides evidence supporting the view that:

- the effectiveness of any learning is dependant on choices the student makes regarding what is important enough to learn;
- Biggs' model highlights the importance of students' beliefs to the learning process;
- Biggs' model highlights the importance of the 'selected input' phase of the learning process

Biggs' (1987) model illustrates diagrammatically that the learning process involves a number of stages. The relevance of this model to this thesis is the significance of the stage labelled 'selected input'. This stage implies that students make choices as what to learn from the total input they receive in the classroom. Biggs suggests that some students *select* important material after a pre-coding phase and then, *if selected*, the content passes through several phases until it is moved into long-term memory. The model demonstrates the importance of the student selecting the content to be learnt in the teaching–learning process, emphasising that from the very beginning the student has control of the learning process. It is the student who must select what is important, and attend to that material, before learning can occur. The student may not pick up the correct cues and so not recognise the importance of some input, the student's beliefs regarding the content may significantly influence what the student perceives is important, or has been described earlier, the student may not value the content and so choose not to invest time and effort in learning the

content. If the content successfully reaches the working memory stage the student still has significant choices to make if effective learning is to occur. The student will need to consider the information, “think about it ...rehearse it ...and code it by linking it to something” (Biggs, 1987, p.45) that is already known. The material can then be stored. The heart of the model for this thesis is the central role of the ‘selected input’ phase to effective learning and, as such, the model highlights the importance of the individual to the teaching – learning processes. The model emphasises that student perceptions, student epistemological beliefs and metacognition all influence the ‘input selection’ phase that is so central to learning.

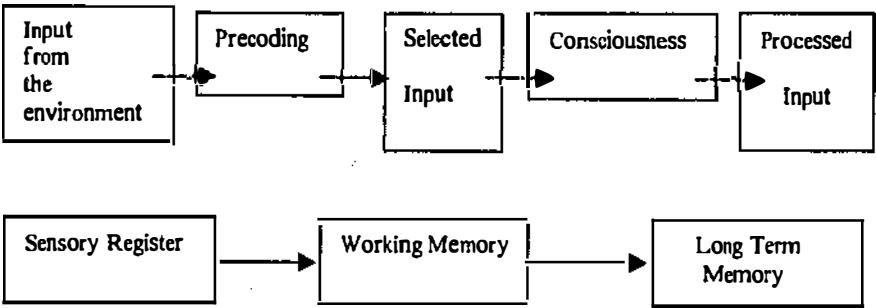


Figure 2.1. Three Memory Systems in Processing Input (Biggs 1987, p.45).

Biggs' model relates directly to the research questions and this thesis. The focus of the model is that the student is 'in control' of the learning process and as such 'chooses' what is to be learnt. This thesis argues that student beliefs about the plausibility of content in the religious education classroom affect learning. Content that is perceived as lacking veracity, is not plausible, requires too high a level of commitment or has too high a level of knowledge to be easily learnt (the students have low motivation to learn), may not be learnt as effectively as other content. Biggs' model therefore describes the parameters involved in this study, relating differences in learning to the 'selection' process students use, prior to committing themselves to the task of learning.

The model also indicates that effective learning requires that the students link the new information to something already learnt. If, as has been described above, the

students' experience of the religious is limited, the capacity of the student to learn in the religious education classroom, by linking new learning to past experiences would be limited. Student learning in religious education may therefore not be effective. Effective learning also requires students to 'select' the content that is important for learning. If the student perceives that the content being presented is not important or relevant to their lives, the model suggests that effective learning of that content may not occur. If, as has been described above, students do not appreciate religious values, their capacity to learn in the religious education classroom may be limited. A response where students indicated that they have learnt fewer of the religious education items (Research Question 1) than the science items (Research Question 2) can therefore be explained within the context of Biggs' model.

The learning process, as described by Biggs' model, supports the conclusions of research by Nipkow, Schweitzer, Faust and Krupka, 1996 emphasising that effective teaching requires close linkages between teacher and student. The effectiveness of long-term learning relates to the depth of learning, and it would seem can be influenced by the students' beliefs. Students who believe that content lacks plausibility, do not trust their teacher or perceive that a subject or the content of a subject lacks relevance to their lives may choose to not learn that content. Learning in the religious education classroom may therefore be different to learning in other subjects such as science that may be perceived as being relevant and representing plausible content.

Deep and surface learning

This section provides evidence supporting the view that:

- students make choices as to how much effort to put into learning different content;
- surface learning is the 'easiest' level of learning, deep learning requires effort;
- school structures encourage surface learning not deep learning;
- students may believe that the content of the religious education classroom is not plausible or relevant to their lives and so choose to not expend much effort in learning that content;

Biggs (1987) and van Rossum and Schenk (1984) described effective learning as deep learning. They described deep learning as “finding out what something really means and is understood and/or ... constructing a personal philosophy or worldview” (Biggs, 1987, p.147). Some learning can be at a low level (shallow learning) or at a deeper level.

Chin & Brown’s (2000) research into deep and surface learning indicated that students make choices about their learning and choose what content warrants the expenditure of time and effort to achieve deep learning and what content does not warrant such an effort. While this research began with only six grade 8 students utilising observation and recorded activities and hence could be seen as contributing little to our understanding of the teaching learning process at work in Australian religious education classrooms, the initial finding were supplemented by extensive follow up survey and empirical analysis of over 100 grade 8 students in the USA. In addition to this extensive research the general conclusions were cross referenced and supported by an extensive literature review. As a result the general conclusions may have some application to the Australian situation.

Chin and Brown’s (2000) research offers additional weight to the proposition that the learning process is influenced by the choices students make in the classroom. In the surface approach to learning, Chin and Brown described how students tend to “memorise discrete facts in isolation from other tasks, and from real life as a whole” (p.110) to meet “accountability pressures with the least possible effort” (p.113). In many ways this type of approach is reinforced by classroom organisation and the nature of academic tasks which “encourage students to get it done, not think it through” (Pintrich et al., 1993, p.181). As Hendry (1994) points out, “achievement tests are used to measure the quantity of absorbed knowledge rather than to ascertain students’ quality of understanding” (p.225), and so it would seem that the very nature of the teaching process in schools may encourage surface learning rather than deep learning. Therefore, if students make decisions about the effort they should expend on learning, their choices may be influenced by their beliefs regarding the content to be learnt. Content that is perceived as having little relevance or veracity may attract little commitment to learn. Subjects that

are perceived as having little relevance to their lives may attract little commitment to learn. Therefore, if as has been suggested, students perceive that religious education lacks relevance and veracity, students may therefore not expend much effort in learning the content of their religious education course. Learning in the religious education classroom would therefore be different to learning in other subjects such as science that may be perceived as being more relevant and represent more plausible content.

Motivation to learn

This section provides evidence supporting the view that:

- motivation to learn is a significant influence on effective learning;
- the motivation to learn is influenced by student beliefs;
- where students perceive little inherent value in learning, that learning may be very ineffective;
- students may perceive little inherent value in learning the content of their religious education class;

Research by Biggs (1987) and Elliott, Hufton & Hildreth (1999) (in the USSR and the USA with 15 year old students) indicates that student learning is deeply influenced by students' beliefs, and that one significant belief factor is the choice students make to either actively seek deep learning, or be content with surface learning. Marsh (1996) introduces motivation as a significant variable in the learning process suggesting that students motivated to learn may more often actively seek deep learning. Marsh (1996) describes intrinsic motivation as not having "any apparent external reward" (p.27), whereas "extrinsic motivation is experienced by students when they receive a reward or avoid punishment (p.28). Marsh highlights the importance of motivation to student learning, suggesting that as a student's needs are met within the learning environment, student motivation to learn will be enhanced. Where a student perceives that a particular subject fails to fulfil his/her needs, it would be expected that the student's motivation to learn might be quite low. Therefore if the content of a subject such as religious education

is perceived as not satisfying a student's needs, learning in this subject may not be effective.

The motivation to learn may influence whether a student chooses to learn at a deep level. Elliott, et al. (1999) investigated the factors influencing educational motivation and, through a comparison of student outcomes in American classrooms, suggested that the reason US based Asian-American children consistently outperform their Caucasian American counterparts, is "rooted in attitudinal and motivational differences" (p.76). Elliott, et al. (1999) suggest that the students' perception of the value of education is paramount to the observed difference in motivation between the two groups of American students and that the observed decline in the motivation to learn in American culture is the result of "the belief that the reason a person goes to school is to get a good job" (p.86).

The belief that the purpose of learning is monetary gain has "robbed our society of two important values" (Elliott et al., p.86). Firstly, students do not seem to be able to see that what they are doing is important and, secondly, they do not seem to see that there is value in knowledge and learning. This perception of the value of education seems to contrast with students in Russia and Asia who "have tended to perceive education as an end in itself; to be articulate, literate and cultured has its own importance", and so "academic and intellectual ability is greatly prized" (p.74). Elliott's observations suggest that learning can be influenced by the presence of a motivation to learn, and that the effectiveness of the learning may relate to the strength of the motivation. When students perceive little inherent value in learning, that learning may be very ineffective.

The conclusions of the research of Elliott et al. (1999) are useful for classroom teachers. If students perceive that the content of the religious education course has little relevance to them, and to their future, the motivation to learn that content would be quite low. An outcome of this low motivation is ineffective or shallow learning. Students may perceive the content of the science course as more relevant, than the content of the religious education course, and as a result of this perception, may have an increased motivation to learn in the science classroom. In addition, the motivational pressure from

external factors such as parents and examinations, to learn the content of science, may be greater than the motivational pressure to learn the content of religious education.

Conclusions from the literature

There is research evidence to support the view that:

- teaching and learning are two processes that are separate yet interrelated;
- students select much of the information they are prepared to learn;
- religious education is perceived as having a low status and so some students choose not to learn much of the content of this subject;
- student beliefs (perceptions) affect student learning;
- students exhibit differing levels of commitment to learning;
- student motivation to learn is influenced by student beliefs;
- some students perceive religious values as not having much relevance in their communities;
- some students perceive that religious education has little relevance to them and so their motivation to learn is low;
- effective teaching generally requires good communication. Good communication is based on trust. If students do not trust their religious education teachers, learning in the religious education classroom may not be effective;
- students' cognitive constructs may not mirror the teachers' constructs and hence communication may not be effective.
- the effectiveness of any learning is potentially dependent on choices the students make regarding what is important enough to learn;
- Biggs' model (1987) highlights the importance of students' beliefs to the learning process;
- students make choices as to how much effort to put into learning different content;
- surface learning is the easiest level of learning, deep learning requires effort;
- some school structures may encourage surface learning to the detriment of deep learning;

- some students may believe that some content of the religious education classroom is not plausible, or relevant to their lives, and so choose not to expend much effort in learning that content;
- motivation to learn is a significant influence on effective learning;
- the motivation to learn is influenced by student beliefs;
- where students perceive little inherent value in learning, learning may be ineffective;
- some students may perceive little inherent value in learning some content of their religious education classes.

PART B

BELIEFS IN THE NATURE OF KNOWLEDGE

Early- life learning

This section provides evidence supporting the view that:

- belief plays an important part in learning;
- an individuals' beliefs regarding the nature of knowledge and learning are largely formed early in a person's life.

Research (Bereiter, 1994 and Palmer, 1999) indicates that informal learning experiences early in a child's life impact greatly on the development of conceptions regarding knowledge. Bereiter's paper challenges whether any empirical or scientific claims exist regarding a comparison of constructivist and socio-cultural perspectives, and yet at the same time does not offer any empirical evidence to support his own conclusions. Bereiter's paper though, is well argued and based on a critical review of extensive literature indicating that his conclusions could make a contribution to our understanding of learning in Australia. Matthews (1998) arrived at a similar conclusion to Bereiter (1994) after statistical analysis of a large number of 11 to 16 year old students in NSW. His paper on the development of knowledge structures, in highlighting the importance of human nature to the learning process, indicates that our "predilection for premature acceptance and assertion and our aversion to suspend judgement, are signs that

we tend naturally to cut short the process of testing" (Matthews, 1998, p.161)¹.

Matthews suggests that we have a tendency to accept what we perceive as reality rather too easily, are often loath to pursue rigorous examination to ascertain the truth and that we learn these epistemological beliefs from our early life experiences. Pajares' (1992) observation that "individuals begin by believing" (p.313) supports Bereiter and Palmer's findings that belief plays an important part in the learning process. Pajares' studies indicated that when children begin the leaning process they tend to accept the content of lessons on the basis of faith (they trust the teacher to teach what is true) rather than 'demand' evidence that the content is true. This observation regarding children's early learning experiences

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1. While it is not possible to fully explore Gardner's model of multiple Intelligences in this thesis, aspects of this model may relate to how a student develops the capacity (competency, intelligence) to effectively learn different types of subjects or different types of knowledge. The reader interested in exploring this area in the literature is directed to the following: Gardner (1991), Walters & Gardner (1995), Kirshenbaum (1995) and Kornhaber (1995). Elloit (1998), Zohar and Marshall (2000), de Souza (2001) are a starting point for a reader wishing to further explore the reservations in the literature concerning Gardner's notion of the plurality of intelligences.

The possibility of a 'religious intelligence' is also raised in the literature. The reader interested in this debate is directed to: Elliot (1998), Gardner (2000), Mayer (2000), Emmons (2000), Edwards (1998), Levin (2000), Sinatar (2000), Zohar & Marshall (2000) and Hyde (2003). This literature introduces the reader to the arguments that support and challenge the notion of a 'religious intelligence'.

Recent research into the structure of the brain and how that structure impacts on learning (Fitzpatrick, 1995, Fischer & Rose, 1998, Bruer, 1998, Hyde, 2003, Wolfe & Brandt, 1998 and Diamond & Hobson, 1998) also provides an interesting insight into how early life experiences can impact on the child's learning. The reader may be interested in the following, as an introduction to the literature that argues that an individuals' intelligence is linked to the physical structure of their brain: Halford (1999), Hay (1999) and Anderson (2000). The possibility of a nexus between brain physiology and spirituality is argued by O'Murchu (1997), Hay & Nye (1998) and Zohar & Marshall (2000). Brain research indicates that the development of linkages in the brain is associated with life experiences. Radford (1999), Malone (1998), Murphy-Russell, Die & Walker (1996), Lynch (1988), Chen & Soudack (1994) and Seng (1994) argue the importance of learning experiences in the teaching of religious education raising the possibility that brain physiology may impact on the students' capacity to effectively comprehend the religious.

may establish a relationship between belief and learning that continues throughout their schooling. It would therefore seem that epistemological beliefs are 'learnt' early in life and that beliefs do play an important part in the teaching learning processes.

Beliefs regarding the content of science and religious education

This section provides evidence supporting the view that:

- most students have been 'taught' to accept science content as 'true' knowledge;
- some students may perceive the content of the religious education course as not having relevance, value or plausibility;
- scientific authority, as a source of knowledge is generally well accepted by most students;
- religious authority, as a source of knowledge, is sometimes not well accepted by some students;
- the religious world is perceived as outside the world of reality by some students;
- content that is counter to students' epistemological beliefs may be poorly learnt by some students;
- education, in the Christian context, has always been true to reason;
- these conclusions may explain why some students perceive the content of their science course as being different to the content of their religious education course and in turn, result in differences in learning outcomes.

Lewis (1990) and Bell et al. (2000) support the observation that belief plays a significant part in learning, and that beliefs are important to student perceptions of the plausibility of knowledge. They also suggest that good science teaching necessitates that students be made aware that scientific observations are constrained by the limitations of perceptual apparatus and are therefore, inherently theory laden and rely to a greater or lesser extent on faith that the apparatus is reliable. In calling for an educational process to raise awareness of the real relationship between science and belief, Bell et al. (2000)

highlight the need to bring students to a realisation that their acceptance of scientific observations as factual relies heavily on belief and to bring students to a realisation of the part that faith (belief) plays in science. The basis of Zoller & Donn (1991) and Bell et al.'s (2000) call is that in our society there is a tendency to accept all scientific knowledge as concrete knowledge, that the content of the scientific method is plausible and therefore that only content based on the scientific method can represent concrete knowledge. Zoller & Donn's (1991) research was based in Canada using grade 11 students and as such may not have direct applicability to the Australian situation. His empirical findings though are reflected by other research and hence may be seen as contributing to our understanding of students' epistemology in Western Australia. The tendency to perceive that the plausibility of knowledge relies on the scientific method may well have an impact on how students respond to content of subjects such as religious education.

Pajares (1992) similarly suggests that "individuals begin by believing their own senses, their intuition and the laws of nature and logic" (p. 313) and so, when presented with content that arises from what is perceived as being human observation, objective intuition and logic, it is easy to see how they accept the plausibility of the content of the scientific method. The observations by Pajares (1992), Bereiter (1994) and Palmer (1999) indicated the importance of personal experiences in the learning processes young children have, even before they come under the influence of formal education.

Educators, being aware of the influence of the myth of science on student learning, are attempting to educate students about the real nature of the scientific method. Their efforts to counteract the power of the prevailing myth of science is hindered by the deep seated learning described by Bereiter (1994) and Palmer (1999) and so, despite the attempts of educators to counteract this incorrect perception of the nature of knowledge, it is doubtful whether such programmes can be successful for all students. Palmer (1999), for example, believes that "there are common ways of thinking in the population, and that they are robust enough to have survived schooling" (p.648). It would seem then, that the prevailing perception that the content of science represents true knowledge, might remain firmly entrenched within the makeup of some high school students. Student perception of

the plausibility of content in the religious education and science classrooms may therefore remain a significant factor in students' epistemological beliefs and, as a result of the nature of these beliefs, the teaching-learning processes at work in these two classrooms may well be different.

Given that the scientific approach to learning seems very likely to be present in all conceivable future educational endeavours (Carey, 2001), the tendency for students to rely on the scientific method as a source of knowledge may remain despite the fact that academics in all spheres of study accept the possibility of reality that "cannot be explained" (Radford, 1999, p.172, Cush, 1999, p.45) by science, and despite calls by educationalists to 'educate' students about the part belief plays in scientific endeavour (Bell et al., 2000). Stollenwerk (1999) suggests that the efforts to educate students about the "naivety of the view that knowledge is concrete" (Cush, 1999, p.140), is "quite irrelevant to the way students view truth" and in many cases does not seem "to reckon in ... students' thoughts" (p.45). Barrett (1999) suggests that one possible impact of this epistemological belief, and 'denial' that other forms of knowing are possible, is on the teaching-learning process. He indicates if one "encounters events or ideas that too radically counter the biases of ... knowledge structures, memory for the events and ideas are likely to be poor" (Barrett, 1999, p.336). It is possible, therefore, that because the teaching-learning processes are dominated by the scientific method, the content of the religious education classroom may well appear counter to the biases of some students, and to their prior learning. Such a contradiction may create problems "for the teacher of religious education, given the literal turn of pupils' minds and the difficulties that they may have with the notion of truth" (Radford, 1999, p.173) and may make effective learning in the religious education classroom difficult.

There is evidence of an increasing concern amongst educators that some students tend to regard the natural sciences as the only source of true knowledge (Talbot, 2000, p.13). The conception that science is indeed the source of all truth is supported by the "widely prevailing myth within the public at large, that scientists are completely objective, unbiased, disinterested human beings" (Zoller & Donn, 1991, p.31) and that the result of

the scientific method is concrete knowledge. Therefore, a high school student presented with a series of statements in a science text, or classroom, may have a strong predilection to accept that the content in that text is indeed factual. Content from other subjects that are not seen as having scientific credibility may well be perceived as lacking the same level of plausibility. Ozorak (1989) suggests that since it is hard to test beliefs that are not subject to empirical proof, such as the existence of God or life after death, some adolescents may relate this lack of 'proof' of some of the content of religious education to the lack of plausibility of the total content of the subject. The resultant belief that the content of religious education lacks plausibility may in turn impact on the learning of that content. Therefore, student perception of the plausibility of content in the religious education and science classrooms may well be different and, as a result of this difference, the learning processes at work in these two classrooms may well be different despite teachers in the religious education classroom making every effort to provide students with strong evidence that the content of the religious education lesson is concrete knowledge.

While suggesting that an awareness that all knowledge is not concrete may develop with higher levels of academic achievement, Byrne's (1999) observation that "human intellectual study appears to be part of the world of human conceptual meaning" (p.347) does suggest that the "mind is dependent on the senses for the acquisition ... of knowledge" (Carey, 1999, p.24). Byrne's and Carey's conclusions suggest that students rely on their senses to learn. What students can see, measure, touch and experience provides them with 'evidence' about the plausibility of knowledge, and may tend to reinforce epistemological beliefs that concepts that cannot be 'proven' by seeing, measuring, touching and experiencing are not plausible, irrespective of an intellectual awareness that all knowledge is not concrete. Therefore, the possibility arises that students who perceive that content is beyond the senses (outside the scientific method) may perceive that content as less plausible and may treat that content differently in the classroom.

While there may be a perception amongst some school students that religious education is in some way 'counter knowledge', the history of Catholic education is very

different. Cooney's (2000) extensive review of Church history and literature draws upon Catholic experiences in education in Australia to suggest that religious education is firmly based on a search for truth. Cooney reports that an early educationalist, Clement of Alexandria (150– 215AD), applied Greek philosophy to Christian teachings by developing an educative process which began with grammar, rhetoric and literature, moved onto arithmetic, geometry and astronomy, and then abstract understandings and philosophy. The result of this process is the "ideal Christian person, the didaskalos or learned one" (Cooney, 2000, p. 56). In the thirteenth century, Thomas Aquinas argued "human reason and Christian faith are compatible and that human reason can discover the essence of things, that is, 'veritas', the absolute truth" (Cooney, 2000, p. 56). The basis of this philosophy is strongly echoed in the Church document 'The Catholic School on the Threshold of the Third Millennium' which emphasises the importance of an "education characterised by the search for truth" (Congregation for Catholic Education, 1998, p. 17) within the Catholic school.

While the research (Lewis (1990) and Bell et al. (2000)), indicates that there is a tendency in society to perceive that the plausibility of knowledge relies on the scientific method, there is evidence that the plausibility of religious concepts is increasingly being brought into question. The Church document, 'The Catholic School on the Threshold of the Third Millennium', recognises that there is "a growing marginalisation of christian faith as a reference point and source of light for an effective and convincing interpretation of existence" (Congregation for Catholic Education, 1998, #1). In addition to a perceived growing marginalisation of Christian faith, there is an increasing tendency where "the truth of religion is publicly disputed" (Jaffee, 1997, p. 326). As a result of this tendency in society to reject the plausibility of religious concepts, students too may tend to perceive that the content of the religious education course lacks plausibility. These epistemological beliefs regarding the plausibility of the content of religious education courses may therefore impact on student learning in the religious education classroom.

Pajares' (1992) studies indicate that when children begin the learning process they tend to accept the content of lessons on the basis of faith (they trust the teacher to teach what is

true) rather than 'demand' evidence that the content is true. Research, into epistemological beliefs of older students indicates a tendency, for some students, to not accept knowledge as concrete. Rioux et al. (1997) in an empirical analysis of 20 year old Canadian university students suggested that "as the levels of education and philosophical creativity increased, more sophisticated views on the justification of belief precluded assumptions of absolute authority-based knowledge or truth, originating from sources of religious authority" (p.412). This research, while based in Canada using 20 year old students, can add to our understanding of student learning in the religious education classroom explaining, in part, the tendency of older students to see religious concepts as lacking plausibility. The world of religious education is perceived by some students as being outside the world of knowable reality, and as a result, is perceived as lacking veracity. This belief may therefore impact on student learning in the religious education classroom. Content that is perceived as lacking plausibility may not be seen as warranting the same investment of time and effort for learning as content from other subjects that are seen as plausible.

It would seem then, from the literature, that while academic circles recognise that their disciplines are not the sole source of knowledge in our world, high school students might hold a different set of epistemological beliefs. Complicating this gap in understanding the true nature of knowledge is the position, within Catholic education, that religious beliefs and religious knowledge are valid, and indeed the main goal of Catholic education is a search for truth. It would seem clear though, that students within the Catholic system tend to not perceive religious education content in this light, and indeed the effective learning processes in the religious education classroom are made all the more difficult because students tend to not perceive content of the religious education classroom as being plausible.

Knowledge and belief

This section provides evidence supporting the view that:

- belief and knowledge are concepts that are closely linked;

- knowledge and beliefs are concepts that cannot easily be defined;
- many students tend to accept content as true as a result of evidence and trust;
- beliefs can be strong enough for some students to perceive that untrue content is concrete fact, and true content may be treated as a belief;
- deep-seated beliefs can last a long time;
- these conclusions may explain why some students perceive the content of their science course as being different to the content of their religious education course, and in-turn result in differences in learning outcomes.

Given that the above discussion points to the importance of epistemological belief in the acquisition of knowledge and learning, a more detailed investigation of the relationship between knowledge and belief¹ is warranted. Pajares (1992) suggests that "knowledge and beliefs are inextricably intertwined" (p.325) and that it is through beliefs that all "new phenomena are interpreted" (p.325). Hogan (2000) too, indicates that entrenched beliefs have "broad explanatory power" (p.56), and so are closely linked to knowledge and learning. While there seems to be some consensus that belief and knowledge are linked, the two terms do describe different concepts. Kardash (1996) suggests that knowledge can be distinguished from beliefs in two ways. First, "a belief can be false" and secondly "a belief may be based on insufficient evidence" (p.262). Admittedly, a belief can be false, but equally a belief can be true. In addition, what is accepted as knowledge (at this point in time) can also be false and, although an item of knowledge may be accepted as knowledge, it may be based on insufficient or incomplete evidence. Therefore, Kardash's (1996) definition relies on perceptions of what

1. This thesis is concerned with the impact of student perceptions of the plausibility of the content. To investigate student perceptions of the plausibility of content two subjects were chosen – religious education and science. This thesis deals with epistemological beliefs about the nature of knowledge in these two subjects. The focus of this thesis is not the development of faith in the religious sense, catechesis or faith formation in the religious education classroom. There is an extensive body of research dealing with this particular issue. A reader interested in this aspect of religious education may wish to note the following: Crawford M & Rossiter, G. (1988), Flynn, M. (1979), (1985), (1993), Groome, T.H. (1980), (1991), (1998), Hill, B. V. (1985), Ryan, M (1997), Rummery, R.M. (1975) and The Australian Catholic Bishop's Committee for Education (1990), Holohan, G. (1999).

constitutes knowledge rather than an objective knowledge. For example, a student may hold that 'X' is true because of a belief that 'X' is true and have no 'reason' to know that it is true. If 'X' is actually true, does that mean that the 'X' is not a belief, but is in reality knowledge? Kardash's second premise does not help resolve the situation of a student's belief in 'X'. The student may believe 'X' for no other reason than "I just do", and so may actually have no evidence to suggest that 'X' is true. Therefore, the attempt by Kardash to distinguish beliefs from knowledge may not be as simple as at first thought, because his definition does not allow for what many students perceive as knowledge. It would therefore seem necessary to seek a clearer understanding of belief elsewhere.

The linkage between knowledge and beliefs is also highlighted by Rokeach (1968), Nespor (1987) and Hofer and Pintrich (1997) who argued that all beliefs have a cognitive component representing knowledge. Although Nespor (1987) suggests that "beliefs have stronger affective and evaluative components than knowledge" (p.320), a belief is likely to have strong knowledge-like qualities. To hold a belief requires cognitive aspects such as commitment. A student may believe 'X' because that student believes he or she has evidence that is accepted or perceived as true. The student's belief therefore has knowledge-like qualities: the student is cognitively committed to the item of knowledge.

Pajares (1992) attempts to clarify the term belief with the following four features – "existential presumptions – the incontrovertible personal truths everyone holds; alternatively; affective and evaluative loading; and episodic structure" (p.309). Again, in both instances, in a practical sense at a classroom level of 15-year-old students, the descriptions by Hofer and Pintrich (1999) and Pajares (1992) do not clarify the difference between belief and knowledge. 'Psychologically held understandings' could equally reflect the belief in 'X' or the (presumption) knowledge that 'X' is true. Hogan (2000) attempts a definition with the observation that "when a cognitive structure contains strong affective associations, limited to one's own identity, has an evaluative dimension and has direct ties to action agendas it is best described as a belief" (p.56). This definition too lacks clarity because, again, many of these characteristics can also have reflections in knowledge. Knowledge is also strongly linked to one's own identity, can act as an

evaluative dimension, and can strongly influence action. Therefore, apart from the loose link to the affective domain, even Hogan's (2000) attempt at a clear distinction between belief and knowledge seems to fail to clarify any differences between these two concepts, at least at the classroom level.

Pajares (1992) suggested that "belief is based on evaluation and judgement", while "knowledge is based on objective fact" (p.13). Unfortunately, the attractiveness of such clear definitions is difficult to maintain given Bell's (2000) statement that observation is inherently theory-laden (p.565), because, inherent in the acceptance of observation is a belief in the integrity of the observer and of the apparatus itself. Matthews (1998) recognises that the distinction between truth and belief is not clear. Driver and Bell (1987) suggest that, "rather than viewing truth as the fit between sense impressions and the real world", constructivists see truth as "the fit of our sense impression with our conceptions" (Driver & Bell, 1987, p.152) indicating that truth can be subjective and more closely akin to belief than knowledge.

Brickhouse et al. (2000) suggest that students tend to believe content as a result of three possible processes. Firstly, because the content appeals to direct perceptual evidence, secondly, as a result of an ability to make inferences based on evidence and, thirdly, as a result of trusting an authority figure (p.341). While these three conditions do not give a clear definition of belief, they do clarify in many regards a problem of distinguishing a difference between a belief and knowledge. Brickhouse seems to suggest that irrespective of the type of content (factual, scientific, religious, myth), students may be prepared to believe that the item of content is true, if one or more of the three characteristics are present. Therefore, the possibility arises that students in a science classroom may believe an item of content because that student trusts the teacher, believing that the authoritative figure will teach what is true even though the teacher provides no evidence to support their teachings. Whether students categorise that item of content as belief or knowledge will be influenced by other variables, such as epistemological beliefs regarding the plausibility of the content. Equally, the content of a

religious education class may also be accepted as true (a belief or an item of knowledge), as a result of the three criteria outlined by Brickhouse et al. (2000).

Both Driver and Bell (1987), and von Glasersfeld (1989), indicated the importance of subjective perceptions in any definition of knowledge. Knowledge, therefore, can be seen as a subjective construct more closely aligned to what one would normally presume is belief, rather than some irrefutable fact that is the objective representation of an observer-independent world. Given this proposal, high school students may perceive the content of science as knowledge, and believe that this content is objectively factual even though the item of content is a theory, hypothesis or best guess of the science text's author. The reverse may also therefore be true. Content that is not perceived as knowledge will therefore not be perceived as plausible. The impact of such a perception on student learning cannot be over estimated. The possibility arises then that students' beliefs could influence not only how learning occurs (via epistemological beliefs), but what learning occurs. A student, therefore, who believes 'X' is true (and in a classroom model has been taught that 'X' is true and hence now 'believes' that the fact that 'X' is true is a matter of knowledge rather than belief) may not easily reject the view that 'X' is true when a new piece of evidence suggests that 'Y' is now true. Nisbett and Ross (1980) and Pajares (1992,) concluded that "there is substantial evidence to suggest that beliefs persist even when there are no longer accurate representations of reality" (p.324). In this way the deep-seated nature of a belief can persist within a person's perception of the world and can, therefore, continue to influence the learning process. In some research, it has been suggested that beliefs may not totally affect what is learnt, but more importantly may influence what is available in the memory and what impacts on the student (Kardash & Scholes, 1996, p.262). This suggests that students may learn (absorb) all sorts of content, but the content that is readily recalled will be filtered through a student's beliefs. Therefore, beliefs can be seen as playing a significant part in student learning.

Learning processes across domains

This section provides evidence supporting the view that:

- there is no conclusive statement regarding the uniformity of students' learning across different domains;
- differing academic disciplines appear to have differing knowledge structures;
- differing knowledge structures that are evident in different domains may well result in differing approaches to learning;
- the influence of the socio-affective factors may produce differing responses and approaches to learning in different domains;
- these conclusions may explain why some students perceive the content of their science course as being different to the content of their religious education course, and in-turn result in differences in learning outcomes.

Some research (Schommer & Walker, 1997; Hofer & Pintrich, 1997) into the influence of students' beliefs on learning is not conclusive as to whether different ontological beliefs may be held for different subjects and, as a consequence, it is unclear whether the learning processes across different domains may vary, resulting in different learning experiences, or whether student learning is consistent.

While Schommer and Walker (1997) declared that "the majority of college students showed a moderately consistent level of epistemology across domains" (p.428), Hofer and Pintrich (1997) describe this possibility as an "underlying presumption" (p.125) and suggest that research in this field is "complicated by the fact that academic disciplines do have differing knowledge structures" (Hofer and Pintrich, 1997, p.127). By this Hofer and Pintrich are inferring that research into student epistemological beliefs between domains may well indicate some degree of uniformity, but that the differing knowledge structures that are evident in different domains may well result in differing approaches to learning in the classroom situation. In practice, therefore, there may be little consistency in student epistemological belief, metacognition and learning practice across domains.

Schommer (1995) proposed that "epistemological beliefs be conceived as a system of four or five independent beliefs" (Schommer, 1995, p.425), suggesting that students use their beliefs inconsistently across different domains. Palmer (1999) observed that

"students will use one idea in some contexts and another idea in other contexts, and so will appear to the observer to be inconsistent" (p.650). Pintrich et al. (1993) also indicated that "students can, and do, adapt different goals and purposes for their school work, and that becoming cognitively engaged in the myriad of classroom academic tasks is really a choice they can make for themselves" (p.168). These observations support the perception that students may well approach the study of different domains in different ways, and this supports the proposition that students may approach the study of religious education and science quite differently.

There are differing "views about whether or not students have similar or different epistemological beliefs within different domains" (Hogan, 2000, p.59, Jheng, Johnson & Anderson, 1993, Schommer & Walker, 1997). The differing views regarding this issue may result in some measure from the complexity of the interaction between epistemology, ontology and social affective factors (Tyson et al., 1997). The complexity of this interaction may well mask the reality of what is happening in the teaching – learning process. It is possible that even though epistemological beliefs and metacognitive knowledge may show strong, consistent and uniform responses by the students, within the context of some domains the influence of the socio-affective factors such as motivational factors, as described by Hogan (2000), and the influence of the interplay of epistemological beliefs, ontology and social/affective variables, may in a practical sense produce differing responses and approaches to learning in different domains. Much research in this particular field may be necessary before a clear consensus is possible.

It would seem that what people already know and believe may have a significant affect on any new knowledge that they experience. In the context of the science classroom, where students generally have a perception that knowledge is concrete, plausible and true, any new learning in this context will be influenced by this belief. The reverse may also be true for learning in the religious education classroom, where the plausibility of that context is often questioned. Any attempt to raise the academic rigour of religious education content may well be hampered by previous experience and beliefs that the

content of the religious education classroom lacks plausibility. Therefore, as a result of previous experiences of subjects such as religious education and science, student approaches to learning in these domains may be quite different.

Epistemological beliefs

This section provides evidence supporting the view that:

- epistemological beliefs impact on student learning behaviour;
- epistemological beliefs change over time from simple to more complex levels;
- high school students tend to regard science as representing static knowledge that is concrete;
- these conclusions may explain why some students perceive the content of their science course as being different to the content of their religious education course, and in-turn result in differences in learning outcomes.

Research into the affect of epistemological beliefs on student learning indicates that epistemological beliefs do play a significant part in the learning process. As a result of the association between epistemological beliefs and learning, a brief investigation of this association may assist in understanding student learning in religious education and science classrooms and how differing epistemological beliefs regarding knowledge in religious education and science classrooms may result in different learning processes.

Hofner and Pintrich (1997) suggested that "personal epistemologies are the theories and beliefs people have about the nature of knowledge and knowing ... which can act as standards for judging the validity of knowledge claims" (p.56). In a similar vein, Hewson (1985) describes epistemological commitments as "the standards which a person holds which he or she uses to judge knowledge" (p.164). It would therefore seem that there is evidence in the research that "epistemological beliefs play a key role in knowledge interpretation and cognitive monitoring" (Pajares, 1992, p.325) in that, where a student holds a belief about the plausibility or certainty of a piece of information, this belief results in a certain behaviour regarding learning that information. Research by Chin and

Brown (2000) supports this contention when they found that “students having epistemological beliefs more aligned with empiricism tended to use more rote like strategies” (p.113), as their principal strategy for learning. Epistemological beliefs, therefore, are about what a student believes is the nature of knowledge and it would seem that epistemological beliefs may affect learning behaviour.

There is some evidence to suggest that epistemological beliefs are not static. The early work of Perry (1970) indicates that at least three stages of epistemological beliefs were in evidence in describing student learning. The first stage, ‘Dualism’, is characterised by the belief that knowledge is absolute. Hofer’s (1997) work also confirmed that at the lower levels described by Perry (1970), students tended to believe that “absolute truth exists with certainty (p.109) and that knowledge is handed down from authority (p.109). Perry (1970) described a second stage – ‘Multiplicity’- which is characterised by the belief that truth is still knowable, and a third stage, ‘Relativism’ where students perceive knowledge as being relative. Hofer (1997) indicates that students develop a capacity to perceive knowledge as “tentative and evolving” (p.120) at a later level of epistemological ‘maturity.’ A similar progression is described in the work of Baxter (1992) whose research was conducted in the USA over a 5 year period involving over 100 university students. The limiting factor in Baxter’s research was the cultural limitations apparent in the study population. Kuhn’s (1993) analysis of interviews of 40 subjects ranging in age from their teens to sixty years old reflected Baxter’s conclusions and is supported by the ten year study by King and Kitchener (1994) who reported stages of increasingly complex thinking regarding knowledge and learning amongst students. While each of these studies have their own limitations having arrived at similar conclusions suggests that their finding may have some applicability to the Australian situation.

Complementing the research (Baxter, 1992, Kuhn, 1993, King & Kitchener, 1994 and Hofer & Pintrich, 1997) that illustrates the increasing complexity of epistemological beliefs amongst students is the work of Tsai (1998) who investigated the ‘reasoning’ behind the students’ epistemological beliefs. He describes how students rationalised their belief that science based knowledge is certain with the realisation that conflicting

scientific theories exist. He found that students "tended to insist that there was one correct answer ... and that the existence of different theories comes from the limitations of technology or inadequate observations" (p.479). It would seem from this research that students are able to rationalise conflicting realities and so maintain their epistemological beliefs. Schommer's (1995) investigation of student thinking revealed how students are able to maintain their epistemological belief that knowledge is certain with the observation that scientific debate occurs. He showed that students believe that "the majority of our knowledge is certain, that some knowledge has yet to be discovered and that a small amount can be considered as changing (p.301).

Research (Perry, 1970, Schommer, 1990, 1992, 1993 and Hofer & Pintrich, 1997) into the field of 'evolving' perceptions regarding learning and knowledge does indicate that generally students progress through increasingly complex stages of epistemological beliefs towards a high level of understanding. Such an observation may be construed as indicating that progress toward the more complex stages may inevitably lead toward a mature realisation that knowledge is far from the simplistic accumulation of facts received from authoritative figures and, as such, that science is not the source of all truth. The work of Perry (1970), Schommer (1990, 1992 and 1993) and Hofer and Pintrich (1997) indicate that progress to the more advanced levels of understanding knowledge is not an automatic progression that occurs with time. Perry (1970) found that many students enter college with beliefs that knowledge is simple and certain and handed down by authority. Schommer's (1993) own factor analysis of over 100 junior college undergraduates and almost 150 university students in the USA suggested that even "junior college students display metacognitive abilities similar to those of high school students (p.410), and that even "students in the medical field have a propensity to oversimplify knowledge" (Schommer, 1992, p.436). Hofer and Pintrich (1997) too, described graduating seniors as having attained only the lowest rung of quasi-reflective thinking (King and Kitchener's second stage) even though Schommer (1995) reported that high school students appear to evolve in epistemological sophistication across the four years of secondary school" (p.425).

Songer and Linn (1991) found that in middle schools in mid-western USA students' views of science fell into three knowledge groups – static (science is a group of facts that are best memorised); dynamic (where science ideas develop and change) and a third group between the two (p.761). Only 15% of middle school students reported a dynamic view of science, 21% had a static view and the remaining 63% had mixed views (Songer and Linn, 1991, p.272). There may therefore be doubt about the automatic progression of young people through the stages of increasingly complex thinking and learning, but generally there appears to be some consensus that the majority of students in lower high school may have quite simplistic attitudes to learning and knowledge and may, as a result, perceive that the content of science courses is true knowledge and plausible. This perception may well have an impact on how students approach learning in science and how and what they actually do learn.

Some research (Perry, 1970, Schommer, 1990, 1992, 1993 and Hofer & Pintrich 1997) suggests that not only do students tend to pass through various stages of epistemological beliefs as their perceptions of knowledge and learning become increasingly complex, but also that this progression is not automatic and did not tend to be evident until late in a students' academic life. Of particular relevance to this thesis are the findings that indicate that while evidence exists that students tend to progress through increasingly complex levels of epistemological beliefs, students in middle high school appear to still have very simplistic views regarding the nature of knowledge. The students who participated in this study are middle high school students and the indication is that this age group holds simplistic epistemological beliefs with a clear implication that knowledge is 'concrete' and this represents a simplistic view of the nature of knowledge.

The realisation that student perceptions of the status of knowledge may impact on the learning process is a significant step forward in understanding the importance of epistemology and metacognition to learning. Schommer (1992) described four epistemological beliefs that impact directly on student learning. These beliefs included: innate ability, where one's ability to learn is fixed and static; simple knowledge, where knowledge is isolated, unambiguous bits; quick learning, where learning occurs quickly

or not at all, and certain knowledge, where knowledge is perceived as lying on a continuum between absolute and tentative (p.436). Research indicates that high school students tend to believe that ability is 'innate', that knowledge is 'simple' and 'certain' and that 'quick learning' is an accurate description of the learning process. This description of a typical high school student's epistemological beliefs and metacognition may account for the different approaches students take in approaching learning in different subject areas. Kardash and Scholes (1996) suggest that the "more students believe in certain knowledge, the more likely they were to interpret tentative information as certain and absolute" (p.261). This observation suggests that uncertain content in a science course may be perceived as being certain and factual, and learned as such. Therefore, a student's epistemological beliefs, metacognition and learning practices may result in a general perception that the content in science is factual and true. A perception that the scientific process results in true knowledge leads to the possibility that subjects, that high school students perceive as lacking scientific rigour, are perceived as lacking plausibility.

As has been described above, student perceptions that the content of science courses has a high degree of plausibility would appear to affect how those students approach learning in that subject. Conversely, in a domain such as religious education, where the content may be perceived as lacking plausibility, the reverse may also be true – students perceive that the content of religious education lacks plausibility and, therefore, they do not approach learning in that subject with a deep commitment.

Ontological beliefs

This section provides evidence supporting the view that:

- ontological beliefs may also have a part to play in influencing how students approach learning;
- epistemology, ontology and social/affective variables all interact and impact on student learning;

- ontological beliefs associated with a subject, such as religious education, may well be different to the ontological beliefs associated with science; and
- these conclusions may explain why some students perceive the content of their science course as being different to the content of their religious education course, and in-turn result in differences in learning outcomes.

In addition to the influence of epistemology on student learning, ontological beliefs may also have a part to play in influencing how students approach learning. Chinn and Brewer (1993) describe ontological beliefs as "beliefs about the fundamental categories and properties of the world" (p.17). Ontological beliefs can be described as how children imagine the nature of objects and events. Tyson et al. (1997) suggest that these objects and events can be placed on a continuum such as "dynamic versus static, cause versus effect and discrete versus continuous" (Tyson et al., 1997, p.399). Ontological beliefs therefore describe a process of cognition, where students categorise pieces of information according to epistemological beliefs. For example, a subject such as religious education may have content that is categorised quite differently to a subject such as science. Religious education content may be perceived as lacking plausibility, academic rigor and "scientific credibility" and, as a result, is categorised in such a manner as to negatively affect learning.

Tyson et al. (1997) critical analysis of learning models highlights the importance of ontology suggesting that three factors play a significant part in learning - 'epistemology', 'ontology' and 'social/affective' variables (Tyson et al., 1997, p.398). Rather than one single factor being the single important factor affecting the teaching – learning process, Tyson et al. describes the interplay of all three factors in the metacognitive process at work within a student's mind, as significant in affecting the teaching – learning process. The suggestion that all three factors interact in the learning process implies a high level of complexity that not only can be seen to hinder a clear understanding of the processes at work within the student's mind in the learning process, but also indicates that student learning cannot be explained with a single factor or variable. While the research

(discussed above) is not conclusive, the weight of evidence seems to indicate firstly, that ontological beliefs are important factors affecting student learning and secondly, that student ontological beliefs may not be constant for all subjects. It is therefore possible that the ontological beliefs associated with a subject, such as religious education, may well be different to the ontological beliefs associated with science and, as a result some students may 'treat' learning in their science classroom quite differently to learning in their religious education classroom.

Conceptual models and student learning

This section provides evidence supporting the view that:

- the degree of confidence that many students have in the certainty of knowledge is likely dependent on the particular type of knowledge being evaluated;
- where a student believes that the content of science is generally more plausible than the content of religious education, this perception may influence how the student approaches learning in these two subjects;
- conceptual models of belief and learning in students change very slowly or not at all;
- educating many secondary school students about the 'real' nature of knowledge may be difficult;
- bringing some students to an awareness that the content of religious education can be concrete knowledge may be difficult;
- these conclusions may explain why students perceive the content of their science course as being different to the content of their religious education course and, in turn result in differences in learning outcomes.

The literature indicates that epistemological beliefs are important factors in the learning process. The beliefs the student holds regarding a subject forms a conceptual model that the student utilises in the learning process. The literature indicates that conceptual models of learning can influence learning in the classroom. The above discussion indicates that the level of complexity of epistemological beliefs can and does

change over time, suggesting that conceptual models of learning may also change, albeit slowly. A brief investigation of this area of research may therefore assist in an understanding of the teaching and learning processes at work in the classroom.

Demands to raise student awareness of metacognition, and the reality of the place of knowledge in a subject such as science, have resulted in an interest in the process of changing conceptual models. Posner et al. (1982) and Pintrich et al. (1993), Duit (1995) and Tyson et al. (1997) suggest that four conditions are necessary before conceptual models of learning can be changed. These conditions include "intelligibility, plausibility, fruitfulness and dissatisfaction" (p.391). In recognising that these four elements are essential to the process of conceptual change, Posner, et al. (1982) and Villani (1992) suggest that the process of changing conceptual models of learning is very slow, even to the point that there is no real "logical progression, rather much fumbling about, many false starts and mistakes and frequent reversals" (Posner et al., 1982, p.223).

The difficulty of altering a student's conceptual learning framework is emphasised by Duit (1994) who states that "there is no single study of research on students' conceptions in which a particular student's conceptions of the deep rooted kind could be totally extinguished and replaced by a new idea ... old ideas basically stay 'alive' in particular contexts" (p.8). This assertion is demonstrated quite clearly in the example of the conception regarding the sun's movement through the sky. Everyone 'knows' the sun does not traverse the sky each day, and yet in the context of every day language the movement of the sun across the sky is very much alive. Caravita and Halden (1994) suggest that we tend to hold a range of conceptions simultaneously, and that we actually select a conception that is appropriate to a particular context. (In the context of conversation, the sun moves and in the context of a science classroom, the earth revolves around the sun or the sun and the earth revolve around each other or their centre-of-mass). This reality is described as the "flickering status of conceptions".

The importance of conceptual models to student learning can be seen, as an additional variable, impacting on the learning-teaching process, in that it contributes to student perceptions regarding the plausibility of the content in science and religious

education. The literature suggests that it is difficult to alter students' conceptions, and that the possibility arises, that students may well retain a range of conceptions (possibly conflicting conceptions) and 'flick' between conceptions according to a particular context. Therefore, students in a science classroom may perceive that the content of science is plausible because of a conception that suggests that the scientific method guarantees that science deals only in facts. Where conflicting facts arise in science, students can deal with this situation by utilising different conceptual models. As a student leaves the science laboratory, and enters the religious education classroom, a new conceptual model seems to be brought into play, so that irrespective of the evidence the religious education teacher provides for students, irrespective of the plausibility of the item content, irrespective of the trust that the students have in the teacher, irrespective of the level of appeal to direct perceptual evidence and irrespective of the ability of the teacher/student to make inferences based on evidence, the dominant conceptual model is that the content of religious education classes lacks plausibility (for many, but not all students).

Our understanding of the teaching - learning processes at work in the classroom is showing that the processes are complex, and affected by a range of personal, social and environmental factors. Pintrich et al. (1993), warns that models of learning must not only focus on cognition, but need to recognise the importance of constructs such as the "individual's goals, intentions, purposes, expectations or needs" (p.170). It is through these latter aspects that the variables associated with beliefs can influence student learning. Nisbett and Ross (1980) similarly view learning as a complex issue and, as has been shown above, recognise that the cognitive and the affective are very closely linked. Their research indicates that conceptualised generic knowledge are composed of a cognitive component, schematically organised, and a belief component, possessing elements of evaluation and judgement. Nisbett and Ross (1980) are not only indicating the linkage between knowledge and belief, but are recognising that the learning process is influenced by judgements that the students themselves make about what and how to learn.

PART C

BELIEF

The concept of belief

It is not the purpose of this thesis to review the literature relating to faith formation within Catholic schools and the Catholic community. This literature can be reviewed elsewhere, particularly in Church documents such as "the Renewal of the Education of Faith" and "The General Catechetical Directory" and in noted authors such as Crawford and Rossiter (1988), Flynn (1979), (1985), (1993), Groome (1980), (1991), (1998), Hill, (1985), Ryan (1997), Rummery (1975) and The Australian Catholic Bishop's Committee for Education (1990). This section relates to the concept of belief (students believe that a particular item in the science course is true for example) rather than the term 'faith' which has a more precise connotation in regards evangelisation, new evangelisation or catechesis.

One aspect of the concept of belief is well understood by the community. Belief is a word that most people use to describe something associated with commitment or trust in something (Chambers and Concise Oxford Dictionaries, 1996, 1993). While an individual's belief can be based on some past justifiable experience, such as the sun rises every morning therefore, I believe that it will rise tomorrow, or my friend has never let me down and therefore I have faith in him/her. Within the general community, there is acceptance that the concept of belief implies acceptance without necessarily requiring real proof: (I have no proof that the sun will rise tomorrow but I believe it will!). (It is of course possible to "possess beliefs as a result of fantasizing, wishful thinking ... brainwashing" (Helm, 2001, p.79)).

While the words 'belief' and 'faith' may sometimes be used interchangeably in general conversation, the Catholic Church uses the concept of faith in a more specific manner. Faith in the religious context is understood "to be a personal act, a free response of the whole person to the initiative of God revealed in Jesus Christ, scripture, the Church's tradition, creation and personal experience" (Ryan & Malone, 1996, p.146). Faith is seen by the Catholic Church as a gift from God and, as such, cannot directly be

taught in the classroom. The adage 'faith is caught not taught' describes the process whereby people experience the faith of others and, based on this experience, and the interaction of God, come to experience faith themselves. (The word 'faith' as used in this thesis refers to the general understanding of the word rather than the specific definition of the word when used in the context of religious faith. Therefore a student can believe that an item of content taught in the religious education classroom is true, but that student may not have faith that God exists or see themselves as having 'Faith' as a Catholic.)

The research (Pajares, 1992) outlined above indicates that students' belief that the content of the science classroom is 'concrete' tends to be based on their past experiences, a trust in their science teacher, a belief that the content of science texts reflects truth and / or epistemological beliefs about knowledge. On the other hand, when it comes to the content of religious education, it appears that some students suspend their trust in the teachers they said they trust in science, and indicate that they now do not trust their teachers to tell them the truth.

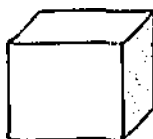
* Verbin (2000) utilises the philosophical work of Wittenstein (1967) to explore the concepts of belief and faith. While not specifically describing the Ryan and Malone (1996) definition of faith, Wittenstein's 'aspect seeing' does give a philosophical view of what belief is, and in so doing, can enhance our understanding of the concept of belief, as it relates to the teaching – learning processes at work in the classroom.

As a concept, Verbin indicates that believing has very little to do with intelligence, logic or the ability to see an opposing view. He states that those who do not believe in God can agree that the argument used by the believers "has shown that God exists and that, as a result, they ought to believe that God exists, but they nevertheless cannot state that they believe that God exists as a result of accepting the argument" (Verbin, 2000, p.1). This indicates that there is a factor beyond logic and argument that enables a person to believe.

The factor that enables a person to believe is described by Verbin as 'aspect seeing' and, as it is beyond logic and argument, it cannot therefore be argued, explained or taught in the classroom. He criticises those who attempt to equate belief in the "existence of

electrons or magnetic fields”¹ (p.2) with belief in the existence of God, because the two types of belief are inherently different. Students can be taught why they should believe in the existence of electrons, and can be brought to believe as a result of evidence, argument and logic. It is his contention that the same cannot be said for the latter. Verbin’s contention that a person can accept arguments for the existence of God as being logical but that this acceptance of the logical argument of God’s existence may not lead to a belief that God does exist as possible appears not to be consistent with the example of belief in the existence of electrons. Verbin explains the apparent inconsistency in his logic by suggesting that there are different types of belief. The examples given by Verbin seem to suggest that different types of knowledge (the existence of electrons – scientific knowledge, and the existence of God – religious knowledge) require different types of belief. Taking that proposition one step further it could then be argued that students in the religious education classroom may tend not to be open to the possibility that much of the content of the religious education classroom can be shown to be true as a result of evidence, argument and logic.

Verbin describes the ‘factor’ that enables a person to have faith that God exists as a ‘sense’ that enables one to see something in a particular way. He utilises a line diagram (below) to illustrate the ability of people to see ‘the something’ in a particular way that may be different to the way other people see the same object. The diagram is actually only a two dimensional arrangement of nine lines, but on seeing the diagram one individual may see it as a cube, while another may see it as a tube and some will easily



1. It is of interest to remind ourselves that Verbin's comparison of the difference in convincing someone that God exists as opposed to convincing someone that electrons exist may not have been as clear in the years immediately after the existence of electrons was first mooted. Other examples of what were controversial scientific propositions and discoveries that are now readily accepted as scientific fact abound in the literature. The reverse is also true. What is now accepted as scientific fact may not be accepted as such in the future.

see a three dimensional object while others will only see a 'flat' geometric figure. The nine lines become a picture because the subject "seeing the picture in a particular manner makes the picture into the picture that it is" for that particular person (p.4). The ability to see something in a particular way is also subject to the will. It makes sense to say see this tube as a cube, but it does not make sense to say see it as a pyramid. Many examples of clever illustrations exist where different people see different objects. In some cases no amount of explaining can help a person see the same object as another. In religion, the same situation appears to exist. A person, for example, can see a sunset and wonder in awe at the power of God, while another person may merely see a sunset. Bringing a person to see the power of God in a common place event such as a sunset, can occur only if the individual has the capacity (sense, aspect seeing, faith, religious intelligence, religious competency) to see God in the sunset. No amount of logic, or argument, might convince some people, who cannot see God's presence in the event that God's presence is there. The person who cannot see God's presence in the world though, can understand the alternative view, recognise the arguments, and may be able to agree that the arguments are persuasive, but without faith, that person will not be able to believe in God.

A miracle, for example, is an event that can be seen in a particular way. If a miraculous event is seen as merely a physical event that is yet to be explained by science, then the observer has not categorised the event as a miracle, but as a natural occurrence. The latter lacks the ability to see the event as a miracle, indicating that the "scientific way of looking at the event is not the way to look at it as a miracle" (p.9). The capacity to see the miraculous is described by Verbin as 'wondering' and is "expressed in one's attitude to the various facts of the world" (p.8). This wondering is the sense that separates the believer and the non-believer because it is a "way of seeing the world and human life" (p.11). The believer sees God in and through the world, and so the faith that the believer has, is expressed in his/her everyday life.

Based on Verbin's contentions it could be argued that "justifications and proofs of religious beliefs are possible by virtue of the fact that religious belief, like thinking, is subject to the will" (p.20). A student can learn about the Catholic faith, can learn how

Catholics express their faith and can learn the justifications Catholics use to prove that God exists. The learning is subject to the will. To demonstrate this point, Verbin suggests that while it may well be possible to teach a child "what a duck is by nothing more than pointing to a duck, we cannot do the same with the concept 'friendly'" (p.12). As a note of caution, Verbin also warns that the "learning of both concepts presupposes a certain agreement in judgement, a certain uniformity in experiencing and reacting to various facts in our world." (p.12). So that an individual, whose only experience of a duck is a particular type (size, colour, shape and so on) may not recognise another duck, as a duck, because its shape, colour and size are very different from his/her experience of what a duck is. In this way, learning concepts like 'friendliness' and 'belief in God' rely on experience, as much as will. Justifications and proofs of religious beliefs, therefore, have little relevance to the student unless that student has first experienced God in their lives. Therefore, attempting to turn a "non-believer into a believer by means of arguments is like attempting to convince a person who dislikes Mozart, of the beauty of his music by an argument" (p.20) and "you cannot hear God speak to someone else, you can hear Him only if you are being addressed" (p.20).

The concept of 'aspect seeing' therefore helps with an understanding of the process of believing that something is true. Belief that an item of content is true can be taught whereas faith cannot be taught, it must be experienced. Students can learn about religion and religious faith but, if they do not have the gift of faith, they cannot learn faith in the classroom. Like 'aspect seeing', a student may be able to understand certain religious arguments that are used as proofs for religious beliefs, and so may well be able to say that he/she 'believes' these proofs. This type of belief utilises the will, and can be seen as being similar to a student saying they believe that electrons exist without having seen an electron. This level of belief is different from the faith that a person experiences when he/she sees God in the world. Without faith, a student cannot truthfully say that he/she believes.

PART D

SUMMARY OF THE FINDINGS FROM THE LITERATURE

This thesis concerns student perceptions of the plausibility of the content of science education and religious education and the effect of those perceptions on learning.

Research in the field of teaching and learning has shown that a range of variables associated with epistemological beliefs, metacognition conceptual models, and beliefs in general, impact on learning and teaching. The major themes evident in the literature can be summarised by the following points.

1. Teaching does not necessarily result in learning. Many students choose what to learn and whether to learn;
2. Some students evaluate what to learn. Factors that impact on what some students choose to learn include the importance of the content and the students' motivation to learn. Many students do not perceive that religious education is an important subject to learn;
3. The depth of learning (surface or deep approach) is determined by students' perceptions of the content;
4. Communication is an important factor affecting both learning and teaching. Communication is not just talking. Effective learning requires engagement of the student;
5. Some students often choose surface learning as an efficient way of passing exams. This approach to learning indicates a belief that knowledge is 'concrete';
6. Learning is not contextless. Effective learning can start with students' life experiences;
7. Students display a range of intelligences that impact on the effectiveness of their learning;
8. Religious literacy provides a platform from which to effectively teach religious education;

9. Effective teaching in religious education probably requires a broader utilisation of teaching methodology than the logical-mathematical model regularly used in schools;
10. Physiological changes in the brain that arise from the life experiences of the student can impact on learning;
11. Student perceptions of the plausibility of knowledge impact on learning;
12. Some students perceive that scientific knowledge is concrete, plausible and true. Students do not always perceive religious knowledge in this way;
13. Students' life experiences and learning experiences seem to have reinforced the belief that the scientific method produces concrete facts that are true. Many students do not perceive religious knowledge in this way;
14. Many students have little conception of the true relationship between knowledge and belief. Many students accept scientific theories as knowledge, but many students do not approach learning in religious education in this way. Many students perceive that knowledge in religious education and science represent two distinct domains;
15. Faith is an experience that cannot be taught;
16. Metacognition, epistemological and ontological beliefs play important parts in student learning;
17. Many students are not able to apply the same metacognition, epistemological and ontological beliefs across different domains;
18. Students have developed conceptual learning models that have an impact on their metacognition, epistemological and ontological beliefs;

CHAPTER THREE

THE MODEL AND THEORETICAL FRAMEWORK

This chapter draws together the major theoretical and philosophical assumptions discussed in the literature review to describe a model that outlines the teaching and learning processes at work in the religious education classroom. A 'general model of learning' (Figure 3.1) is briefly described indicating the complexity of the interaction of the variables at work within the classroom. While this thesis recognises the complexity of this array of variables, and their complex interaction within the general model, the focus of this thesis utilises the theoretical and philosophical basis of the general model to develop a specific model (Figure 3.2), that is directly relevant to this thesis. This specific model of learning forms the theoretical framework for this study and describes the specific variables relevant in this thesis. This study will investigate student perceptions of their beliefs in religious education and science content and how these perceptions impact on learning within the framework of the model developed by the author, and depicted in Figure 3.2.

A general model of learning

The teaching and learning processes in the religious education classrooms of Catholic schools are a result of a complex interaction of an array of variables. To fully understand the interaction of all the variables affecting the teaching and learning processes for every student would be exceedingly difficult. It is possible though to simplify the interrelationships by utilising a theoretical model in which only the most important variables are used. Such a model could provide an understanding of the interaction between the main variables, guide the research with respect to data collection and provide direction for analysis and interpretation of results.

It is expected that learning in the religious education classroom is influenced by four groups of independent variables – Personal Qualities, Teacher Qualities, Learning

Environment and Learning Processes. Within each of the four major independent variables, there are a number of individual variables that have a direct influence on the teaching and learning process in the religious education classroom (such as epistemology, metacognition, motivation, the teacher's skills and so on). Figure 3.1 illustrates how the four main independent variables interact to affect the teaching and learning processes. A series of boxes is used to represent the complex interaction between the variables. The largest box represents learning in the Catholic school environment. The interaction between the variables is indicated through the use of arrows as two-way effects, because it is expected that any change in one variable affects another. The complexity of this interaction and the large number of variables evident within the model make a detailed analysis difficult.

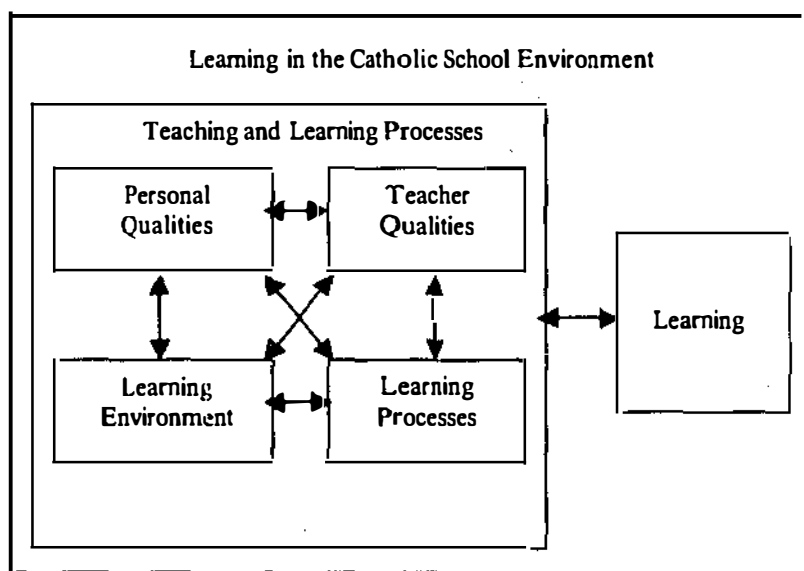


Figure 3.1. A general model of student learning.
Source: Created by the author from the literature review.

The specific model used in this study

The model developed for this study (Figure 3.2) is proposed as a general model applying to students in any Catholic educational system in Perth, Western Australia. In developing this model, it is assumed that basic generalisations regarding all students

exist. These generalisations are embedded in the model, and when these generalisations are applied to a specific classroom situation, such as the Catholic education system in Western Australia, the model can then be tested.

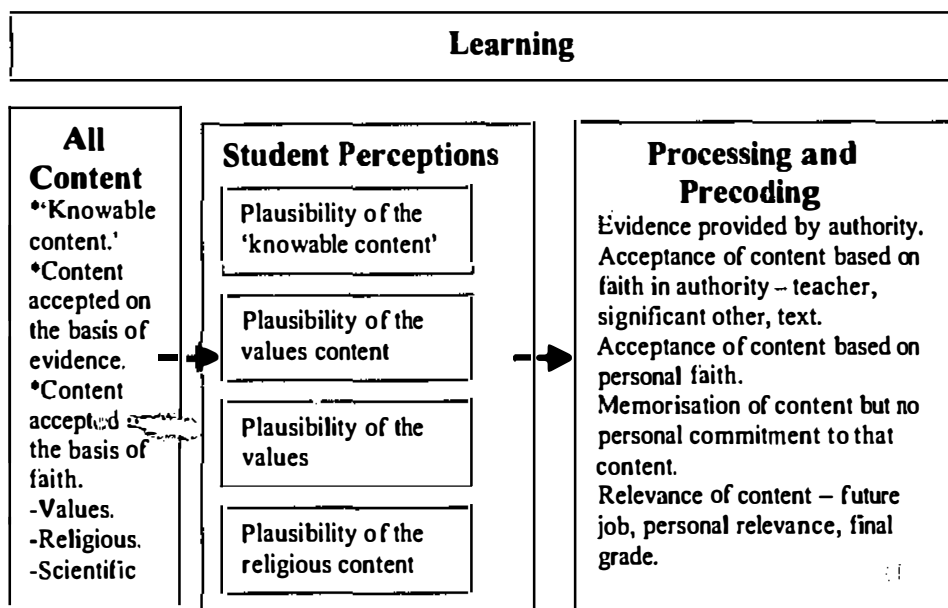


Figure 3.2. The specific model of learning used in this study for science and religious education. Source: Created by the author from the literature review.

As outlined above, the teaching and learning processes in the religious education and science classrooms of Catholic schools are a result of a complex interaction of an array of variables. The theoretical model simplifies the interrelationships of the variables in the teaching and learning process by focusing on the most important variables. Such a model provides an understanding of the interaction between variables, guides the research with respect to the formulation of a specific research model, and subsequent data collection, and also provides direction for analysis and the interpretation of results. The specific research model focuses on the teaching and learning processes, as affected by student perceptions of the plausibility of the science and religious education content.

Figure 3.2 illustrates the teaching and learning processes that underlie learning outcomes (represented by the box at the top of the figure). The left hand box represents all content that is presented to students in a religious education and science classroom. This content may be either 'knowable content', or content that is beyond proof, and hence

can only be accepted on the basis of faith. 'knowable content' can be defined in this study as that content which can be proven (within reasonable limits) and is hence accepted as factual. On the other hand, some content can only be accepted on the basis of faith. It may be generally accepted as true by our society, but cannot be proven by scientific means. Values content can be defined, in this study, as the content that relates to values accepted by our society or the school community. This third type of content cannot be proven in the scientific sense but nevertheless can be real, felt and experienced. Religious content can be defined, in this study, as that content that relates specifically to religious issues that are accepted by the Catholic community. The religious education programmes of Catholic schools contain content that can fall into each of these four categories. The science programmes of schools also contain content that would fall into the first three categories described above.

In Figure 2.1, of the previous chapter, the general teaching and learning process is represented by a series of stages. The first stage - 'Input from the environment' - is followed by a second stage - 'Pre-coding'. In the specific learning model (Figure 3.2) the 'content of the lesson' equates with the 'input from the environment' stage of Figure 2.1. Between the first stage in the teaching and learning process and the 'pre-coding' stage, the specific learning model for science and religious education (Figure 3.2), suggests that an intermediary stage exists where students 'filter' content according to their perceptions of the plausibility of that content. The content of the lesson is 'filtered' according to a 'measure' of plausibility that may vary according a range of variables. These variables include the students' perception of the veracity of any evidence presented in the classroom, as proof that the content is factual, or their acceptance of the content because of faith in an authority such as a teacher, significant other or textbook. Other variables may include the acceptance of the content based on personal faith or the acceptance of the content without any personal commitment to that content. Finally, students may perceive the content of the lesson as having relevance for their future, as having an undefined personal relevance or as having relevance as a consequence of an imminent final grade.

The specific learning model (Figure 3.2) suggests that learning in the classroom, is directly influenced by student perceptions of the content of the lesson.

The model suggests that content that can be easily explained and verified, will be easily learnt by the students because they will be more readily able to accept the plausibility of the content. If students can see the evidence, or the justification that 'proves' the reality of the content, then students would be expected to more easily learn the content, and also to believe that the content is indeed true. It would therefore be expected that content which cannot be easily explained or verified is, as a result, more difficult to learn and more difficult to believe.

An example can clarify the model. An item of 'knowable content' from the religious education course - God created in people a concern for justice - (stem item 1, Appendix 1) can be quite easily demonstrated in a classroom. (All students have experienced a concern for fair treatment, justice in the world, have been upset when they have been treated unfairly and so on.) As strong evidence demonstrating the veracity of this item can be made available to the students, it would therefore be expected, according to the model, that the students would perceive that this item would be very plausible. As a consequence of this high level of plausibility, the model predicts that students would be able to easily learn the item, recall the item and to believe that the item is true. Similarly, stem item 15 (Appendix 1) could be classified as 'values content'. It is difficult to provide evidence that can convince fifteen-year old students that life begins at conception and consequently abortion is wrong. As a consequence, students may perceive that this item is not plausible and, as such, they may find it difficult to accept, to believe and to recall.

The model indicates that several factors may be important in the teaching learning processes but it does not specify the order of importance of the factors. However, "an order is needed if a Rasch measurement approach is used to measure a variable on a linear interval level scale" (Waugh, 2002, p.73). An initial conceptual order of the item categories can be developed based on past research and pre-testing but, as this study is developing a model in an area of research that lacks extensive research, the results of a

Rasch analysis may indicate that the initial conceptual order might need to be changed, so that a better model can be developed, and as a result, a better understanding of the importance of student perception of the plausibility of content can be achieved.

The specific model developed to explain how students learn in religious education and science classrooms leads directly to the research questions for this study. These research questions are stated in chapter 1, and are answered in chapters 5 to 9.

IMPLICATIONS FOR TESTING

There are at least three implications from this model of learning. One relates to the difficulty of learning religious content that is not perceived as 'concrete' knowledge. For example it may be difficult to provide evidence that some items are true (category C and D items) and hence some students may find these items more difficult to learn. The second relates to the difficulty of learning various science aspects, (items that are quite complex in their nature and generally outside the students' experiences may be more difficult to learn than other items that relate to the students' every day experiences) and the third relates to the difficulty of various perspectives of belief involving evidence, trust, and faith. This third implication relates to variations in students' perceptions of what constitutes valid evidence (what some students will accept as evidence that an item is true may not convince other students), variations in the perception of trust in the students' teacher and particularly for the religious education items, variations in faith experiences that may help some students believe items.

Further explanation regarding testing and the questionnaire are given in the next chapter. The Research Questions given in chapter 1 flow from a method of testing parts of the learning model – items organised from easy to hard.

These implications can be tested using a Rasch measurement model to calibrate the item difficulties, the item perspectives and the person measures on the same scale. The Rasch model is explained in the next chapter and the Rasch analysis results are explained in chapters 6 and 7.

CHAPTER FOUR

METHODOLOGY

This study required that it be possible to compare the student responses to the religious education and science items on the one scale. Achieving this goal would enable a direct comparison of the students' perception of the difficulty of recalling and believing that the science and religious education items are true. To enable the analysis of the students' responses on the one scale, the development of the questionnaire necessitated that the ordering of the stem items and the items themselves reflect an order of difficulty from easy to hard. The Rasch measurement model would allow for the analysis of these ordered responses and result in a reasoned response to the research questions.

The Rasch measurement model

The statistical model used in this study is based, in general, on item response theory and, more specifically, on the work of the Danish mathematician George Rasch, who developed the Simple Logistic Model (Rasch, 1960 / 1980). The Rasch measurement model computer programmes have, in the last ten years, been used to measure many variables in education and educational psychology. These studies include academic motivation, academic self-concept, quality of student experiences, studying and learning, academic coping, self-regulated learning, teacher leadership, classroom environment and ADHD (see Waugh, 2003, 2004). The Simple Logistic Model is limited to dichotomous responses to items that are answered right or wrong, yes or no. "Item response theory models the relationship between a person's level on the trait being measured by a test and the person's response to the test item" (Pascoe, 1999, p.87). The Rasch model utilises the key aspects of item response theory, and produces measures that are calibrated on the same scale as the item difficulties.

The Rasch measurement model requires that items are ordered by level of difficulty from easy to hard. It also requires that 'person measures' be ordered from low to high. The Rasch measurement model calibrates the 'person measures' on the same scale as the

item difficulties. Persons (students) with high measures have a strong probability of answering positively all the items (hard, medium and easy). Persons with medium measures have a strong chance of answering the medium and easy items and a low chance of answering the hard items. Persons with low measures have a strong probability of answering the easy items positively but not the medium or hard items. The probability of answering the items correctly depends only on the difference between a person's ability and the item difficulty.

RUMM (Rasch) computer program

The RUMM computer program tests the measurement model and provides five-tests-of-fit to the Rasch measurement model. One is the Person Separation Index. The Person Separation Index should be greater than 0.90 and errors should be small compared to the separation of the person measures. Two is the Person-item-fit statistics. When the mean of this statistic is near zero and the standard deviation is approximately one, the data (items and persons) fit the measurement model. Three is the Item trait statistic. A chi-square where $p > 0.05$, indicates that all the items are influenced by a single trait – a unidimensional variable. Four is residuals. Residuals are the difference between the actual responses and those predicted from the estimated model parameters. The residuals should be within the range of +2.0 to -2.0 standard deviations. Five is targeting. Targeting gives an item map to show whether person measures match the item difficulties on the same scale.

The questionnaire

The questionnaire (Appendix 2) has four sections. The first section is composed of 59 items that are the teaching points of the year 10 religious education course. The wording of the stem items is exactly the same as the teaching points of the religious education course. The second section comprises 37 statements drawn from the year 10 science course. As each secondary Catholic school had slightly different science programmes, the 37 stem items represent the common components of the science courses. The third

section has four open-ended questions. These questions provide the students with the opportunity to comment on the similarities and differences between teaching and learning in religious education and science. The fourth section comprises four open-ended questions directed at the students' religious education teacher. This section provides the teachers with an opportunity to comment on the teaching and learning similarities and differences they perceive between religious education and the teacher's other teaching areas.

Item wording

The wording of the religious education stem items is exactly the same as the wording used in the religious education curriculum document (Appendix I). This duplication of wording ensures that students are not confused in any way as to what is being asked. As the science courses of the nine study schools are not exactly the same, it is not possible to use exactly the same nomenclature for the science items. The wording of the science items reflects a common thread present in the science courses. Given that the content of the science course represents largely 'concrete' knowledge it was not expected that small variations in language would confuse the students. The trial process did not indicate any confusion amongst the students as to what was being asked.

The items contain the word 'believe' (Figure 4.1) that may be construed as a source of confusion for the students and the potential variation of understanding may be the source of variation in response. The word 'believe' is present in the item wording for Box 2 -5 (Figure 4.1). Reference to the Concise Oxford, Chambers and Macquarie dictionaries indicates some variation in the understanding of the word belief. It is this variation that is reflected in the alternative responses available to the students in Box 2, Box 3 and Box 4 (Figure 4.1). The Concise Oxford dictionary defines 'belief' as "the mental action oftrusting a person; trust; confidence; mental assent to or acceptance of a proposition ...as true on the ground of authority or evidence" and 'believe' "to have confidence or faith in" (Concise Oxford Dictionary, 1973). The Chambers dictionary defines 'belief' as "a principle accepted as true especially without proof; trust or confidence; a firm opinion"

and 'believe' as "to regard as true; to accept as true, to be firmly persuaded, to have faith (with, in, on) (Chambers 21st Century Dictionary, 1996). The Macquarie dictionary defines 'belief' as "conviction of the truth or reality of a thing, based upon grounds insufficient to afford positive knowledge". The definitions indicate at least three understandings of the words believe and belief. The definitions indicate belief can be based upon grounds insufficient to afford positive knowledge, but can also be just believe to be true, and may incorporate a possible 'rationale' for accepting the veracity of something, such as 'evidence', 'persuasion', 'trust' or 'conviction'.

Within the context of this thesis, the meaning of 'believe' mainly reflects the Concise Oxford and Chambers definitions (Box 2 and 3), but accepts that belief can be based on 'reasons' that do not necessarily "afford positive knowledge", but are sufficiently persuasive to convince a person as to the veracity of an item. (Box 4 allows for the Macquarie definition.) The trial process suggested that the common understanding of the word 'believe' included a 'rationale' for belief (seeing evidence, trusting a text, teacher, their 'gut' feeling or past experiences) which reflected the Oxford and Chambers definition of the word. To ensure that students had a common view of the word 'believe' the instructions (Appendix 2) clarified the difference between 'belief' as a result of seeing evidence (Box 2), belief on the basis of trust (Box 3) and belief "based upon grounds insufficient to afford positive knowledge" (Box 4).

The definitions of the words 'trust' and 'evidence', as defined by the three dictionaries used above, indicate a general understanding of the words that would not lead to confusion amongst the students. The trial process confirmed this view. To further ensure a common understanding of 'trust' and 'evidence' the instructions (Appendix 2) clearly defined the terms.

Administration

Samples

The sample size of the student group is 1418 students. The students were year 11 students from nine co-educational Catholic colleges in Perth, Western Australia. The

sample size of the student group who took part in the Reference Group is 19. These students were selected from one of the study schools.

The reluctance of school principals to allow access to students for research precluded a random selection of schools. The Rasch measurement model requires a minimum number of respondents per item to achieve significant results and so a nominal figure of 1400 respondents was determined. The principals of each Catholic co-educational college in the Perth metropolitan area were contacted. From these contacts nine principals agreed to participate in the study.

Data Collection

The initial survey occurred in week three of term 1, when the students were in year 11. After close liaison with the Head of Religious Education in each of the study schools, the necessary number of questionnaires was bundled, together with clear instructions for the teacher administering the questionnaire. The students' normal religious education teacher administered the questionnaire during the students' normal religious education period. The Head of Religious Education distributed the open-ended questions to the religious education teachers and collected the completed forms.

As a result of the absence of a 'top quality' scale of the data (which could be accepted at the highest standards of Rasch measurement), it was decided that a Reference Group needed to be convened to gain a deeper insight into the thinking of the students and to answer questions that arose from the data analysis. The difficulty of achieving the goals of the Reference Group precluded a random sample. To overcome the difficulties of meeting with many students from different schools, it was decided to form the Reference Group from one of the study schools. Twenty-five students were randomly selected from 270 students in one of the study schools. The purpose and the expectations of the Reference Group were explained to the 25 students. The students were then asked if they would be willing to participate in the Reference Group. Six students were not willing to participate. The two, one hour sessions were held in a normal classroom during the

students programmed 'free' study period in term three. Each of the students in the Reference Group had participated in the initial survey.

The Reference Group was run on an open discussion format, led by the author. The basis of the discussion was the items that the Rasch analyses indicated are the five 'easiest' and the five 'hardest' items to believe. The purpose of the discussion was to understand why students find these items easy or hard and hence the discussion centred on this aspect of the items. There were two, one hour sessions. The content of these sessions was taped and then transcribed into text format for analysis.

Item Differences

This thesis compares the responses of students to the items listed in the questionnaire. The comparison produced three potential difficulties. One, the different number of items (59 religious education items compared to 37 science items); two, the religious education items represented the total religious education content for all schools, whereas the science items are representative of the common curriculum; three, the differences between religious education and science items in terms of knowing.

The use of the Rasch measurement model enables potential differences between items to be overcome. Traditionally "the difficulty of one test (or set of items) could not be compared with the difficulty of a different test (or set of items)" (Swain & Godfrey, 1996,p.3). Rasch measurement analysis overcomes this problem. Thus a score in the 'easier' religious education items can be compared, on the same scale, to a score in the science items. This characteristic of the Rasch measurement model is called 'sample free' measurement and allows items that vary in difficulty, and different tests that vary in difficulty to be plotted on the one scale. This feature of the Rasch measurement model overcomes the potential difficulties that may have arisen from the perceived differences in the item had an alternative statistical analysis tool been utilised.

Similarly, the Rasch measurement model produces logit values that are 'value free' and hence enable a comparison to be made between differing sets of items. The 59 religious education and the 37 science items can therefore be compared on the same scale.

Indeed, the Rasch measurement model will allow a comparison of subsets of items within the questionnaire, so that differences in the number of items representing different sections of the religious education (A,B,C and D) do not produce an impediment to this study.

Ethics

Ethics approval for this study was granted by Edith Cowan University. Each of the schools granted approval for the students to take part in the study and each student, and their parents, completed informed consent forms prior to the administration of the questionnaire.

Data Analysis

The data analysis comprises four phases (Figure 4.2). The first phase (piloting) is reported in this chapter. The second phase of the analysis is reported in chapter 5. This phase of the analysis utilises descriptive statistics to provide an overview of the data and to gain an initial impression of the patterns evident in the data. The results of the student and teacher responses to the open-ended questions are reported in chapter five.

The preliminary analysis indicates that the data supports the learning model and provides an insight into the different responses of the students to the religious education and science items. The third phase of the analysis uses the Rasch Unidimensional Measurement Model (RUMM 2010) computer program (Andrich, Sheridan, Lyne & Luo, 2000). The results of the Rasch analysis (reported in chapter 6 and 7) indicate that the students had not responded to the items in a conceptually ordered manner and despite numerous attempts to achieve a satisfactory scale, the analyses are not successful to the extent required. This caused a re-think of the way that the data should be analysed and reported, and resulted in further analyses of the data to provide corroborative evidence to support the general patterns evident from the imperfect Rasch analysis.

The absence of a scale acceptable at the highest Rasch measurement standards indicates that the students had not responded to the items in a conceptually ordered

manner. A detailed investigation of the pattern of individual student responses was therefore necessary to understand the thinking behind the student responses, to understand why the students were not responding to the items in the conceptually ordered manner, and to provide an additional level of understanding to respond to the research questions. This was the fourth phase of the data analysis, and involved interviews with a Reference Group of 19 students. This analysis is reported in chapter 8.

Conceptual order of difficulty of the items in the questionnaire

It is expected that believing that content from a lesson is true would generally require a personal 'commitment' to that item and so it is expected that the majority of the students would find it 'easier' to recall the stem item than to believe that the stem item is true. On the basis that a significant factor impacting on student motivation to learn is relevance to their future, expectation to pass exams and the like, it is also expected that students in year 11 would tend to find it 'easier' to recall items from their science course

Religious Education Items		I can recall being taught this in class	I believe this because I have evidence it is true	I believe this because I trust my teacher to teach me what is true	I believe this even though I do not have any evidence to suggest that it is true	I do not believe that this is true
A Discovering Human Potential		BOX 1	BOX2	BOX3	BOX4	BOX 5
1	People are capable of developing their potential for goodness.					
2	Developing a vocation may include finding employment.					
3	To develop just love, people need to love the human family.					
4	Just love brings happiness and contentment.					
5	The search for goodness leads people to discover moral conscience.					

Figure 4.1. A sample of the directions and items in the questionnaire. Source: Designed by the author for this study (the full questionnaire is given in appendix 2.)

work (because science is perceived a relevant and important for the future) than to recall items from their religious education course. Similarly, initial discussions with year 10 students and preliminary trials of questionnaire formats indicated that students perceive that the content of the science classroom is verifiable through the scientific method, whereas the content of the religious education classroom lacks veracity. As a result of this perception, it was expected that the majority of students would find it 'easier' to say that they do not believe in the religious education items than the science items.

In addition to these stem item categories, the questionnaire contained three additional item categories. One, belief that the item is true as a result of 'being provided with evidence' to show that it is true. It is expected that the students would say that this is easy to say this about the science items. Two, belief as a result of 'trust in the teacher'. It is expected that it would be somewhat 'harder' to say this about the science items because 'evidence' that an item is true is convincing, whereas trusting another person to teach the truth requires faith in that person. Faith is less tangible and requires a personal commitment to accept that the item being taught is indeed true. Three, belief that the item is true as a result of 'other' factors. It is expected that the students will say that this category of item will be the 'hardest' of the three 'belief' items. This item is included in the survey to give students, who believe that an item of content is true, but are unable to verbalise why they believe that it is true, the opportunity to indicate that they do believe the item of content. This alternative allows for that 'gut feeling' students (and others) would rely on to explain why they accept that something is true. It is expected that there will be some variation of student response, but in particular, it is expected that there may be significant variation between the student responses to the science items and the religious education items. This variation is expected because discussions with students, preliminary questionnaire trials and the literature indicate that the students do treat science and religious education content. As there is no specific research utilising Rasch measurement to 'measure' student perceptions, it is expected that the conceptual ordering of the item categories may have to be reviewed following the analysis of the student responses to the full questionnaire.

The possibility of minor amendments to the model is within acceptable bounds because in Rasch models, improvement in 'fit of data to the Rasch model' can be achieved by rewording individual items that fail to 'fit' the model (Waugh, 2002, p. 77). In this study though, rewording of the stem items is not possible because the stem items are the actual 'outcome' statements of the religious education and science courses. Altering the wording of these stem items may also confuse the students. While "one can use a model to fit the data (traditional approach) or model the data to fit strict measurement criteria (Rasch approach)" (Waugh, 2002, p. 73), the modelling advantages of the Rasch approach may be enhanced with minor amendments to the model, that in this study may include reordering the stem items or the items themselves.

The questionnaire contains 96 stem items. The first section contains 59 stem items taken from the year 10 religious education course. These 59 religious education stem items and the 37 science stem items were 'tested' in questionnaire trials and were ordered from easy to hard as a result of these trials and analysis of the item wording. In addition to the ordering from easy to hard of the stem items, the 59 religious education items are categorised into four groups that reflect the structure of the religious education course. It is expected that the items in the first two groups (Sections A and B) will be perceived as easy because the items in these sections tend to relate to specific human experiences that can be more easily 'demonstrated' to the students. It is expected that the students will say that the items in the latter groups are 'harder' because the items in these groups relate to Catholic faith concepts that are difficult to 'prove' to students.

As has been outlined above, each stem item has five possible response choices, with each student being required to select at least two choices – firstly whether the item is recalled or not, and secondly, if the item is believed or not. If the item is believed, the student was requested to indicate why it is believed. The three categories of belief are ordered from easy to hard and have been described above. In total therefore, there are 480 possible alternative responses to the items. A sample of the stem items and item categories (one item of recall and four items of belief) is provided (Figure 4.1) and the full survey, together with instructions are provided in Appendix 2.

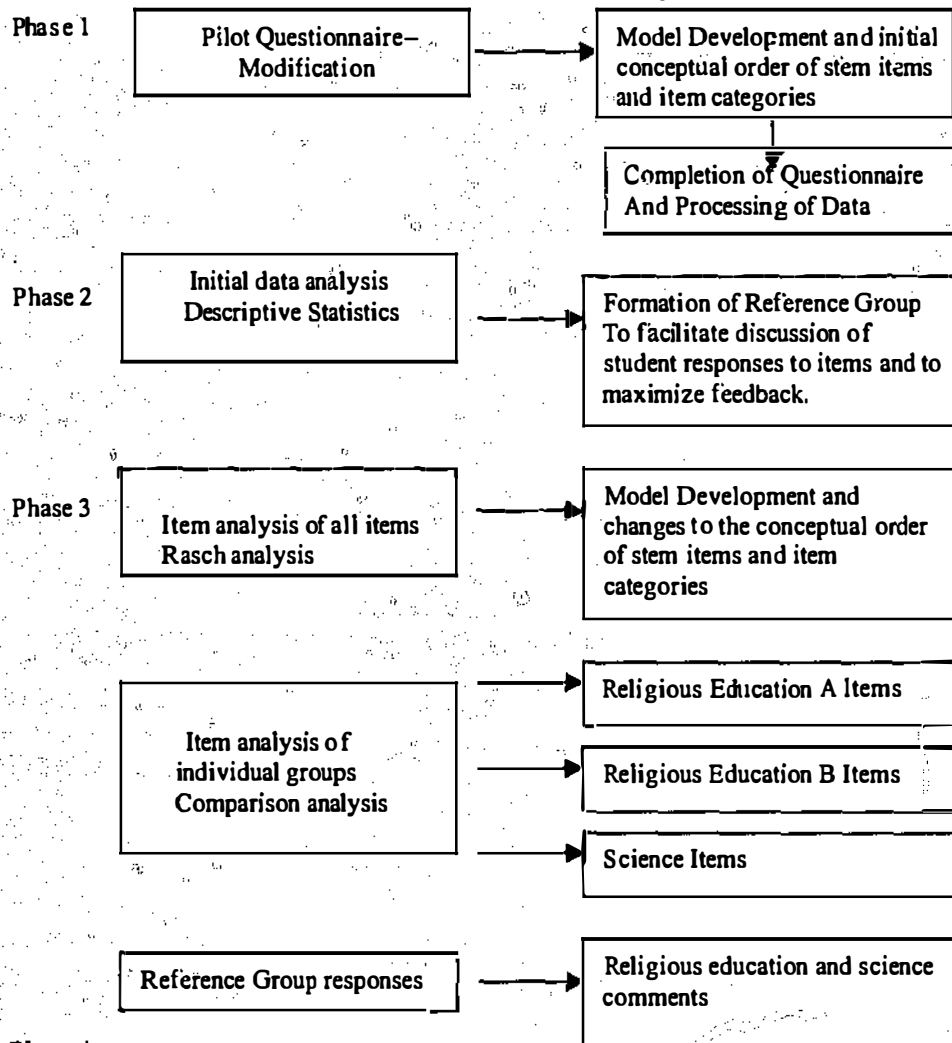


Figure 4.2. Phases for data analysis.

The section of the questionnaire dealing with the religious education items is divided into three sections that reflect the structure of the religious education course. In addition to the 96 items, an opportunity for each student to respond to several open ended questions regarding their perceptions of the nature of learning and teaching in their religious education and science classrooms was provided. The teachers of religious education were also invited to respond to several open ended questions regarding their

perceptions of the nature of learning and teaching in their religious education classroom and the classrooms of their other teaching area.

Phases of analysis

While the Rasch approach is to “model the data to fit strict measurement criteria” (Waugh, 2002, p.73), in the case of this study, changes to the item stem wording to eliminate ‘noise’ and to improve the fit between the data and the model were not possible because the item stems are taken directly from the ‘outcome’ statements of the religious education course. In addition to this limitation, there is no previous research using the Rasch method supporting a particular conceptual order of the categories of recall or belief. A third variable impacting on the conceptual order of the item categories is the expected difference between how students perceive the content of their science and religious education classrooms. As a result of these limitations, in some ways this study may require a degree of flexibility in determining the conceptual order of the item categories and so, to this extent it may reflect some aspects of traditional research methodology where “one can use a model to fit the data” (Waugh, 2002, p.73). In addition, because of the expected differences between how students perceive the plausibility of the content of their science and religious education classroom, the conceptual order of the item categories may vary with the groups of items. As a result of these considerations, the study methodology has a four-phase approach (Figure 4.2).

Summary

The evidence indicating that students are not responding to the items in an ordered manner suggested that further enquiries into the students’ perceptions and thinking were necessary. To respond to this need, a Reference Group was established to discuss in detail their responses to the items, their beliefs and values, and their reasoning behind their responses to the items. The results of these discussions, presented in chapter 9, provide a valuable insight into student epistemology, metacognition and ontology, adding considerably to the statistical analysis of the student responses.

Finally, chapter 10 summarises the main conclusions evident from the study and outlines implications for educationalists, theorists and classroom teachers. To respond directly to the research questions established at the beginning to this study, the research questions themselves form the section headings for this chapter.

CHAPTER FIVE

PRELIMINARY ANALYSIS

Introduction

This chapter uses descriptive statistics to provide an overview of the data and to gain an initial impression of the patterns evident in the data. Each of the statistical methods utilised in this first phase of the analysis helps to provide evidence that relates directly to the research questions stated in chapter 1. The students involved in this study were also given an opportunity to respond to several open-ended questions relating to the teaching of religious education and science and their learning in these subjects. The results of their responses are described in this chapter. The teachers involved in this study were also given the opportunity to respond to a range of open-ended questions regarding their teaching of religious education and their main curriculum area, as well as their impressions of their students' approach to learning. The results of their responses are described in this chapter.

There are 37 items in the questionnaire relating to the content of the year 10 science course and 59 items relating to the content of the year 10 religious education course. Using the indicated level of recall of each item (the students indicated that they could recall being taught that item in the previous year), student recall responses are grouped into seven categories. Each category was determined by considering the range and distribution of the recall responses and, given that the number of items in each section of the questionnaire differed, the categories have been expressed as percentages of the total number of items to allow for ease of comparison. Category 1 - students indicated that they can not recall being taught any of the items; Category 2 - students indicated that they can recall between 0% and 29% of the items; Category 3 - students indicated that they can recall between 30% and 38% of the items; Category 4 - students indicated that they can recall between 39% and 55% of the items; Category 5 - students indicated that they can recall between 56% and 69% of the items; Category 6 - students indicated that they can recall between 70% and 82% of the items and Category 7 - students indicated that they

could recall between 83% and all of the items. On the basis of the level of recall, the student responses to the 'belief' items can be described.

After indicating whether they could recall being taught the items, the students were then asked to consider whether they believe that the items are true and are given three alternatives that form the basis for their belief. The three alternatives are; one, that they believe the item because there is evidence that the item is true; two, that their belief is based on trust that the teacher would teach them what is true; and three, that their belief is the result of some other factor. The student responses to these three alternatives, allows for a response to the research questions that relate the belief patterns of the students, to their level of recall. If the students feel that they can not indicate that they believe that an item is true, they were asked to indicate that they do not believe that the item is true.

The preliminary analysis of the data has eight sections. Each of these sections briefly describes the students' responses to the questionnaire so that an overview of the students' recall and belief patterns is evident. The eight sections are:

- i. belief in science and religious education content according to level of recall;
- ii. levels of recall of science and religious education items;
- iii. levels of belief of science and religious education items;
- iv. the pattern of student belief of religious education and science items;
- v. student comments on the teaching of religious education and science;
- vi. student comments on the teaching of religious education and science;
- vii. teacher comments on the teaching of religious education and science;
- viii. summary of findings.

An overall impression of the students' beliefs regarding their religious education and science content is possible by utilising the students' level of recall and belief (Table 5.1). This information gives an initial insight into the possible relationship between the ability to recall content and belief, and is directly related to several of the research questions. A deeper understanding of the student responses to the issues of belief can be gained by an analysis of the actual numbers of students in each category of recall and belief. The students' level of recall of science items (Table 5.2) and religious education items (Table

5.3) provides an impression of the differences between student learning outcomes in these two subjects. The numbers of students in each of the recall and belief categories (Tables 5.6 and 5.7) again provide further evidence that students treat learning in religious education and science differently. Visual impressions of the patterns that are evident between levels of recall and categories of belief (Figures 5.1 to 5.7) supplement the statistical evidence available in tabular form.

Questionnaire results

Belief in science and religious education content according to level of recall

The student responses to the questionnaire indicated that, as the level of recall increases, there is an increasing level of belief in the items (Table 5.1). This pattern of recall and belief is evident from the student responses in both the religious education and science items. The students, who indicated that they could recall none of the items, also indicated that they believe that 65.8% of the religious education items and 88.4% of the science items are true. The group of students who indicated that they could recall between 83% and 100% of the items also indicated that they believe that 86.4% of the religious education items and 96.8% of the science items are true. At each level of recall, the students indicated a higher level of belief in the science items than the level of belief in the religious education items. The difference in the level of belief is generally in the order of 10% for each category of recall.

While the students indicated differing levels of belief in the religious education and science items according to each of the categories of recall (Table 5.1), the use of average percentage scores belies a far greater response difference (see footnote page 92 regarding this data), than is evident with a comparison of the numbers of students in each of the categories of recall.

Of the 1418 students surveyed, only 170 could recall being taught between 83% and 100% of the religious education items taught the previous year. This figure contrasts markedly with the same category for the science items where 539 students, of the 1418 surveyed, indicated that they could recall between 83% and 100% of the science items.

Table 5.1.

BELIEF VERSUS LEVEL OF RECALL FOR RELIGIOUS EDUCATION AND SCIENCE ITEMS (N = 1418; 59 religious education items, 37 Science items)

	Believes in religious education Items (%)	Believes in Science Items (%)
Can recall no items	65.8	88.4
Can recall between 0% and 29% of Items	80.2	88.9
Can recall between 30% and 38% of Items	80.0	88.4
Can recall between 39% and 55% of Items	79.7	89.2
Can recall between 56% and 69% of Items	81.5	91.8
Can recall between 70% and 82% of Items	82.9	92.4
Can recall between 83% and 100% of Items	86.4	96.8

The number of students in each level of recall of the religious education items tends to decrease from the second category (can recall between 1% and 29% of the items), where 342 students indicated that they could recall on average 14.9% of the items, to only 170 students who could recall the majority of the items. This pattern contrasts with the pattern of recall levels of the science items that show a general trend whereby with each category of recall more students are able to recall the items. Only 89 students indicated that they can recall none of the science items. The number of students increased to 139 in the second category averaging a recall level of 15.4% of the items, to 539 students in the seventh category who indicated that they can recall on average 93.8% of the science items.

Footnote regarding the differences between categories:

In this study, student responses are reported in categories as percentages without any calculations of their statistical significance. The author is aware that a reader might wonder why. It could be considered that a chi-square might be an appropriate statistic. For example, when there are five perspectives (N = 1418), one could assume that the problem is like a 5-sided dice and check whether the number of responses in any one category varies significantly from an expected average ($1418/5 = 283$ or 20%). But thinking this way and providing these significance levels may be misleading the reader in terms of the model being tested. Additionally, the data comparisons are between the responses to the religious education items and the science items rather than between the categories within each set of responses.

A comparison of the students' level of belief, based on their level of recall, is possible and provides some of the data necessary to answer the research questions. Of the 170 students who indicated that they can recall between 83% and 100% of the religious education items, 160 students indicated that they believe an average of 39% of the items as a result of having been provided with evidence. These students not only can recall the highest number of religious education items, but they also indicated that they believe (as a result of having been provided with evidence), the highest percentage of any of the categories of recall. Of the 539 students who indicated that they can recall over 83% of the science items, 469 students also indicated that they believe an average of 53.8% of the items, as a result of having been provided with evidence during the teaching of those items. Not only is the number of students who can recall 83% or more of the science items much larger than the numbers who can recall a similar number of the religious education items, but the number of students who believe that the items are true (as a result of having been provided with evidence) is larger and the average number of items that these students believe shows a similar level of difference. At each level of recall, the difference between the levels of belief in the religious education and science items is quite evident. In each category of recall, more students recall more science items than religious education items.

While the levels of belief (as a result of having been provided with evidence) of the religious education items in each category of recall are fairly similar, there is a general tendency for the students to indicate higher levels of belief with increasingly higher levels of recall of the religious education items. The students who could recall the fewest items indicated that they believe (as a result of having been provided with evidence) on average 16.8% of the items, rising to 39.0% of the items when they can recall between 83% and 100% of the items. A similar pattern appears in the levels of belief that the science items are true, in that, as the level of recall increases, the level of belief also tends to increase.

When considering the basis of their belief in the religious education items, the students select each of the three categories of belief equally. Of the 170 students in the highest category of recall, for example, 160 students indicated that they believe (as a result of being given evidence) on average 39% of the religious education items, 147 of these same students indicated that they believe (as a result of trusting their teacher) 21.5% of the items, 159 of the students indicated that they believe (for some other reason) 21.4%, and 150 students indicated that they do not believe 13.6% of the items. The number of students in each of the belief categories is between 86% and 94% of the total number of students in this category of recall. A similar pattern of responses and proportions of students is evident in the other categories of recall.

By contrast, a different pattern of belief is evident in student responses to the science items. The tendency is for a majority of students in each category of recall, to indicate that they believe (as a result of being given evidence) a majority of the items, and then, for both the number of students in each of the remaining categories of belief and the proportion of items they select, to decrease. For example, there are 539 students in the highest category of recall, with 469 (87%) indicating that they believe (as a result of being given evidence) on average 53.8% of the science items. Of these 539 students, a decrease in the number of students from the previous belief category, 347 (64%), indicated that they believe (as a result of trusting their teacher) on average 26.8% of the science items. Again this pattern continues for the third category of belief, where 296 (55%) of the students indicated that they believe (for other reasons) on average 8.4% of the items. Of the 539 students who could recall the majority of science items, 213 (39%) students indicated that there are only on average 3.2% of the science items that they do not believe to be true. A similar pattern of belief and disbelief is apparent in the remaining six categories of recall.

Levels of recall of science and religious education items

The level of recall of the science and religious education items is a significant part of this thesis and is central to several of the research questions. Student responses to the

Table 5.2.
THE PERCENTAGE OF STUDENTS IN CATEGORIES OF RECALL FOR SCIENCE
ITEMS

	Percentage of Students who could Recall Science Items
Can recall no items	6.3%
Can recall between 1% and 29% of Items	9.8%
Can recall between 30% and 38% of Items	5.4%
Can recall between 39% and 55% of Items	9.2%
Can recall between 56% and 69% of Items	15%
Can recall between 70% and 82% of Items	17%
Can recall between 83% and 100% of Items	38%

Table 5.3.
THE PERCENTAGE OF STUDENTS IN CATEGORIES OF RECALL FOR
RELIGIOUS EDUCATION ITEMS

	Percentage of Students who can Recall religious education Items
Can recall no items	3.5%
Can recall between 1% and 29% of Items	24%
Can recall between 30% and 38% of Items	9.9%
Can recall between 39% and 55% of Items	20%
Can recall between 56% and 69% of Items	17%
Can recall between 70% and 82% of Items	13%
Can recall between 83% and 100% of Items	12%

science items of the questionnaire indicated that the percentage of students in six of the recall categories ranges from 5.4% in the category that could recall between 30% and 38% of the science items, to 17% in the category who could recall between 70% and 82%

of the science items. The category of students who indicated the highest level of recall is very different to the other six categories, in that the highest alone has 3.8% of all students. Student responses to the religious education items of the questionnaire indicated that the majority of students, almost 57%, could recall less than 55% of the religious education items (Table 5.3). The remaining three categories of recall have similar percentages of students in each category with only 12% of the students indicating that they could recall over 83% of the religious education items.

Interesting enough the percentage of students who indicated that they could recall none of the religious education items (3.5%) is almost half the percentage (6.3%) who indicated that they could recall none of the science items. After this category, the difference between the two sets of responses reverses for the subsequent three categories of recall, in which over double the percentage of students indicated that they can recall the science items, as opposed to the recall of religious education items. The percentage number of students in the final category of recall provides the greatest contrast between the two sets of items in that 3.8% of the students indicated that they can recall between 83% and all of the science items, whereas only 12% of the students indicated that they can recall the same percentage of religious education items.

The additional information that is available from the numbers of students in each category of belief allows an insightful response to the research questions that relate to the students' belief of the 'knowable content' of the religious education and science courses. In responding to the questionnaire, the students are able to indicate three categories of belief which reflect a scale from easy (I believe this item because I have evidence that it is true) to hard (I believe this item on the basis of trust or on the basis of an 'other' factor). To maintain continuity in the analysis of the students' responses, the same groupings used for the categories of recall are used for the categories of belief.

Levels of belief of science and religious education items

There are 575 students (4.1%) who indicated that they believe (on the basis of evidence) less than 29% of the science items (Table 5.4), while 1060 students (7.5%)

indicated belief in the same percentage of religious education items (Table 5.5). The difference between the numbers of students who believe the science items, as compared to the number who believe the religious education items, is apparent. The number of students in each of the categories of belief is shown in Table 5.4. As can be seen 192 students believe between 30% and 38% and between 39% and 55% of the items, 108 students indicated belief in 56% to 69% of the items, 137 believe 70% to 82% of the items and 214 (15%) students indicated that they believe in excess of 83% of the science items. By contrast, the numbers of students in each category of belief of the religious education items (Table 5.5) decreases with each subsequent category so that only four (0.3%) students are prepared to indicate that they believe that 83% or more of the religious education items are true (on the basis of evidence). The contrast with the data on belief in the science and religious education items is once again quite clear.

Given that so many students indicated that they believe a high proportion of the science items on the basis of evidence, the numbers of students who indicated that there are science items that they believe on the basis of trust, must as a result be much less. Nevertheless, there are 518 students (Table 5.4) who indicated that they believe that up to 29% of the science items are true, not because they have evidence that the items are true, but as a result of trusting their science teacher to teach them what is true. The students (over 60%) indicated that there are up to 55% of the science items that they believe (on the basis of trust) (Table 5.4).

By contrast with the pattern of belief (on the basis of trust) of the science items, the students again indicated a different pattern of belief of the religious education items. The majority of students (1298 of the 1418 students) indicated that, as a result of trusting their religious education teacher, they believe fewer than 55% of the religious education items. Of the remaining students, only 74 indicated that they believe between 56% and 100% of the religious education items on the basis of trust, which is less than 40% (186 students as opposed to 74 students) of the number of students in the same science categories.

Table 5.4
NUMBER OF STUDENTS IN EACH CATEGORY OF BELIEF FOR SCIENCE
ITEMS (N=1418; 37 science items)

	Number of students who believe (evidence)	Number of students who believe (trust)	Number of students who believe (other)
Believes no science items	150	375	440
Believes between 1% and 29% of science items	425	518	771
Believes between 30% and 38% of science items	192	179	135
Believes between 39% and 55% of science items	192	160	46
Believes between 56% and 69% of science items	108	88	9
Believes between 70% and 82% of science items	137	45	5
Believes between 83% and 100% of science items	214	53	12

Table 5.5
NUMBER OF STUDENTS IN EACH CATEGORY OF BELIEF FOR RELIGIOUS
EDUCATION ITEMS (N =1418; 59 religious education items)

	Number of students who believe (evidence)	Number of students who believe (trust)	Number of students who believe (other)
Believes no religious education items	188	46	76
Believes between 1% and 29% of religious education items	872	817	1017
Believes between 30% and 38% of religious education items	223	279	162
Believes between 39% and 55% of religious education items	114	202	109
Believes between 56% and 69% of religious education items	13	49	34
Believes between 70% and 82% of religious education items	4	14	12
Believes between 83% and 100% of religious education items	4	11	8

Having considered their reasons for believing that the items are true, the majority of students believe the majority of science items on the basis of evidence and trust, and hence a decreasing number of students indicated that they believe the science items as a result of 'other' factors. In comparison to the numbers who believe the science items on the basis of 'other' factors, there is some indication that a greater number of students believe more of the religious education items on this basis. Despite the evidence of this pattern of belief, a small number of students did indicate that they believe a few of the science items on the basis of 'other' factors. Approximately 54% (771 students) indicated that there are some of the science items (less than 29% of the items) that they believe as a result of 'other' factors, while for this same category of belief, a greater number of students, 1017, indicated that they believe the same proportion of religious education items on the basis of 'other' factors. Of the remaining items (30% or more), only 207 of the 1418 students indicated that they believe the larger number of science items because of 'other' factors, which is similar to the 325 students who indicated that they believe the same proportion of religious education items.

The pattern of belief, therefore, seems to maintain the patterns that are evident in the previous data. Generally more students indicated that they believe more science items on the basis of evidence and trust than indicated belief in the religious education items for those two reasons. Fewer students indicated belief in the science items on the basis of 'other' factors, but more students indicated that factors other than trust and evidence are the reason they believe in the religious education items.

The pattern of student belief of religious education and science items

The evidence from the questionnaire data supports the anecdotal evidence referred to in Chapter 1 that student responses to religious education items and science items are different. The differences are apparent in the level of recall and the category of belief that the items are true. An analysis of the relationship between the level of recall and the category of belief of both the science and religious education items provides further insight into the differences that are apparent in the above tables (see Figures 5.1 to 5.5).

The 'X' axis of each Figure represents the level of recall for the four 'belief' scales of the questionnaire: 1. The level of recall; 2, Believe as a result of evidence; 3, Believe as a result of trust; 4, Believe as a result of 'other' reasons; 5, Do not believe.

The 'belief' scale responses for the students who indicated that they could not recall being taught any of the items in the science questionnaire indicates that, on average, these students believe that 24.9% of the science items are indeed true (because they believe that they have evidence to suggest that the items are true) (Figure 5.1). For comparison, the students who could not recall any of the religious education items indicated that they believe that only 16.8% of the religious education items are true. The students who could not recall any of the science items indicated that they consider that 21.4% of the science items are true (because they trust their teacher to teach them what is true) in comparison to 12.9% of the religious education items. The students indicated that they believe that almost 16% of the science items are true for some 'other' reason which is less than the almost 29% of the religious education items that the students believe for 'other' reasons. The students who could not recall any items indicated that they consider that 11.6% of the science items are not true, while 34.2% of the religious education items are believed to not be true.

A comparison of the student responses to the science and religious education items (Figure 5.1) indicates that fewer of the science items could be categorised into the 'harder' end of the 'belief' scale (it is harder to believe something is true without evidence) and, indeed, the students indicated that very few of the science items could not be believed as true (11.6%). On the other hand, for the religious education items, students tend to categorise more items into the 'harder' end of the belief scale to the extent that almost 30% of the religious items are perceived as being true for a reason other than trust in their teacher or the provision of evidence. The students indicated that they believe that over 34% of the items are not true.

The pattern of belief of the students who could not recall any of the science items (Figure 5.1) shows a decreasing proportion of items in each category of belief/disbelief whereas, apart from the decline in the percentage of religious education items, the

students indicated they believe as a result of trusting their religious education teacher, the percentage of items in each of the subsequent two belief categories increases. Students indicated that they believe fewer religious education than science items on the basis of trusting their teacher.

In response to the religious education items, the students tend to believe a larger proportion of religious education items as a result of 'other' reasons and the percentage of religious education items that students do not believe is larger than the number of science items that students do not believe.

The students who indicated that they could recall between one and 29% of the science items indicated that they believe that 27% of the science items, and 24.2% of the religious education items, are indeed true (because they believe that they have evidence to suggest that the items are true). They believe that 23.2% of the science items, and 18.1% of the religious education items are true (because they trust their teacher to teach them what is true), and almost 20% of the science items, and 29% of the religious education items are true for some other reason (Figure 5.2). These students indicated that they consider that 11.1% of the science items and 19.8% of the religious education items are not true.

The pattern of responses to the science items of this group of students is similar to the previous pattern in which students indicated that fewer items could be categorised at the 'harder' end of the 'belief' scale (it is harder to believe something is true without evidence) and indeed believe that a similar percentage of the science items could not be true. The pattern of student responses to the religious education items is also similar to the pattern in Figure 5.1 with the exception of a decrease in the percentage of items that these students could not believe, instead of the increase that is apparent in Figure 5.1. The students indicated that they believe that almost 20% of the items are not true in comparison to almost 30% of the previous group of students. This level of 'disbelief' of science items of each group of students is similar.

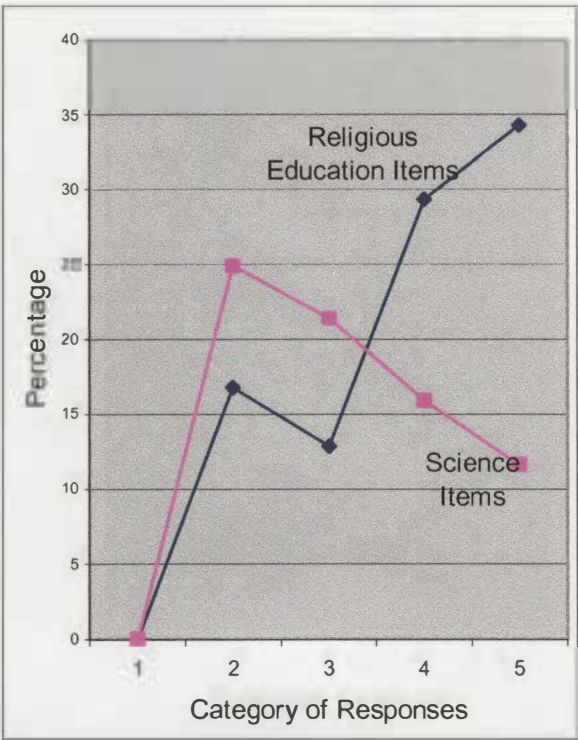


Figure 5.1: Percentage average response to science and religious education items of students who could not recall any items (Category 1 is level of recall, category 2 level of belief based on evidence, category 3 level of belief based on trust, category 4 level of belief based on other reasons and category 5 represents the level of non-belief in the items)

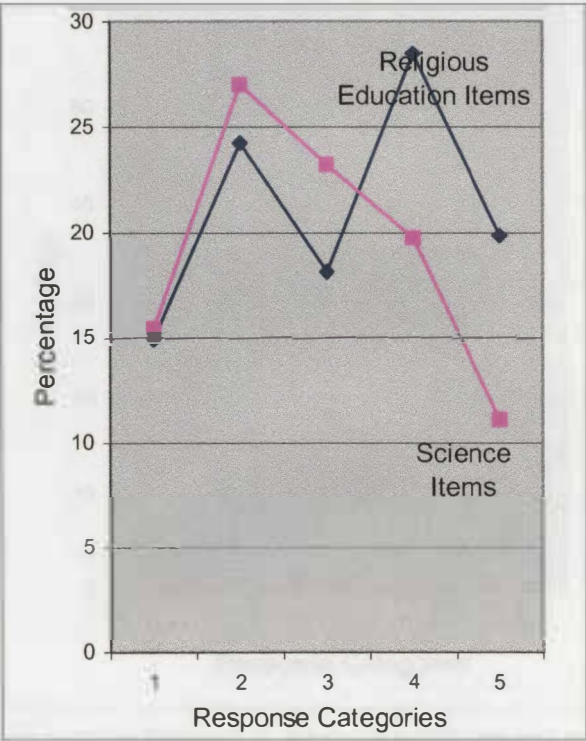


Figure 5.2: Average percentage response to religious education and science items of students who could recall between 1% and 29% items (Category 1 is level of recall, category 2 level of belief based on evidence, category 3 level of belief based on trust, category 4 level of belief based on other reasons and category 5 represents the level of non-belief in the items)

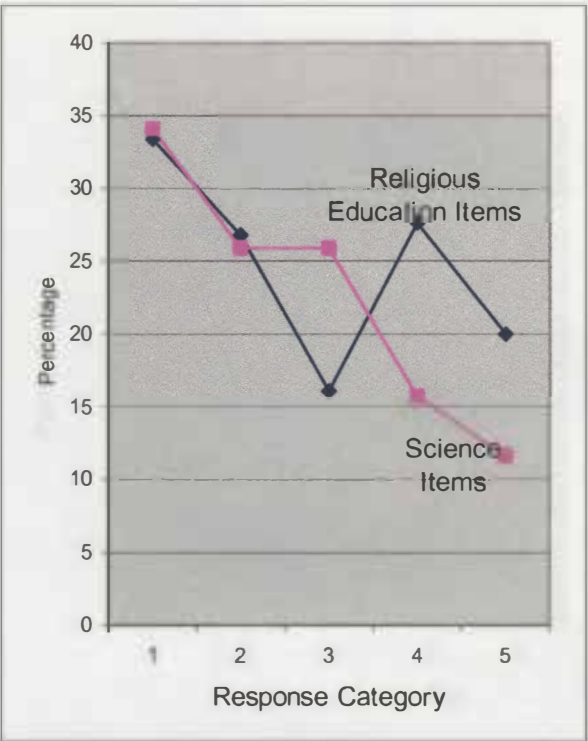


Figure 5.3: Percentage average response to religious education and science items of students who could recall between 30% and 38% items (Category 1 is level of recall, category 2 level of belief based on evidence, category 3 level of belief based on trust, category 4 level of belief based on other reasons and category 5 represents the level of non-belief in the items)

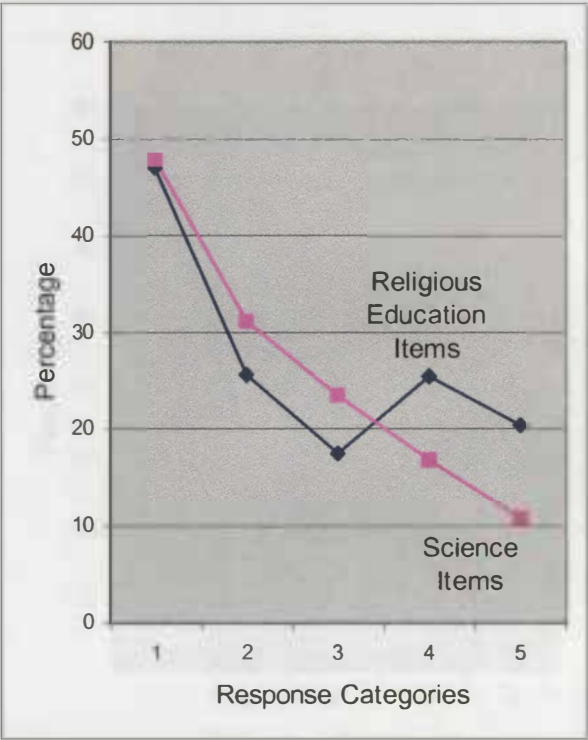


Figure 5.4: Percentage average response to religious education and science items of students who could recall 39% to 55% items (Category 1 is level of recall, category 2 level of belief based on evidence, category 3 level of belief based on trust, category 4 level of belief based on other reasons and category 5 represents the level of non-belief in the items)

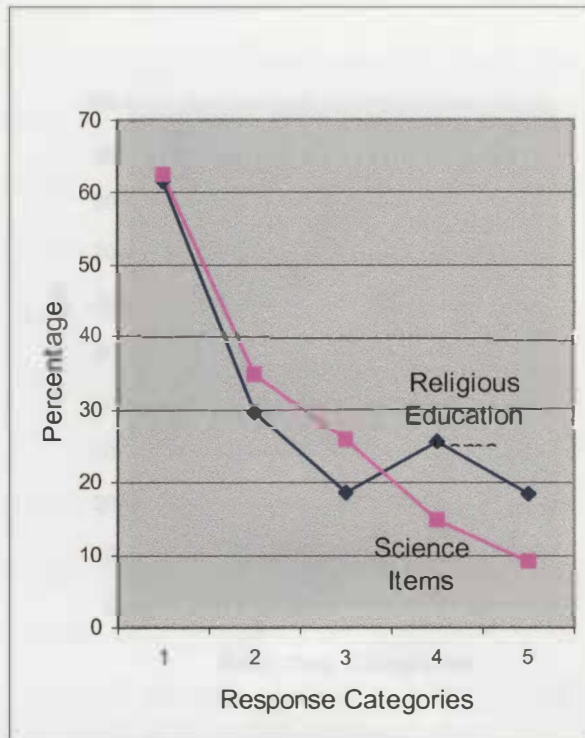


Figure 5.5. Average percentage response to religious education and science items of students who can recall between 56% to 69% items (Category 1 is level of recall, category 2 level of belief based on evidence, category 3 level of belief based on trust, category 4 level of belief based on other reasons and category 5 represents the level of non-belief in the items).

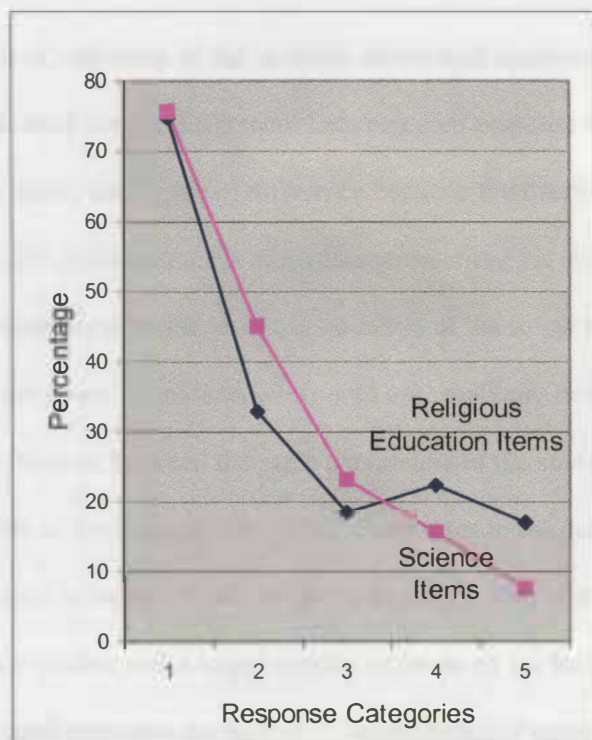


Figure 5.6. Average percentage response to religious education and science items of students who can recall between 70% to 82% items (Category 1 is level of recall, category 2 level of belief based on evidence, category 3 level of belief based on trust, category 4 level of belief based on other reasons and category 5 represents the level of non-belief in the items)

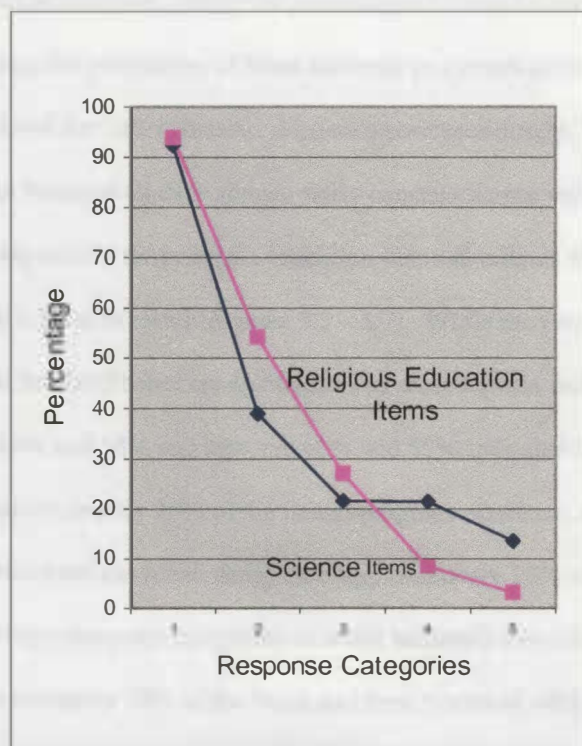


Figure 5.7. Average percentage response to religious education and science items of students who can recall between 83% to 100% of items (Category 1 is level of recall, category 2 level of belief based on evidence, category 3 level of belief based on trust, category 4 level of belief based on other reasons and category 5 represents the level of non-belief in the items).

While the pattern of responses of the students, who could recall more items than the previous group, indicated similar differences between their response to the science and religious education items, the degree of difference between their responses to the religious education and science items is much less pronounced for this second group. For example, the difference between the level of non-belief of the science and religious education items of the group of students who could not recall any items (Figure 5.1) is 22.6%, while the difference between the same parameters of the students who could recall between 1% and 29% of the items is only 8.7%. Responses to the questionnaire indicated that students again tend to believe fewer religious education than science items on the basis of trusting their teacher and a larger number of items on the basis of ‘other’ reasons.

As the level of recall increases the pattern of belief/disbelief tends to remain fairly similar to the pattern of responses for those students who could recall between 1% and 29% of the items (Figures 5.3 – 5.7). While the pattern of belief is similar generally, with each level of recall, there is an increase in the percentage of science items students

believe as a result of evidence, and as the percentage of items believed as a result of evidence increases, the percentage of items believed as a result of trust in their science teacher and believed for 'other' reasons decreases correspondingly. The percentage of science items not believed tends to remain fairly constant across each category of recall. The pattern of response to the religious education items also tends to remain fairly constant with each level of recall (Figures 5.3 – 5.7). While the pattern is fairly regular, small changes in levels of belief are apparent. The students who indicated that they could recall between 30% and 38% and between 39% and 55% indicated that they tend to believe more (approximately 25% of the items) religious education items than the students in the two previous recall categories (approximately 15% of the items). The students in the two subsequent categories of recall indicated a similar increase in the level of belief to approximately 30% of the items and then to almost 40% for the students who could recall between 85% and 100% of the religious education items. The students in each category of recall also tended to indicate a fairly uniform level of belief (as a result of trust in their religious education teacher).

By combining the data from the Figures 5.1 to 5.7, it can be seen that there is a general tendency for the percentage of items that students indicated they believe, because they feel that they have evidence to indicate that the item is true, to increase with increasing levels of recall. Students who could recall the majority of items indicated that they believe almost 39% of the religious education items as a result of having evidence. The students who indicated the lowest level of recall indicated belief in almost 17% of the items. Between these two categories, the general trend of increasing levels of belief with each category of recall is evident. The data indicating belief in the religious education items, as a result of trusting the teacher to teach what is true, is 'fairly' constant across each category of recall ranging from 12.9% for the lowest category of recall to 21.5% for the category of students who indicated the highest level of recall. The intervening categories are quite uniform across the categories ranging from 16% to 18%. The data indicating belief in the item, for a reason other than trust or evidence, is again quite uniform across each of the categories of recall ranging from 29.3% for the students with

the lowest level of recall to 21.4% for the students with the highest level of recall. The trend for this category of belief tends to show a decreasing level of belief with increasing levels of recall. While the percentage of items that students indicated they do not believe is high (34%) for the lowest level of recall and only 13.6% for the students who have the highest level of recall, the intervening categories of recall indicated very similar levels of 'disbelief' ranging from 17.1% to 20.3%.

As with the religious education items, levels of belief that the science items are true (as a result of evidence) tend to show an increase with each higher level of recall. The students, who indicated that they could not recall being taught any of the science items listed in the questionnaire, indicated that they nevertheless believe that almost 25% of the items are true. The group of students, who could recall being taught the most items, indicated on average, that they believe that 54.1% of the items are true on the basis of having been given evidence during the teaching process. The percentage number of items the students indicated that they believe as a result of trusting their teacher to teach what is true, for each of the categories of recall, tends to remain fairly constant ranging from 21.4% to 27%. A similar pattern is evident with the percentage number of items believed for some other reason. While the level of belief for the highest category of recall is lowest at 8.3%, the other categories are quite similar ranging from 14.9% to 19.7%. The percentage number of items the students indicated they do not believe to be true are similar (7.6% to 11.6%) for the first six categories of recall but decrease to 3.2% for the group of students who indicated that they could recall the majority of science items.

A comparison of the patterns in the student responses to the religious education and science items is possible by comparing the average percentage levels of recall and belief/non-belief, for each of the categories of recall. Generally for each category of recall, the students indicated that they believe that more science items are true than religious education items, as a result of being shown evidence and as a result of trusting their science teacher. For example the category of students who can recall between 83% and 100% of the science items indicated that they believe 54.1% (as a result of evidence) and 27% (as a result of trust) of the science items, and in comparison, believe 38.9% (as a

result of evidence) and 21.5% (as a result of trust) of the religious education items. In each category of recall, the students indicated that they believe more of the religious education items for some 'other' factor. The example of the students in the highest category of recall illustrates this pattern in that they indicated that they believe 21.4% (as a result of 'other' reasons) of the religious education items in comparison to 8.3% of the science items. The students tend to not believe more of the religious education items in each category of recall. In the highest category of recall, for example, the students indicated that they do not believe 13.6% of the religious education items in comparison to 3.2% of the science items. The data quite clearly indicates that there are differences between the patterns of belief and recall of the science and religious education items.

The relationship between student responses to the categories of recall and belief

The model predicts that student learning may be enhanced when students perceive that their teachers have provided evidence that indicates that the content is true. The model therefore suggests that there is a relationship between learning and belief. If an item of content is believed then the learning may well be enhanced. This study utilises three 'reasons' for belief - one, having been provided with evidence to 'prove' that the item of content is true; two, trust that the teacher will teach only what is true and three, belief that arises for some 'other' reason that the student cannot explain. By calculating the percentage of students responding to each category it is possible to describe the relationship between the categories of recall and belief.

The percentage of students who indicated that they can recall each science item and the percentage of students who indicated belief in the item correlates quite strongly (Table 5.6) to significant levels ($p < 0.001$) for 'evidence', 'other' and 'non-belief'. The relationship between the recall and belief scores indicates that the student responses to the science items are quite ordered. Items, that a high percentage of students indicated that they can recall, are also believed on the basis of evidence by a high percentage of students. The reverse relationship between the level of recall and belief for 'other' reasons and recall and non-belief is also strong (Table 5.6) indicating that the science

items that a high percentage of students can recall, tend to be the items that few students believe on the basis of 'other' reasons, or that few students do not believe. The relationship between recall and believing the items on the basis of 'trust' though, is not strong ($r = 0.25$) and indicates that the items that a high percentage of students indicated that they can recall tend to not be the items that students indicated that they believe on the basis of 'trust'.

Table 5.6.

SUMMARY OF CORRELATION COEFFICIENTS FOR SCIENCE CATEGORIES. STUDENT RESPONSES AS A PERCENTAGE FOR LEVEL OF RECALL AGAINST LEVEL OF BELIEF AS A RESULT OF EVIDENCE, TRUST, OTHER AND NON-BELIEF. (N = 37)

Evidence	Trust	Other	Non-belief
.85	-.12	-.89	-.87
$p < 0.001$	$p < 0.25$	$p < 0.001$	$p < 0.001$

Table 5.7.

SUMMARY OF CORRELATION COEFFICIENTS FOR RELIGIOUS EDUCATION CATEGORIES. STUDENT RESPONSES AS A PERCENTAGE FOR LEVEL OF RECALL AGAINST LEVEL OF BELIEF AS A RESULT OF EVIDENCE, TRUST OTHER AND NONBELIEF. (N = 59)

Evidence	Trust	Other	Non-belief
.61	.07	.07	-.79
$p < 0.001$	$p < 0.31$	$p < 0.31$	$p < 0.001$

The percentage of students who indicated that they can recall each religious education item and the percentage of students who indicated belief in the item correlate quite strongly (Table 5.7) at a significant level ($p < 0.001$) for 'evidence' and 'non-belief'. The relationship between the recall and belief scores indicated that the student responses to the science items are quite ordered. Items, that a high percentage of students indicated

that they can recall, are also believed on the basis of evidence by a high percentage of students. The reverse relationship between the level of recall and non-belief is also strong (Table 5.6), indicating that the religious education items that a high percentage of students indicated that they can recall, tend to be the items that few students indicated that they do not believe. The relationship between recall and believing the items on the basis of 'trust' and 'other' reasons though is not strong ($r = 0.31$) and indicates that the items that a high percentage of students indicated that they can recall tend to not be the items that students indicated that they believe on the basis of 'trust'.

Results of open-ended questions

Student comments on the teaching of religious education and science

Questionnaires and surveys often cannot provide insight into the thinking of the individual completing the forms. In an effort to overcome this lack of detail, and to gain an insight into the opinions, views and thinking of the students, each student was invited to comment on four questions relating to the teaching of religious education and science (Appendix 3). To provide an introduction to the comments the students made regarding teaching and learning in their religious education and science classrooms, the responses of three students are initially reported. A more detailed report of student comments, grouped according to their levels of recall of items follows.

Student 2024 indicates that his/her religious education class is "more controlled" than his/her science class and that in "religious education all homework is done". The student also feels that in religious education "we were able to learn a lot more (than in science)". In response to the open ended question 'Describe any similarities you see between how you approached learning in religious education and how you approached learning in science', the student stated that "in both religious education and science I could have tried better, but I did most of my homework, tests. I studied a lot more for science as I felt that religious education wasn't so important, and I don't need it for my future like science". This student indicates that he/she could recall being taught seven of the 59 religious education items and 29 of the 37 science items. Twenty-two religious education

items are not believed compared with 5 of the science items, and 19 of the religious education items and 22 of the science items believed on the basis of 'other' reasons. The student's admission to having done little study in religious education is evident in the fact he/she could recall being taught only 7 of the 59 items. The student indicates that he/she believes 28 of the religious education items and 27 of the science items and that the basis for this belief is predominately (19 of the religious education items and 22 of the science items) 'other' reasons.

Student 2040 reported, "I loved my year 10 religion class. Not only did Mr make it as fun as possible, he made it enjoyable and easy to understand. I learned more in my year 10 religion class than I have ever learned about religion. Because of the fact that I seem to think science is more important than religion in the long run, I devoted a lot more of my homework and study time to my science work. I never really put a lot of effort into my religion homework because I didn't really see the point". Despite indicating that he/she learnt more in this religious education class than any other, this student indicates that he/she could recall only 13 of the religious education items, but recall 27 of the science items. The stated trust in the religious education teacher seems to be reflected in the belief in 49 of the religious education items. This student also indicates a belief in all of the science items. The basis of the belief in the religious education items is split between trust in the teacher to teach what is true (27 of the 49 items) and 'other' reasons (20 of the 49 items). By contrast, the student indicates that his/her belief in the science items is based upon evidence (17 of the 37 items) or trust (18 of the 37 items).

Student 2087 indicates that he/she can recall 44 of the religious education items and 34 of the science items. This student indicates that his/her belief of the religious education items (49 of the 59 items) and of the science items (29 of the 37 items) is not based on having been given evidence but for 31 of the religious education items and for 20 of the science items is based on 'trust' in the teacher to teach what is true. An additional 18 religious education items and 9 science items are believed on the basis of 'other' reasons. The student's responses to the open ended questions suggest an open, positive approach to learning both subjects. He/she wrote "In both RE and science I tried to be as

inquisitive as possible. I thought that RE would help my morals while science would give me a factual background. They (religious education and science) sometimes contradict each other which is good because it means we have to make up our own minds on stuff.”

To provide a basis for an analysis of the students' comments, the students' responses were allocated to the seven categories (used for the data analysis) according to their indicated level of disbelief of the religious education items. This provides for a greater understanding of the association between the students responses to the items and their general perception of learning in religious education and science.

There are only eight students who indicated that they disbelieve over 83% of the religious education items and, of these, three students took the time to complete the four open ended questions regarding religious education and science. A common response evident in each of the students' comments is that religious education “is a waste of time”, that “science is important and religious education is not. Science is factual and religious education is not” and that “religion is all fake and fairy tales”. One student added, “I can't believe a subject that defies logic at the best of times is compulsory”. In general the comments are brief, being either phrases, or one line statements, and give the reader the feeling that the students are antagonistic towards religious education.

Nine students indicated that they did not believe between 70% and 82% of the religious education items and, from this group of students, six responded to the open-ended questions. In the next category, 39 students indicated that they did not believe between 56% and 69% of the religious education items and of these 23 responded to the open ended questions. Both groups of students tend to have similar comments regarding the teaching of religious education and science. With these two groups the responses of the students tend to be much longer. Their answers are often paragraphs and do not portray any of the antagonism evident in the first group of students. The students in these categories tend to focus on the structural differences between religious education and science, pointing out that “we did less homework in religious education, had less assessments, we weren't expected to do much and all work was simple”. There is a

common perception that "science is taught and that religious education is not" that seems to arise from the students' perceptions that in religious education "we discuss and the teacher talks" whereas in science the teaching methodology involves experiments, tests, assessments, text books and facts. One student's comment reflects the result of the data analysis that indicated a general perception that the students do not trust their religious education teachers with the comment "how could they try and convince and make us read that 'crap' when I know that they probably don't believe in it".

Of the 109 students who indicated that they do not believe between 39% and 55% of the religious education items, 75 students completed the opened ended questions. Again the responses of these students tend to be more substantial than the earlier groups, often being almost an A4 page in length, but the one significant difference that is apparent, is the number of students who report positive comments (almost half) about their experiences in religious education classes. These students seem to be aware that their teachers are making a significant effort to make the lessons in religious education interesting and worthwhile – "well both (science and religious education) were taught by teachers who understood that sometimes the work is boring so they made it interesting", "religious education curriculum seemed to be much more interesting", "I tried in all my subjects, I strive for the best in my education, religion was fun". In general though, the students' comments tend to consistently reflect the themes outlined above including "don't care about religious education, whereas you try in science", "I worked harder in science, it was a more important subject" and "religious education is boring, the teacher just talks".

Of the 163 students who are categorised into the group who indicated that they do not believe between 30% and 38% of the religious education items, 114 students were prepared to comment on the open-ended questions. The comments these students make regarding the teaching of religious education tend to be very similar to the comments made by the students in the above three categories reflecting the same criticisms of the teaching process used in religious education and indicating the same low level of effort on their part. A number of students in this category are able to reflect more deeply on the

differences between religious education and science. One student commented on the poor attitude students have regarding religious education stating that "students' attitudes to science were more serious ... because it is assessed, important to students in a 'material', 'seeable (sic)' way: ie. to get a job. Religious education is on the other hand too abstract and 'not useful' for physical success". A common theme evident in the comments of this group of students (approximately 30% of the comments) focus on their perception that religious education does not deal with facts: "science was more facts and they showed evidence. Religious education was more on faith without showing evidence", "religion was just about beliefs and not much knowledge", "science was much more focused on remembering formulae and exams", "science is based on experiments and proof or scientific knowledge", "science is the truth whereas religious education is a theory", "religious education is about spiritual stuff". These are common statements that appear on the students' questionnaires. One student made a clear distinction regarding the teacher's level of professionalism with the comment that "I believe my science teacher because she went to university and studied for a long time" suggesting possibly that the student trusts their science teacher but not their religious education teacher.

The vast majority of students (1016 of the 1418 students) indicated that they do not believe between 1% and 29% of the religious education items and are grouped into the sixth category for this analysis of student perceptions. The comments these students make regarding the teaching of religious education while being similar to the comments that appear in the previous discussions differ in a subtle ways. There is evidence that these students seem to understand that the two subjects are indeed different and so are prepared to accept the differences. The students regularly comment on the use of discussions as a learning opportunity rather than the 'boring, irrelevant monologue' described by students in the previous categories and indicated that religious education lessons are "fun and enjoyable", "I learnt a little bit and looked forward to religious education". Many of the students indicated that they try equally hard in religious education as in science. One student whose comment reflects many others, indicates that religious education and science "are both based on theoretical stuff and apply practical

knowledge”, while another suggests that “in both subjects we have learned about human life”.

There are 76 students who indicated that they believe all of the religious education items and of these, 45 completed the open-ended questions. The overall impression that is evident from the students' comments is that the students recognise that there are differences between religious education and science and so are accepting of the differences – “they are completely different subjects and so I do not expect them to be taught similarly”. As a result the antagonistic and negative comments that are evident in the previous students' comments appear less frequently.

In an attempt to relate the students' comments regarding the teaching of religious education with their teachers' comments, the students were asked to indicate the name of their religious education teacher. This allows for a comparison of student perceptions of the teaching of religious education for different religious education teachers. It is interesting to note that, irrespective of the individual teachers' perceptions of their own teaching, the students' comments reflect a full range of responses from 'good' to 'bad'. Teachers who perceive their teaching in religious education as creative, interesting and challenging receive comments from students who wrote that the teachers' style is uninteresting, unimaginative whereas other students found it inspiring and worthwhile. The same range of comments appear from students who had teachers who felt that they taught as well in religious education as their main teaching area, teachers who indicated that they put more into their planning and preparation of religious education lessons than their main teaching area and teachers who indicated that they approach the teaching of religious education in a quite casual manner. Each teacher had students represented in each of the categories of disbelief described above.

The analysis of the students' comments on the teaching of religious education and science indicates firstly that there is a common thread that appears in many of the students' comments that is independent of level of belief in the religious education items or the teacher the students had for religious education. This common thread relates to negative experiences in the religious education classroom where the students do not enjoy

their religious education classes, find the work repetitive and uninteresting and of little relevance to their lives or their futures. In addition, students comment on the perception that the content of their religious education lessons lack academic rigour and are not based on facts, or truth, but rather faith. The second conclusion that is evident is that there are patterns in the student responses. Having categorised the students based on their levels of disbelief of the religious education items, changes in the tone, content and depth of comments are evident across categories. Students who indicated the highest level of disbelief are very negative about their religious education teachers and lessons. These types of comments appear less frequently as the level of disbelief declines. As the level of disbelief declines, more students tend to indicate that not only do they enjoy their religious education lessons, but they also feel that they learn from their work in this subject. With increasing levels of belief, students tend to indicate an increasing appreciation of the inherent differences between religious education and science, and so are prepared to accept different approaches to the teaching of these subjects.

Teacher comments on the teaching of religious education and science

The teachers of religious education were invited to comment on their perceptions of their students' approach to learning in religious education and their other teaching area (Appendix 3). Of the 60% of the teachers who responded, the majority of teachers (70%) indicated that they see their students making a far less effort in their religious education class than in their other teaching area. This lesser effort in religious education reflects the students' own comments, described above, and supports, with the teachers' own statements, that they give less homework, have few tests and fewer assessments, are less content orientated (and more often utilise strategies such as open discussions, debates, role plays and discussions based on videos) than their main teaching area, and are more relaxed about teaching religious education. Many teachers comment on the poor attitude to study and effort in religious education and tend to use phrases such as "few treat religious education seriously", "students have less respect for religious

education", "most see religious education as unimportant" and "about the only way I could get anything out of them, was through drawing posters and cartoons".

Contrasting with the majority of teachers who indicated that they approach the teaching of religious education differently, almost 25% of the teachers said that they taught religious education in the same way that they taught their other subjects and "set similar amounts of homework", "expectations about the standard of work and application (of students) are the same", "maintain the same discipline, dedication and effort". These clear statements indicating academic rigour in the teaching of religious education represent a very small number of the teachers surveyed. While the majority of teachers indicated that their teaching tends to have a less academic approach, many of the teachers indicated that their preparation for their teaching of religious education requires a greater degree of effort than their teaching of their main learning area. To account for this admission, several teachers reflected that their knowledge and understanding of the curriculum of religious education is lacking and so "the amount of preparation time takes more than my main subject area" and because the students are so 'anti' religious education, "if you want to make it exciting and relevant it requires a lot more effort and time".

Some noticeable differences in the teachers' comments appear when the main teaching area of the religious education teachers also differs. Teachers that teach the quantitative type subjects (mathematics, science, accounting, computing) tend to see clear differences between the way they teach their main teaching area and religious education. A science teacher's comments reflect this general difference saying that science is "clinical, safe, tests, notes and memorising" and that their students see science as "important, job specific, hard and content oriented" and see religious education as "non-essential, irrelevant, easy, values, fun and more freedom". A different perception seems to be present amongst the 'humanities' teachers who indicated that they feel confident that their teaching skills developed in their main teaching area enable them to teach religious education effectively, utilising strategies such as "journal writing, reflective times, right

brain and creative activities, holistic, integrative and linked to all areas of the curriculum".

Attempts to account for the poor attitude of their students to religious education tend to be quite uniform across many of the teachers. These 'explanations' include: "few practicing Catholics in my class", "students can't see the point", 'religious education is seen as irrelevant" and from one teacher "negativity/switching off values that are self orientated and narrow. In other subjects students perform better if they actually see the end result of their work eg a storybook, and are praised or receive a good mark. In religious education, how does one always measure success?" Another teacher points out that students "create 'mental blocks' in religious education lessons because they see the content of religious education as different and yet the same students will share and discuss freely and write deeply about spirituality in year 12 Literature, when studying Tim Winton's 'Cloudstreet'", suggesting that students are very spiritual and religious but will not participate in what they perceive as a formalised, Catholic, indoctrination process.

Despite some differences in individual differences generally, the dominant comments of the religious education teachers indicated that they perceive that their students are very negative in their religious education classes and make little effort in their lessons, in comparison to the efforts that the very same students make in their 'other' subjects. In addition to this generalisation, the teachers indicated that their approach to the teaching of religious education is less rigorous than their other teaching area.

Summary of findings

The detail of the findings of the preliminary analysis can be summarised, for clarity purposes, with twenty brief statements:

1. As the level of recall increases, there is an increasing level of belief in the science and religious education items;
2. Irrespective of the level of recall, students generally indicated that they believe more science items than religious education items;

3. More students recall more of the science items than the religious education items;
4. When comparing the numbers of students who can recall science items and religious education items, the number who can recall the majority of science items is three times the number who can recall the same number of religious education items;
5. The number of students who believe the science items, on the basis of evidence, is larger than the number of students who believe the religious education items on the basis of evidence;
6. As the level of recall increases, there is an increase in the number of items believed on the basis of evidence for both science and religious education items;
7. When considering religious education items, the reasons students give for believing that the items are true tend to be divided equally amongst the three alternatives: evidence, trust, other;
8. When considering science items, the dominant reason students give for believing that the items are true is evidence;
9. Over twice as many students indicated that they can recall science items than religious education items;
10. More students indicated belief in science items on the basis of trust in their teacher than for religious education items;
11. More students indicated belief in religious education items than for science items on the basis of 'other reasons';
12. The pattern of belief, on the basis of evidence, trust, other reasons and non-belief, tends to be 'fairly' constant irrespective of level of recall;
 - i. students believe more science items than religious education items on the basis of evidence and trust;
 - ii. students believe more religious education items than science items on the basis of other reasons;

iii. students indicated that they do not believe more religious education items than science items;

13. When students perceive that they have evidence to show that items are true, they can recall a higher percentage of science and religious education items;

14. When students perceive that they can trust their teacher, they can recall a higher percentage of science items;

15. Items that students find hard to recall are also the items they find hard to believe;

16. Students who have low levels of recall and belief of religious education items perceive that religious education has little value and importance when compared to science;

17. Students who have high levels of recall and belief of religious education items perceive that religious education has value and importance in their lives;

18. Many students comment that they do not trust their religious education teacher. The students believe that their religious education teacher teaches religious education because they are required to by school authorities, and that the teachers themselves do not believe that the content is true;

19. Irrespective of how teachers perceive their teaching of religious education, student responses to their teaching style reflect a full range from negative to positive comments; and

20. Some teachers of religious education perceive that students do not value religious education.

CHAPTER SIX

RASCH MEASUREMENT ANALYSIS

Introduction

The previous chapter outlines the results of the preliminary descriptive analysis of the data, to provide an overall view of the pattern of the students' responses to the questionnaire. This preliminary analysis indicates that the data seems to support the model and provides a valuable initial insight into the differences in how students respond to the religious education and science items. However, these are raw data and, strictly, interval-scale measures are needed to test the model. The student responses provide evidence to answer the research questions that relate to the recall and belief patterns of the content of the students' religious education and science courses. The initial analysis of the student responses focuses on the series of Guttman-type patterns that form the questionnaire. In addition to these Guttman-type patterns, the students were also able to give extended responses to a series of open-ended questions and the students' religious education teachers were also invited to comment. The analysis of the students' and teachers' comments regarding the teaching of religious education adds further support to the patterns evident in the data and provides an additional and valuable insight into the metacognitive processes at work as the students approach their lessons in their religious education and science classrooms.

Chapter six allows for a deeper insight into the patterns evident in the data, as the focus of this second phase of the analysis uses the Rasch Unidimensional Measurement Model (RUMM 2010) computer program (Andrich, Sheridan, Lyne & Luo, 2000). This chapter describes a generalised pattern evident in the total data and provides results that enable a response to the research questions dealing with the use of the RUMM 2010 program for developing a model that describes student recall and belief patterns in religious education and science classrooms. The absence of a 'top quality' scale from the initial Rasch analysis necessitated a series of further analyses of the data to ascertain whether a 'top quality' scale could be achieved. The results of these additional and

extensive analyses are reported in chapter 7. A fourth phase of the analysis was necessary because of the absence of a 'top quality' scale raised questions about the validity of the Rasch-created scale data. The corroborative data from this phase of the analysis is incorporated in this chapter.

DATA ANALYSIS WITH THE RUMM 2010 PROGRAM *

Rasch scale creation

The student responses to the items in the questionnaire were converted to numbered codes (one indicating a 'yes' response, two indicating a 'no' response and a nine indicating missing data) and entered into an Excel file. The Excel file was converted to text format, suitable for analysis by the Rasch Unidimensional Measurement Model (RUMM 2010) computer program (Andrich, Sheridan, Lyne & Luo, 2000). The initial analysis by the RUMM computer program incorporated all 480 items (96 stem items) to provide an initial overview of the data and to allow for a possible single linear scale of the items.

The initial analysis by the RUMM program using all 480 items provides two clear results. One, the Student Separation Index (akin to a Cronbach Alpha) is excellent and two, the absence of a 'top quality' scale. The absence of a 'top quality' scale raises two issues. One, that the student responses to the items are not consistent, in that 'good' students who are able to answer the hard questions could not consistently answer the easy questions, and that 'poor' students are able to answer some of the hard questions positively. Two, as a result of the first issue, the validity of the Rasch-created scale data

Footnote: Twenty-two separate Rasch analyses were performed with the data to test the conceptual model used in this study. None of these analyses were successful to the extent required. This caused a re-think of the way the data should be analysed and reported. Problems like this are not new in science and in testing models. Research, based on plausible theories, can often lead down dead-ends. For example, the Nobel Prize winners Feynman, Watson and Crick have described how some discoveries are made even though the researchers are not following mainstream thought, have many 'starts' and 'stops', have miscommunications, and start down research leads that turn out to be wrong (see Gleick, 1992, pp. 386 – 387 and Youngson, 1998). Similarly, a review of scientific research indicates that "chemistry is progressive and self-corrective, the progression is often discontinuous, and progress may be made even when the theory is wrong in some aspects" (Talbot, 2000, p.13).

is compromised, even though the Student Separation Index (reliability) is excellent. The absence of a 'top quality' scale prompted a series of further analyses in an attempt to overcome the problem. Twenty two separate Rasch analyses were done without any success in being able to construct a proper interval-level scale to the standard required by Rasch measurement experts. The separate analyses included the 185 science items alone, the 295 religious education items alone, several subcategories that are evident within the science and religious education items (biological stem-items and each of the five categories within the religious education stem items), selected items that indicate good individual item chi-squared probability in a combination of stem-items and/or a selection of items (such as 'evidence' and 'trust'), and finally the elimination of individual student responses that indicate extreme or random patterns. Despite extensive efforts to reconfigure the stem-items and items themselves, and eliminate extreme answers in each of the twenty two analyses, the various test-of-fit statistics indicate that a 'top quality' scale is not possible in any of the cases.

Problems with developing an interval-level scale

In this chapter, it is not instructive to provide the reader with a description of all the problems in regards to the attempts to create an interval-level scale in each of the twenty two cases. (A description of some additional analyses carried out in an effort to provide a 'top quality' scale, is described in chapter 7.) At this stage it is instructive to give one example that indicates the problems for this case. This case is chosen because it exhibits most of the measurement problems applicable to the other cases. The case that illustrates the measurement problems, included 480 stem items (Appendix 4) and 1418 persons. The results of the analysis of the responses to these items are summarised in Table 6.1. (Appendix 3 displays each item with the 'difficulty' (logit) values that were calculated from the Rasch analysis.)

The interval-level scale requires that the items are ordered from easy to hard. The four item - perspectives are conceptually ordered from easy to hard on the basis that being able to 'recall' being taught an item in class, is 'easier' than 'believing' that the item is true.

(Belief requires personal commitment whereas remembering that an item was covered in class requires no personal commitment.) The other three item - perspectives relating to belief, are also conceptually ordered from easy to hard, on the basis that it is 'easier' to believe an item when the student perceives that the teacher provided evidence that the item is true, somewhat 'harder' to believe as a result of

Table 6.1.

SUMMARY TEST-OF-FIT STATISTICS FOR ALL ITEMS

	<u>Items</u>	<u>Students</u>
Number	480	1418
Location Mean	0.00	-0.95
Standard Deviation	0.87	0.36
Fit Statistic Mean	-0.51	-0.55
Standard Deviation	4.55	3.36
Total Item Chi-Square	39443.04	Student Separation Index = 0.90
Total Chi-Square Probability	0.00	Power of Tests-of-fit: Excellent

Notes on Table 6.1.

1. The item means are constrained to zero by the measurement model
2. When the data fit the measurement model, the fit statistic approximates a distribution with a mean near zero and a standard deviation near one. The standard deviations are too far from 1 and the means are too far from zero indicating a not-too-good fit to the measurement model.
3. The Student Separation Index is the proportion of observed student response variance considered true (in this scale 90.0%). The Student Separation Index is constructed as the ratio of the estimated true variance among persons and the estimated observed variance among the persons using the estimates of their person measures and the Standard Error of these measures (Andrich & van Schonbroeck, 1989, p.483).
4. Student measures and item difficulties are given to two decimal places to be consistent with the measurement errors.
5. The total item chi-square is too large indicating that there is a significant interaction between the responses to the items and the locations (person measures) of the persons along the trait. This means that there is insufficient conformity for a unidimensional measure.

trusting the teacher to teach what is true, and 'harder' still to believe that the item is true on the basis of some other factor such as faith or an inner feeling. Having established that the item-perspectives are ordered from easy to hard, it would be expected that the person measures would be ordered from easy to hard and calibrated on the same scale as the item difficulties. The measurement model requires agreement among the students with low, medium and high measures as to the ordering of the item - perspective difficulties. Thus students with low scores would only be expected to positively respond to the easier item - perspectives. Students with medium scores should respond to both the easiest item- perspectives and those item- perspectives that are moderately difficult. Students with the highest scores should respond positively to the most difficult item-perspectives, as well as the moderately difficult and easiest item-perspectives.

The tests-of-fit statistics indicate that the students' responses are not ordered as expected. The 'Fit Mean' (Table 6.1) is expected to approach zero and the standard deviation should approach one. The 'Fit Statistics' are too far from zero and one, indicating a not-too-good fit to the measurement model. The item trait chi-square is too high indicating that no unidimensional trait is present and that agreement between students about item difficulties is not good enough. The Student Separation Index is constructed as the ratio of the estimated true variance among the persons and the estimated observed variance among the persons using the estimates of their person measures and the Standard Error of the measures. The Student Separation Index is good, indicating that the person measures are separated by more than the errors of measurement, and thus, we can have faith that the test-of-fit statistics are accurate and that the fit is not satisfactory.

A particular example can exhibit the measurement problems that arose in this study as a result of some students answering the hardest items, but finding it difficult to respond to the easiest items. Using the number of students responding to each item as an indication of level of difficulty, the three religious education items that the 1418 students find 'hardest' to believe (on the basis of having been given evidence by the teacher) are stem

item # 37 (God seeks to protect people against behaviours that prevent them from following their vocations.); 15.7% of the students indicated that they believe this item, # 29 (God seeks to protect people against unformed conscience.); 16.2% of the students indicated that they believe this item and # 15 (Formed moral conscience leads to long-term happiness.); 17.1% of the students indicated that they believe this item. The three religious education items that the 1418 students find 'easiest' to believe (on the basis of having been given evidence by the teacher) are stem item # 49 (Parents have responsibilities towards their children.); 60.9% of the students indicated that they believe this item; # 50 (Members of a family have responsibilities to each other.); 56.4% of the students indicated that they believe this item; and # 53 (The Fifth Commandment forbids the deliberate killing of human life.); 46.6% of the students indicated that they believe this item. Of the 1418 students, 222 indicated that they are able to believe the 'hardest' item (stem item # 37). As this is the 'hardest' item to believe it would be expected that these 222 students would also be able to indicate that they believe the 'easiest' item. This is not the case, as only 145 of the 222 students are also able to indicate that they believe that the 'easiest' item is true. This indicates that the students are not responding to the items in an ordered way. Of the 1418 students, only 30 students are able to indicate that they believe all three religious education stem items that are 'hardest' to believe (on the basis of having been given evidence by the teacher). Again, as these are the three 'hardest' items to believe, it would be expected that these 30 students would also be able to indicate that they believe the 'easiest' items. This again is not the case, as only 19 students are able to indicate that they believe the three 'easiest' items. This indicates that the students are not responding to the items in the conceptually ordered way.

The students' pattern of response further demonstrates the lack of an ordered response to the items (Table 6.2). As 30 students are able to indicate that they believe the three 'hardest' items, it would be expected that they would also believe all the 'easier' items. Only one student (# 234) exhibits this pattern of response (Table 6.2). Four of the students (students # 481, # 548, # 684 and # 698) who are able to indicate that they believe (on the basis of having been given evidence by the teacher) the three 'hardest'

items, are only able to indicate belief in 26 items (of the 59 religious education items, these students indicated that they believe the three 'easiest' and three 'hardest' items, and only 20 items of the remaining 52 items). One of these students (# 481) indicates that he/she does not believe that 26 of the 'easier' items are true despite being able to indicate belief in the three 'hardest' items (Table 6.2). The response pattern evident in this example is exhibited in the attempts to develop an interval scale that could produce significant test-of-fit results using the Rasch Unidimensional Measurement Model program. The pattern indicates that the students are not responding to the items in an ordered manner, as expected by the model.

Table 6.2.

RESPONSE PATTERN FOR THE 59 RELIGIOUS EDUCATION ITEMS OF 19 STUDENTS WHO INDICATED BELIEF IN THE THREE 'HARDEST' ITEMS

Student Number	Items Believed (evidence)	Items Believed (trust)	Items Believed (other)	Items Not Believed	Items Receiving No Response
17	42	2	15	0	0
83	56	0	1	2	0
164	49	10	0	0	0
234	59	0	0	0	0
327	40	2	2	2	13
369	40	2	2	14	1
404	40	6	3	10	0
481	26	0	6	26	1
493	50	0	0	9	0
548	26	15	7	4	7
563	57	0	1	1	0
684	26	15	7	4	7
698	26	15	7	4	7
713	40	4	9	6	0
717	43	2	10	4	0
754	40	4	9	6	0
758	43	2	10	4	0
953	51	1	6	1	0
1060	58	0	0	1	0

Only two of the students (# 548 and # 481), used in the above example, responded to the open-ended questions in the questionnaire. Student # 481 stated that he/she had the same teacher for science and religious education, and as a result, "it was very confusing",

because “one minute he was talking religiously and the next he was talking scientifically!!” This response indicates that this student perceives that science and religious education are quite different subjects. Seeing the two subjects differently is also evident in a second comment, where the student noted, “in religion you believe in God, in science you believe in scientific things”.

The second student (# 548) also indicates that science and religious education are quite different. This student actually uses the word ‘different’ in his/her response to the open-ended questions, writing “religious education was a lot different to science as in religious education we formed our own opinion and were allowed to believe what we wanted” and again later in the response, “I approached the topics different (sic) to each other.” From the comments, these two students perceive that science and religious education are quite different subjects, requiring different approaches to learning. The comment “believe what we wanted” (student #548) is a common comment, evident in many of the students’ responses to the open ended questions. This comment may indicate that students perceive the religious education and science items as quite different. It is also evident from the comments that the students treat each item quite differently so that any one student may find it quite easy to believe a particular item that is considered hard to believe by the other students, and yet, that same student may not believe items that the other students considered easy to believe. It would seem that what one student finds hard to believe is not necessarily what any other student finds hard to believe.

Figure 6.1.1 and Figure 6.1.2 represent the same data and locate the student measures and the item difficulties on the same scale for all 185 items and the 1418 students utilising different colour codes to accentuate the different patterns present within the data. Figure 6.1.1 utilises a colour code to highlight the relative location of science and religious education items, whereas Figure 6.1.2 utilises colour to highlight the relative location of the items themselves (recall, evidence, trust, other, no belief).

Location	Persons	Difficulties of Items
3.0	High Measures	Hard Items
		N320 N330
2.0		N245, N300, N365, N310, N360 N355 N440, N385, N340, N405, N325, N435, N375, N250 N400, N305, O329, N380, N315, N415, N5 T243, N265, O319, N200, N425, O359, N445, N395, N255, N450, N420, N430, N30, O299, O309
1.0		T248, N280, T193, N260, N270, N455, T18, N345, O364, N475, N275, N465, N410, T268, O374, N350 N165, N150, N90, T38, N370, N290, O394, N480, T3, N10, O404, O354, N130, O439, O409, O314, N5 T278, O304, E72, N160, O424, T73, N170, O339, T78, O379, O414, O349, E142, T118, N390, E182, O389, T108, O449, T253, N470, T263, O384, O334, O399, T103, O324, O429, T68, O464, N135, T258, T13, N335, T63, T113, N215, N25, O419, N460, O434 O204, T218, N285, O369, O479, O344, T283, E177, E232, T223, E62, T83, E57, T293, E82, O244, T168, N210, T208, T43, E77, N220, T125, T88, O459, T93, O444, T313, T198, T8, E32, T188, O454, T123, T308, T273, T98 O474, E172, T143, O79, T323, N105, N230, T213, E42, O189, N240, N175, E152, T28, E137, T238, O264, T128, N195, E67, N45, O64, N15, T203, E157, E52, E227, N155, E97, T398, T58, T53, T33, O249, N140, T148, N95, T48, E222, E292, T288, T173
0.0		N35, T348, O184, O269, T158, E37, O129, N55, N100, N60, O84, O209, E162, O274, T373, O109, N120, O133, T154, O433, T363, O219, T233, O229, T333, O239, E117, T378, N110, O9, O199, O54, T163, O74, N295, T298, O224, O234, O19, O254, T423, T153, E12, T23, N235, N115, T228, E132, E202, T138, N20, O114, T458, N180, E237, E22, O259, T183, O69, O469, T418, T178, O104, T428, E187, T328 O49, T358, T413, E112, T318, O149, O29, O29, O294, N225, O169, O99, T403, T463, O34, E212, T318, E167, T478, O159, O134, T443, E147, T448, O174, O164, T453, T338, O279, E92, O144, N205, O289, T473, N185, O284, T303, O59, T343, T353, O179, O89, O94, O139, O214, O124, T383, E107, E467, E282, T368, O119, O40, R291, O194, T468, O39, N145 E87, R281, R96, E367, N70, E17, E192, R56, E127, E102, R106, O14, E27, E287, T438, R76, E477, T408, O44, E472, T393, E122, E207, E387, O24, E47, N190, N85, R221, E217 xxxxxxx E447, R31, R226, R81, R66, E407, E412, R101, R111, E7, N65, R36, R181, R116, E462, T4, E332, E442, R141, E277, E457, N80, E452, E191, E2, R71, N75, E342 xxxxxxxxxxxxxxxxxxxxxxx R201, R176, E257, E422, R41, E337, E437, E197, R11, R231, E302, R16, R186, R61, E347, R466, R171, E272, R91, E392
-1.0	xxxxxxxxxxxxxxxxxxxxxxx	E397, R156, R471, R86, R266, E432, E352, R121, R386, E262, R151, E417, E427, R276, R136, R206, E267, R286, R402, B382, B377, R51, E252 xxxxxxxxxxxxxxx R341, E362, R451, R456, E372, R166, R211, E317, R236, R146, R216, R161, E322, E357, R246, R131, R366 xxxxxxx R1, E312, R6, R421, E247, R271, R301, R251, R241, E297, R21, R441, R476, R256, R46 xxxxxxx R376, R381, E242, R126, R426, R26, R196, R461, R416, E327, R446, R261, R331 x R336, R311, R431, R436, R307, R406, R396, R411, R346, R391 -2.0 x R401, R321 R361 R351, R306, R371, R296 R316, R326 R356
-3.0	Low Measures	Easy Items

Item Key	
R, R	Recall Items
E, E	Evidence
T, T	Trust
O, O	Other
N, N	No Belief
401	Science Items
242	Religious Education Items
X =	19 Persons

Figure 6.1.1: Recall and Belief Scale with Student Measures and Item Difficulties
Measures calibrated on the Same Scale.

Location	Persons	Difficulties of Items
3.0	High Measures	Hard Items
		S320
		S330
2.0		R245, S300, S365, S310, S360
		S355
		S440, S385, S340, S405, S325, S435, S375, R250
		S400, S305, S380, S315, S415, R5
		R243, NR265, R200, S425, S445, S395, R255, R450, R420, S430, R30,
1.0		R248, R280, R193, R260, R270, S455, R18, S345, S475, R275, S465, S410,
		R268, S350
		R165, R150, R90, R38, S370, R290, S480, R3, R10, R130,
		R5
		R278, R72, R160, R73, R170, R78, R142,
		R118, S390, R182, R108, R253, S470, R263,
		R103, R68, R135, R258, R13, S335, R63, R113, R215, R25,
		S460,
		R218, R285, R283, R177, R232, R223, R62, R83, R57, R293,
		R82, R168, R210, R208, R43, R77, R220, R125, R88, R93,
		S313, R198, R8, R32, R188, R123, S308, R273, R98
		R172, R143, S323, R105, R230, R213, R42, R240, R175, R152,
		R28, R137, R238, R128, R195, R67, R45, R15, R203, R157, R52, R227,
		R155, R97, S398, R58, R53, R33, R140, R148, R95, R48, R222, R292, R288,
		R173
0.0		R35, S348, R158, R37, R55, R100, R60, R162,
		S373, R120, R154, S363, R233, S333, R117,
		S378, R110, R163, R295, S298,
		S423, R153, R12, R23, R235, R115, R228, R132, R202, R138, R20,
		S458, R180, R237, R22, R183, S418, R178, S428, R187,
		S328
		S358, S413, R112, S388, R225, S403, S463,
		R212, S318, R167, S478, S443, R147, S448, S453,
		S338, R92, R205, R289, S473, R185, S303,
		S343, S353, S383, R107, S467, R282, S368,
		R291, S468, R145
		R87, R281, R96, S367, R70, R17, R192, R56, R127, R102, R106, R27, R287,
		S438, R76, S477, S408, S472, S393, R122, R207, S387, R47, R190, R85,
		R221, S217
	xxxxxxx	S447, R31, R226, R81, R66, S407, S412, R101, R111, R7, R65, R36, R181, R116,
		S462, R4, S332, S442, R141, R277, S457, R80, S452, R191, R2, R71, R75, S342
	xxxxxxxxxxxxxxxxxxxxxxx	R101, R176, R257, S422, R41, S337, S437, R197, R11, R231, S302, R16, R186, R61,
		S347, S466, R171, R272, R91, S392
-1.0	xxxxxxxxxxxxxxxxxxxxxxx	S397, R156, S471, R86, R266, S432, S352, R121, S386, R262, R151, S417, S427,
		R276, R136, R206, R267, R286, S402, S382, S377, R51, R252
	xxxxxxxxxxxxxxx	S341, S362, S451, S456, S372, R166, R211, S317, R236, R146, R216, R161, S322,
		S357, R246, R131, S366
	xxxxxxx	R1, S312, R6, S421, R247, R271, S301, R251, R241, S297, R11, S441, S476, R256,
		R46
	xxxxxxx	S376, S381, R242, R126, S426, R26, R196, S461, S416, S327, S446, R261, S331
	x	S336, S311, S431, S436, S307, S406, S396, S411, S346, S391
-2.0	x	S401, S321
		S361
		S351, S306, S371, S296
		S316, S326
		S356
-3.0		
	Low Measures	Easy Items

Item Key	
316	Recall Items
242	Evidence
408	Trust
	Other
75	No Belief
S	Science Items
R	Religious Education Items
X = 19 Persons	

Figure 6.1.2: Recall and Belief Scale with Student Measures and Item Difficulties Measures Calibrated on the Same Scale.

The scale of Figure 6.1.1 and Figure 6.1.2 is in logits and each 'X' represents 19 students. Student scores (the left side of the scale) range from -0.6 to -2.0 logits. Item difficulties (right side of the scale) range from -2.6 to +2.4. The range of scores does not cover the range of items at the high end of the scale. This means that the many of the items are 'too hard' for the students.

The pattern of items in Figure 6.1.1 and Figure 6.1.2 indicate: one, the clear separation of the groups of items (recall items are 'easier' than evidence, evidence items are 'easier' than trust and so on, and, recall of science items is easier than recall of religious education items, believing science items is 'easier' than believing religious education items and so on) that is evident from the high Separation Index (Table 6.1) and the results from the different phases of the data analysis (Chapter 5, 6 and 7); two, the 'clumping' of 'person scores' indicates that the students tend to respond to the items in a similar manner (there is a high level of agreement amongst the students); three, the item difficulty scores indicate that the students treat the religious education items differently to the science items, but the difference between the two types of knowledge (religious education and science) form a continuum rather than represent two distinct and separate sets of data.

To further investigate the absence of an 'ordered' response to the items, a Reference Group was established. This Reference Group provides a format for detailed discussions with students about what they believe and what is the basis of their belief (A full discussion of the results is given in Chapter 8). The findings of this Reference Group indicate that the belief patterns of students for their religious education and science items are not ordered. When students in the Reference Group explain why they believe or did not believe the stem items, their reasoning is, to them, valid and logical, suggesting that their responses to the items are 'ordered' for them. An example can demonstrate this point. Some students indicated that they do not believe in God and thus, when the word 'God' appears in any item they indicated that they do not believe that the item is true. Thus easy items such as 'God created in people a concern for justice' (stem item # 1) are not believed, whereas hard items such as 'parents have responsibilities towards their children' (stem item # 17), are believed. This example demonstrates how the student

responses to the items could appear to lack an ordered pattern, but at the same time appear to the students themselves as logical and valid.

The results of the Rasch analysis (summarised in Table 6.1) indicate that there is little agreement among the students with low, medium and high measures, as to the ordering of the item difficulties. Therefore, the scale is not acceptable as a Rasch-generated interval level scale from which valid and reliable inferences can be made. The results of the analysis though, can be used as a guide and, with collaborative evidence, can assist with enhancing our understanding of student perceptions regarding belief in the content of science and religious education items. This is now presented and explained.

The student belief scale

It is expected that the item-perspectives, in order of difficulty from easy to hard, would be 'Recall' (easiest) – this is reflected in the average Rasch logit value of -0.83 (Table 6.3.1) for the religious education items and -1.63 for the science items, 'Belief – based on evidence' – reflected in the actual average Rasch logit value of -0.06 for the religious education items and -0.76 for the science items, 'Belief – based on trust of the teacher', 'Belief – based on other reasons' and 'Non-belief' at the 'hardest end of the difficulty scale. The results of the Rasch analysis indicates that the conceptual ordering of the items is reflected in the students' responses for the science items, but the actual ordering of the religious education category items place 'Belief – based on other reasons' third in the order of difficulty ($+0.01$) not fourth, and 'Belief – based on trust of the teacher' as the 'hardest' category ($+0.06$) rather than third in the order of difficulty. As is explained above, the results of the Rasch analysis can only be used as an indicator of a pattern. The ordering of items, as indicated by the average logit values, is corroborated though, by the percentages of students who respond to each item (Table 6.3.2). The average percentage of students who indicated that they could recall the 59 religious education items, 47.9% (Table 6.3.2) being higher than the average percentage who indicated that they believe that the items are true (28.4%), indicates that on average, the students find it 'easier' to recall the religious education items, than to believe that the

items are true. The initial results of the Rasch analysis indicate that further analysis of the data is essential, and that the students' response to the religious education items is not only different to what was expected, but also different to the students' responses to the science items. Further analysis and review of the religious education data will therefore be essential.

If the initial conceptual ordering of the religious education category of items is treated the same as the ordering of the science items, in spite of the clear evidence from the earlier statistical analysis, and the initial results of the Rasch analysis indicating that the students are responding to the religious education items quite differently to the science items, the ability of the model to reflect the data would be significantly compromised. A significant number of items would fail to fit the model (a sample appears in Table 6.4 and 6.5) and would, by necessity, have to be removed from the analysis. While the Rasch analysis of the science items does not produce a top quality scale the logit values in the sample of the science items (Table 6.4) indicate that the order of difficulty of the science items does reflect the conceptual order of the model (as logit values increase in magnitude, there is an increase in the level of difficulty of the items). Appendix 4 lists the logit values for all 37 science stem-items and shows that only two items (the 'other' belief perspective for stem-items 18 and 19) do not fit the conceptual order of the model.

The logit values in the sample of the religious education items (Table 6.5) indicate that the order of difficulty of the religious education items does not reflect the conceptual order of the model. In the sample, the logit values for the items related to 'I believe this item for other reasons' indicates that these items are 'easier' than the items related to 'I believe these items on the basis of trust'. This pattern does not reflect the conceptual order of the items. Appendix 4 lists the logit values for all 295 religious education stem-items. The large number of 'no fit' items indicate that the conceptual order of the religious education items do not fit the students' perception of the order of difficulty. The students quite clearly treat the science items quite differently to the religious education items. To minimise the number of 'no fit' statistics the religious education items were regrouped into two groups of items called 'Religious Education Group A' and 'Religious

Education Group B'. On the basis of the raw score order of difficulty of the items (Appendix 4) the order of items from easy to hard for Religious Education Group A items is one, 'I can recall this item'; two, 'I believe this item (evidence); three, 'I believe this item (other); four 'I believe this item (trust) and five 'I do not believe this item. On the basis of this ordering of the 125 items, 18 items do not fit the pattern. The order of items from easy to hard for religious education Group B items is one, 'I can recall this item'; two, 'I believe this item (other); three, 'I believe this item (evidence); four 'I do not believe this item and five 'I do believe this item (trust). On the basis of this ordering of the 170 items, 35 items do not fit the pattern.

On the basis of the preliminary results that clearly show the students are responding to the religious education items quite differently to the science items, a review of the conceptual ordering of the religious education category of items may therefore be warranted. In addition, a review of the conceptual ordering of items may allow the model to better reflect the students' beliefs and so may provide a greater insight into the metacognition of the students in the religious education classroom. (A more detailed investigation of the order of the religious education items occurs in Chapter 7.)

Table 6.3.1

AVERAGE LOGIT VALUES FOR THE CATEGORY OF ITEMS

Category of Items	Religious Education	Science
Recall	-0.83	-1.63
Belief – based on evidence	-0.06	-0.76
Belief – based on trust	+0.50	+0.01
Belief – based on other reasons	+0.01	+0.79
Non-belief	+0.49	+1.45

Table 6.3.2
AVERAGE PERCENTAGE VALUES FOR THE CATEGORY OF ITEMS

Category of Items	Religious Education	Science
Recall	47.9%	65.1%
Belief – based on evidence	28.4%	41.5%
Belief – based on trust	17.8%	24.7%
Belief – based on other reasons	25.5%	13.2%
Non-belief	19.1%	7.6%

Table 6.4.
A SAMPLE OF LOGIT VALUES FOR SCIENCE ITEMS

Science Items	I can recall this item	I believe this item (evidence)	I believe this item (trust)	I believe this item (other)	I do not believe this item
1 Human blood contains white blood cells that help to fight disease	-2.25	-1.28	0.09	1.38	2.09
2 White blood cells make antibodies to get rid of dead microbes	-1.30	-0.67	-0.06	0.61	1.47
3 The earth pulls downwards on all objects by means of what is called its gravitational force.	-2.27	-1.71	0.58	1.39	2.14
4 Rocks are broken down in the process of weathering	-1.78	-1.35	0.54	0.99	1.53

Table 6.5
A SAMPLE OF LOGIT VALUES FOR RELIGIOUS EDUCATION SECTION A ITEMS

Religious Education Stem Items	I can recall this item	I believe this item (evidence)	I believe this item (other)	I believe this item (trust)	I do not believe this item
Section A					
2 Developing a vocation may include finding employment.	-1.35	-0.55	0.09	0.55	0.92
4 Just love brings happiness and contentment.	-0.66	-0.34	0.10	1.06 (no fit)	0.14
10 God created within people the potential to love justly.	-1.22	-0.21	-0.20	0.37	0.99

Notes on Table 6.5: The '(no fit)' annotation indicates that item 4 does not fit the Rasch measurement model

The Rasch analysis of the 480 items allows a comparison of the religious education and science items on a single scale of item difficulty, if it could be shown that a 'top quality' scale had been constructed. The initial results (Table 6.3.1, corroborated by Table 6.3.2) lend further support to the results of the statistical analysis described in the previous chapter indicating that the student response to the religious education items is different to their response to the science items. The corroborative evidence (Table 6.3.2) shows that the ordered pattern evident from the Rasch analysis does represent the pattern evident from the raw student responses. The average logit values indicate that the students find it 'very much easier' to say that they could recall the science items (-1.63) than the religious education items (-0.83). The results also indicate that the students find it 'very much easier' to believe the science items (-0.76) on the basis of evidence, than to believe the religious education items (-0.06), and easier to 'not believe' the religious education items (0.49) than to not believe the science items (1.45). The results indicate that the students find it 'harder' to believe the religious education items (0.50) on the basis of trust than the science items (0.01). (This result clearly reflects the students' comments to the open ended questions and the comments of the students in the reference group described in the previous chapter.)

As has been noted above, the item category - 'Belief – based on other reasons' - is more important as a factor in the students' belief of the religious education items (0.50) than it is for the science items (0.79), not only as a comparison of the level of difficulty, but also as this factor ranks third in order of difficulty for the religious education items, and fourth for the science items.

Student belief patterns of science content

The Rasch analysis of the student responses provides logit values for the religious education and science items that indicate the level of difficulty of the items themselves. These logit values are calculated on the same scale and, if they are to all fit the

measurement model, a direct comparison of the level of difficulty of the religious education and science items is possible. This chapter compares the student responses of the 'recall/belief' items for the science and religious education stem items, but because there is not a good fit of persons and items to the measurement model additional analyses were carried out using percentage response rates to items. The results of these additional analyses are included in this chapter to corroborate the patterns evident from the Rasch analysis. A comparison of the students' perception of the level of difficulty of being able to 'recall' each science item and the level of difficulty of believing each item as the result of 'evidence', 'trust' and 'other' factors is therefore possible. This section also uses the results of the Rasch analysis to directly compare student responses to the religious education and science items on the basis of each of the 'recall/belief' items.

The logit values of the science stem items indicate the level of difficulty of each item. Graphing the logit values of each of the 37 science stem items for the five perspectives (making a total of 185 items), and reordering the stem items from easy to hard on the basis of the 'Recall' stem items (I can recall being taught this item), indicates a pattern of relationships between the stem items (Figure 6.2). The increasing level of difficulty (easy logit value of -2.7 to hard logit value of -0.6) is clearly evident for the 'Recall' items (Figure 6.2). As the level of difficulty of the 'Recall' items increases, the logit values for the 'Do not believe' items (I do not believe that the items are true) indicate two patterns. One, the students' responses indicate that it is 'harder' to not believe the science items are true than it is to recall being taught the item (the logit values of the 'Do not believe' items range from +2.1 to +0.8 whereas the logit values of the 'Recall' items range from -2.7 to -0.6). Two, as the level of difficulty of the 'recall' items increases, the level of difficulty of the 'Do not believe' items tends to decrease, indicating that as it becomes 'harder' to recall science items, it becomes 'easier' to believe that the items are not true. This second trend is also evident in the pattern of logit values for the 'other reasons' (I believe the items for 'other' reasons) is also evident.

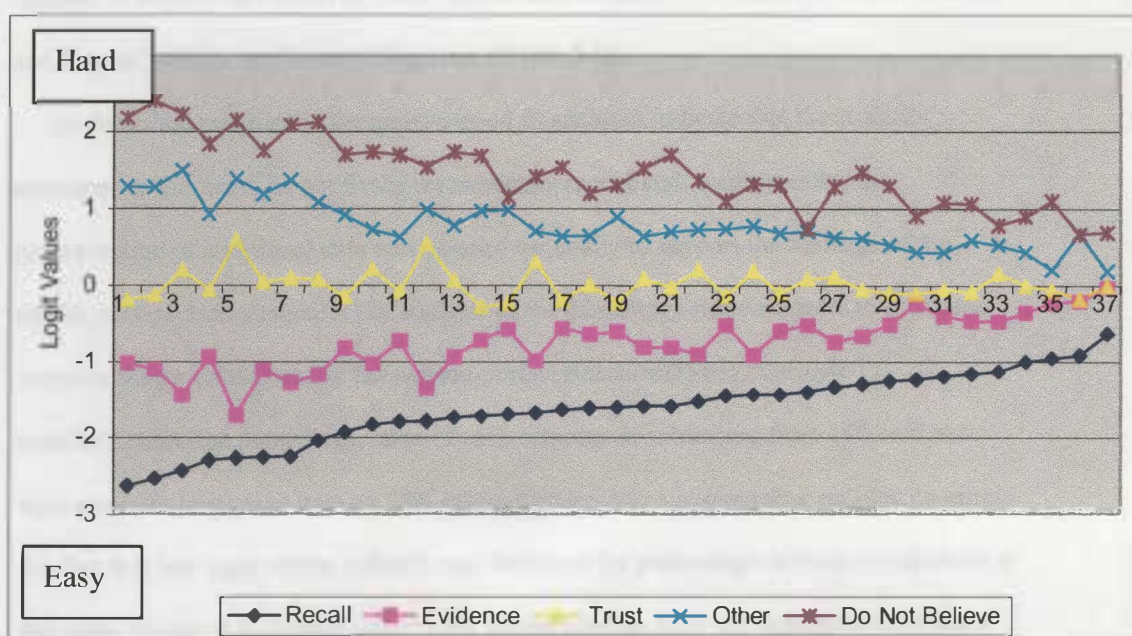


Figure 6.2. Logit values of science items ordered from easy to hard on the basis of recall.

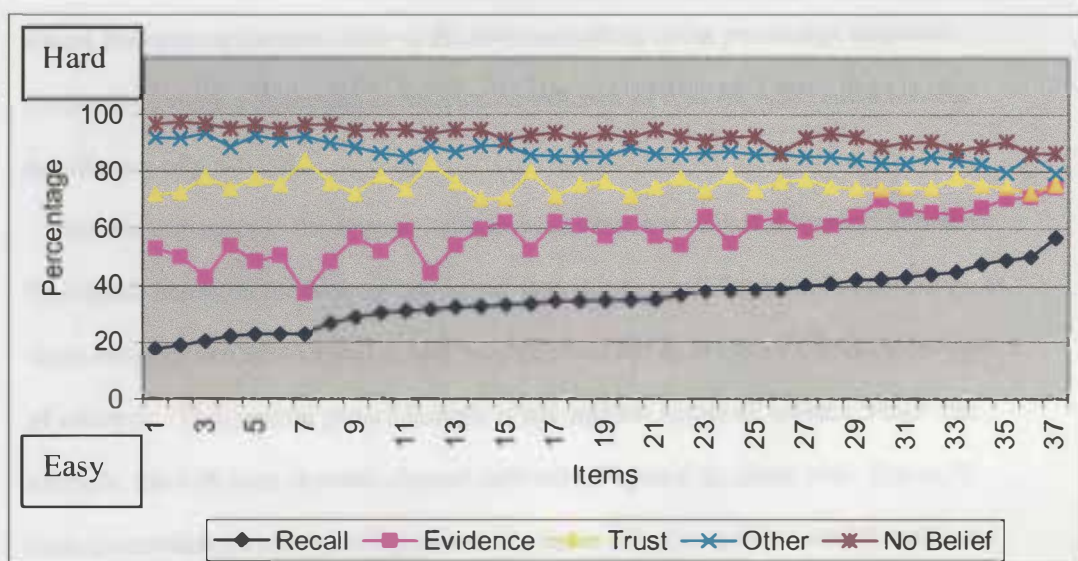


Figure 6.3. Science Items Ordered from easy to hard on the basis of the inverse percentage of students responding to each item. (The items are ordered on the basis of the percentage level of ‘Recall’ of items)

The separation of the logit values for the five sets of stem items is quite clear, with each set of logit values becoming more ‘positive’ (ie indicating decreasing level of difficulty) (Figure 6.2) indicating that the items support the model. The model predicts that student responses to the four ‘belief’ items (I believe the items because of ‘evidence’, because I ‘trust’ the teacher, because of some ‘other’ factor or I ‘do not believe’ the item) would indicate that it is ‘easier’ to believe the items because of ‘evidence’, somewhat

'harder' to believe as a result of 'trust', harder still to believe the items for 'other' reasons and 'harder' still to 'not believe' the items (Figure 6.2).

As described previously, the not-too-good fit statistics indicate that the students' responses to the items do not fit the measurement model and, consequently, the corroboration of additional data was deemed necessary to support the findings of the results of the Rasch analysis. The analysis of the percentage response rates to the items supports the patterns found in the not-too-perfect Rasch analysis. A simple transformation (the percentage value of each response is subtracted from 100 so that a high response level easy item eg. 70% is transformed into a low number eg. 30%, to mimic the fact that low logit values indicate easy items) of the percentage of student responses to the items (Figure 6.3) closely mirrors the pattern evident from the logit patterns (Figure 6.2). In addition, the rank order of the science items according to the logit values is almost the same as the rank order of the items according to the percentage responses (Appendix 6) with a Spearman correlation co-efficient of 0.93 ($N = 37$) and a level of significance of $p < 0.001$.

Student responses to the science items indicates that not only is it 'harder' to believe the science items, on the basis of 'evidence' than it is to recall the item, but generally, as items become 'harder' to recall, it also becomes 'harder' to believe the item on the basis of evidence. This general pattern though, is not uniform across all science items. For example, the fifth item in order of recall difficulty (Figure 6.2), (Item 306: The earth pulls downwards on all objects by means of what is called its gravitational force), has a logit value (-2.17) indicating that it is the 'easiest' item to believe on the basis of evidence. Similarly, the sixteenth (Item 396, logit value -0.986: Mankind has evolved over time on earth) and the twenty-fourth item (Logit value -0.908, Item 416: Isaac Newton developed a Law of Motion that predicts that a passenger in a car who is not wearing a seat belt may go through the wind-screen when that car has a head on collision) in order of difficulty of recall, have logit values that indicate they have the same degree of difficulty to believe (on the basis of evidence) as the first item (Item 356, logit value -1.019: Protons have a positive charge). Therefore, while the general trend of the order of

difficulty of the 'recall' and 'belief' (on the basis of evidence) fits the model, individual items indicate some minor variations to the model.

The logit values of the 'trust' items indicate little variation from easy to hard across the range of items. The range of logit values is low, with the 'easiest' item (Item # 25: Isaac Newton developed a Law of Motion that predicts that a passenger in a car who is not wearing a seat belt may go through the wind-screen when that car has a head on collision.) having a logit value of -0.18 and the 'hardest' with a logit value of +0.57 (Item # 2: White blood cells make antibodies to get rid of dead microbes), indicating little variation in the level of difficulty of the items. This pattern indicates that while the items became 'harder' to recall, and 'harder' to believe on the basis of 'evidence', the student responses to the items indicate that the level of difficulty of believing the items on the basis of 'trust' is quite uniform. The Rasch measurement analysis results for this set of items can be corroborated by the percentage responses. For example, the 'easiest' item, (#29: Chlorophyll enables plants to use energy from the sun to convert carbon dioxide and water into sugar. This sugar can then be converted into energy that the plant can use.), according to the percentage results (29.6 % of the students), is the sixth 'easiest' item according to the logit values. The second 'hardest' item, (# 3: The earth pulls downwards on all objects by means of what is called its gravitational force), according to the logit values, is rated as the 'hardest' item (16.1%) on the basis of the percentage responses. While the correspondence between the order of difficulty, as determined by the logit values and the order as determined by the percentage values is not perfect, the strong similarities between the two sets of data suggest that the conclusions drawn from the data can be relied upon.

Student belief patterns of religious education content

The logit values of the religious education stem items indicate the level of difficulty of the stem items. Graphing the logit values for each of the 59 religious education stem-items and reordering the stem items from easy to hard on the basis of the 'Recall' stem

items (I can recall being taught this item), indicates a pattern of relationships between the stem items (Figure 6.4). The purpose of including Figures 6.4 and 6.5 at this stage is to demonstrate the similarity between the pattern evident from the logit value and the pattern evident from the analysis of results using percentage response rates to items. As described previously, the item-person statistics indicate that the students' responses to the items do not fit the measurement model and, consequently, 'weaken' the validity of the item logit values. A simple transformation (the percentage value of each response is subtracted from 100 so that a high response values indicate easy items) of the percentage of student responses to the items (Figure 6.5) level easy item (70%) is transformed into a low number eg. 30% to mimic the pattern evident from the logit patterns (Figure 6.4). In addition, the rank order of the religious education items according to the logit values is almost the same as the rank order of the items according to the raw percentage responses (Appendix 6) with a Spearman correlation co-efficient of 0.64 ($N = 59$) and a level of significance of $p < 0.001$.

A comparison of level of difficulty of the religious education and science items

Despite the Rasch analysis failing to generate 'top quality' item-person and item-trait statistics indicating that the students' responses to the items do fit the measurement model perfectly, the Rasch analysis nevertheless does indicate an excellent Student Separability Index for the 480 items. This excellent Student Separability Index is evident in Figure 6.1.1 and Figure 6.1.2 where the colour coded Item difficulties show clear separation into ordered groups. This means the proportion of the observed variance considered to be true (akin to a Cronbach Alpha reliability) is 90%. This statistic, together with the clear similarity between the patterns evident from the logit values corroborated by the percentage responses (Figures 6.1, 6.2, 6.3 and 6.4), suggests that the Rasch analysis does add to the results of this thesis, and hence the logit values that enable a comparison of the student responses to the religious education and science items are included.

As has been described above, a difference in logit values indicates a difference in the degree of difficulty. An increase in the logit value indicates an increase in the degree of difficulty. By ordering the ‘recall’ logit values from easy to hard, a comparison in the degree of difficulty of the science items and religious education items is possible (Figure 6.6). The logit values for the 59 recall religious education items range from -1.53 to -0.01 , while the logit values for the 37 science recall items range from -2.63 to -0.64 (Figure 6.6). The percentage response of the students to these items (Appendix 7, Figure A) support the pattern evident from the logit values and provides corroborative evidence that supports the imperfect Rasch scale. The clear separation of the two sets of logit values (Figure 6.9) indicate that the level of difficulty of the recall religious education items is perceived as being more difficult than the level of difficulty of the recall science items. The ‘easiest’ religious education items are separated from the ‘easiest’ science items by a logit value of approximately 1.0. The degree of difference tends to decrease as the items become ‘harder’ to recall, to a logit value of approximately 0.5 and then, for the ‘hardest’ items, the logit values become similar indicating that the difference in level of difficulty between the science and religious education items decreases. The average

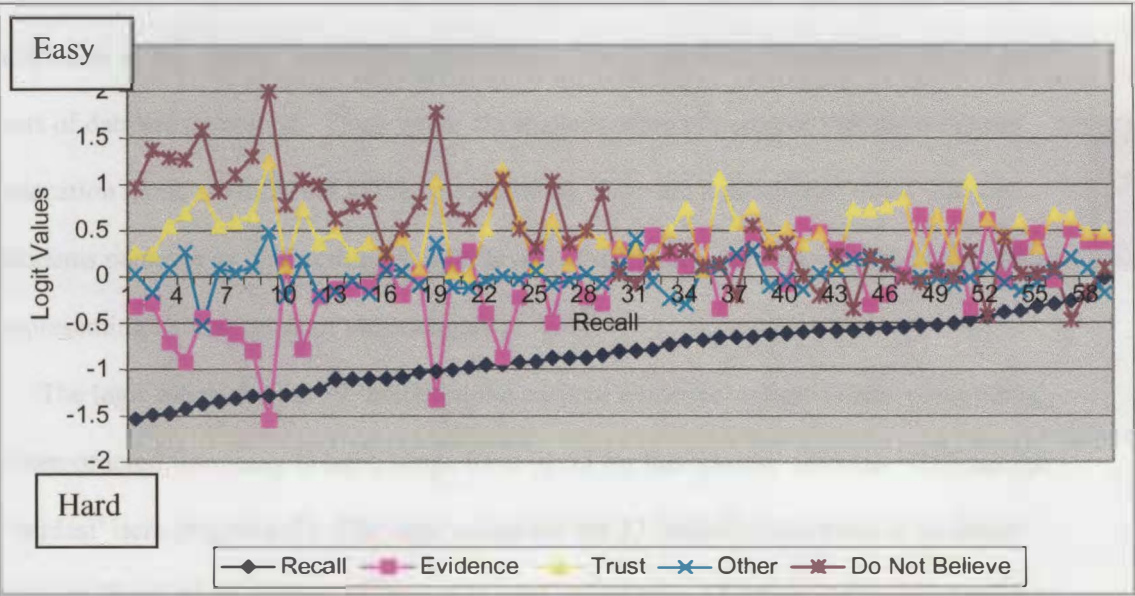


Figure 6.4. Logit values of religious education items ordered from easy to hard on the basis of recall.

Note: Due to the complexity of the data and the limitations of the page width it is not possible to increase the vertical scale to reduce the clutter of this figure.

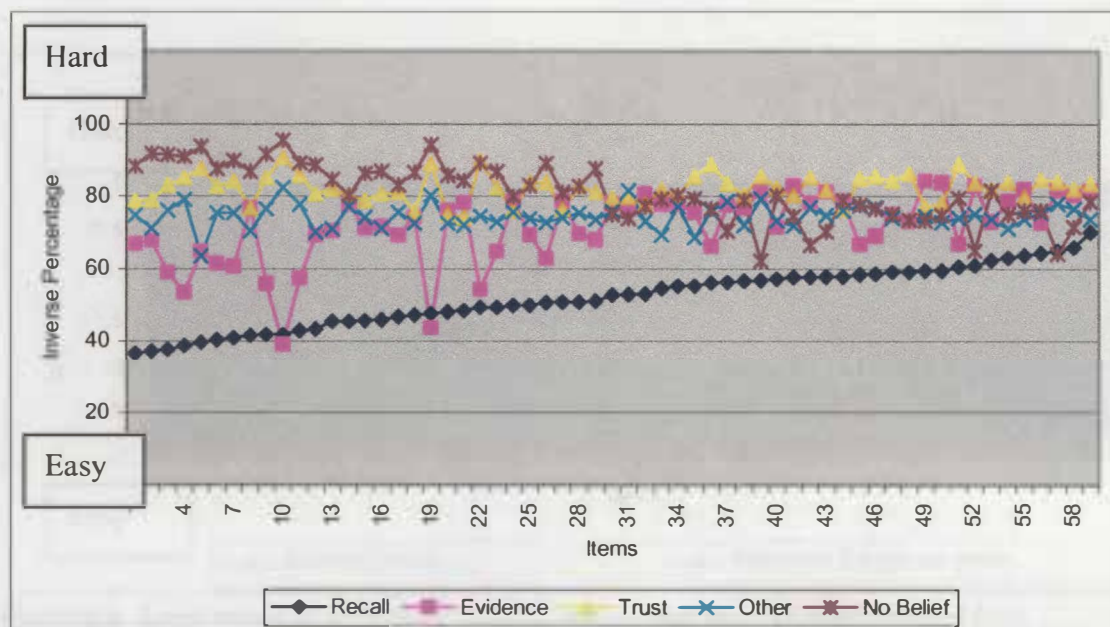


Figure 6.5. Religious education Items Ordered from easy to hard on the basis of the inverse percentage of students responding to each item. (The items are ordered on the basis of the percentage level of ‘Recall’ of items)

level of separation of the two sets of logit values is 0.58 logits. The separation of the two sets of items indicates that the students do perceive that the two sets of items are different.

While the differences are evident it must also be noted that the two sets of data do not form two distinct groups. The logit values of the ‘hardest’ 16 science items are equivalent to the logit values of the ‘easiest’ 37 religious education items. The level of difficulty of the science and religious education does produce a continuum when the two sets of data are combined. Thus, while the students seem to perceive that the religious education items are different to the science items, there are a number of items that the students perceive as representing similar levels of difficulty and thus may be perceived as representing similar types of knowledge.

The logit values for the 59 ‘belief on the basis of evidence’ religious education items, when ordered from easy to hard, range from -1.55 for the ‘easiest’ items to $+0.67$ for the ‘hardest’ item (Figure 6.7). The logit values for the 37 ‘belief on the basis of evidence’ science items, when ordered from easy to hard, range from -1.71 for the ‘easiest’ items to approximately -0.03 for the ‘hardest’ item (Figure 6.7). The first science item (Item 307: The earth pulls downwards on all objects by means of what is called its gravitational force) and the first religious education item (Item 242: Parents have responsibilities

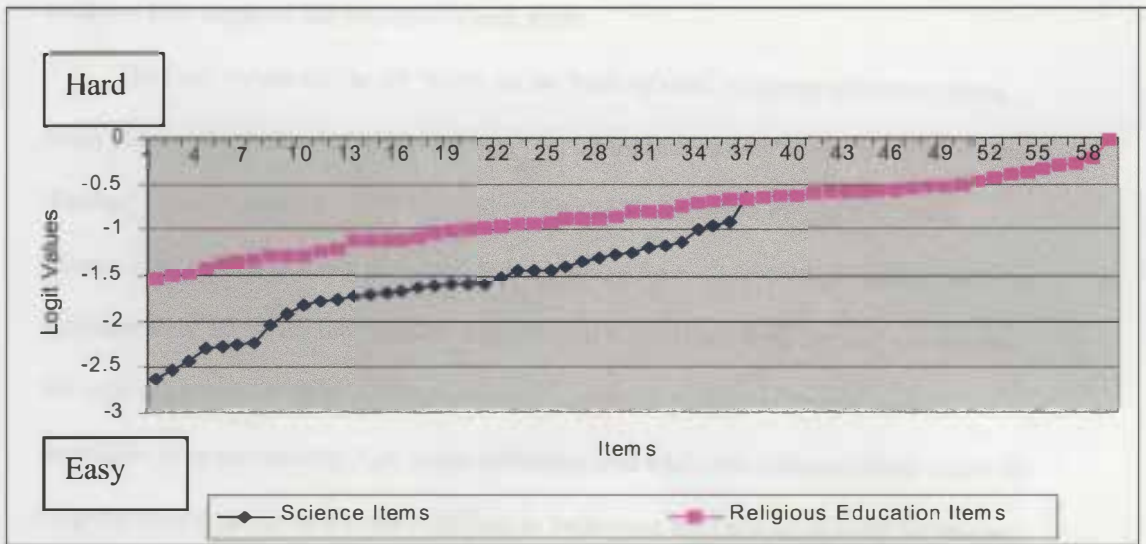


Figure 6.6. Logit values of religious education and science items (Recall) ordered from easy to hard’.



Figure 6.7. Logit values of ‘belief on the basis of evidence’ of science items and religious education items

towards their children) have similar logit values indicating that the perceived level of difficulty of these items is similar. Apart from these items, the remaining items have logit values that have a separation of approximately 0.50, indicating that the students perceive that believing the religious education items on the basis of their teacher having given them evidence to ‘prove’ that the items are true, is more difficult than believing the science items. The percentage response of the students to these items (Appendix 7,

Figure B) support the pattern evident from the logit values and provides corroborative evidence that supports the imperfect Rasch scale.

The logit values for the 59 'belief on the basis of trust' religious education items, when ordered from easy to hard, range from +0.02 for the 'easiest' items to +1.25 for the 'hardest' item (Figure 6.8). The logit values for the 37 'belief on the basis of trust' science items, when ordered from easy to hard, range from -0.28 for the 'easiest' items to approximately +0.58 for the 'hardest' item (Figure 6.8). Apart from the last science item, the logit values of the religious education and science items tend to have a level of separation of approximately 0.30 logits indicating that while the students perceive that the religious education items are more difficult to believe on the basis of trusting the teacher to teach what is true, the degree of difference is generally the smallest (an average difference of 0.49 logits) of the five sets of item comparisons. The percentage response of the students to these items (Appendix 7, Figure C) support the pattern evident from the logit values and provides corroborative evidence that supports the imperfect Rasch scale.

The logit values for the 59 'belief on the basis of other reasons' religious education items, when ordered from easy to hard, range from -0.52 for the 'easiest' items to +0.49 for the 'hardest' item (Figure 6.9). The logit values for the 37 'belief on the basis of other reasons' science items, when ordered from easy to hard, range from +0.19 for the 'easiest' items to approximately +1.51 for the 'hardest' item (Figure 6.9). Generally, the level of separation of the two sets of items increases from 0.7 logits for the 'easiest' 1.4 logits for the 'hardest' items.

The pattern (Figure 6.9) indicates that students perceive that the difference in the level of difficulty in believing the items on the basis of 'other' reasons tends to increase as the items become 'harder' to believe. The percentage response of the students to these items (Appendix 7, Figure D) support the pattern evident from the logit values and provides corroborative evidence that supports the imperfect Rasch scale. The difference in the level of difficulty between the religious education and science items for this category of belief is quite high, being the second highest average (0.77 logits) difference.

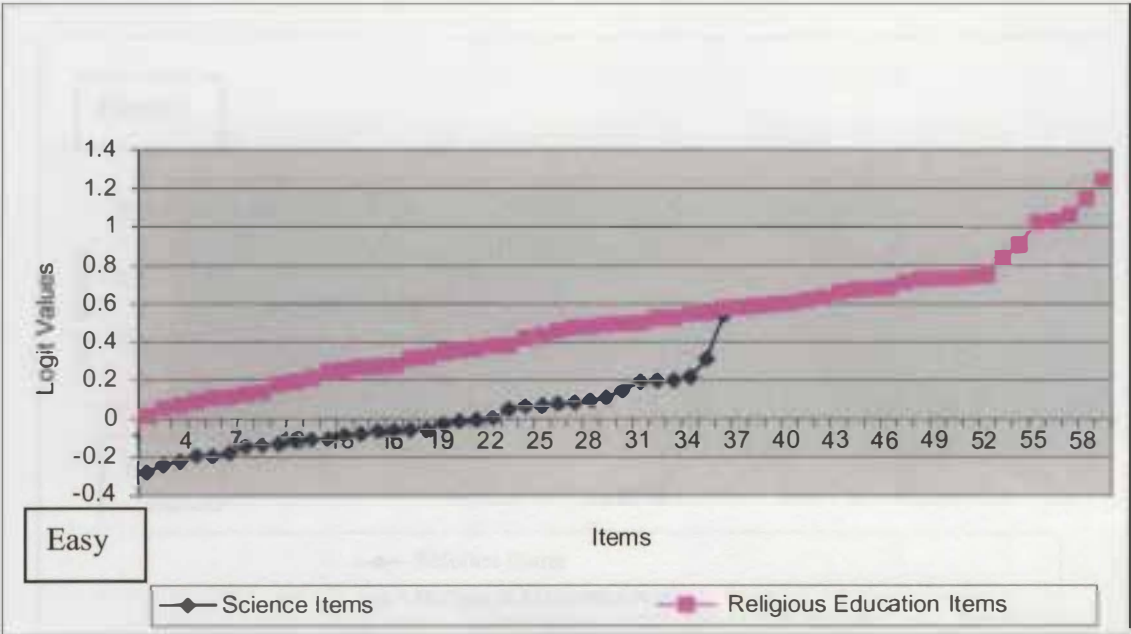


Figure 6.8. Logit values of 'belief on the basis of trust' of science items and religious education items

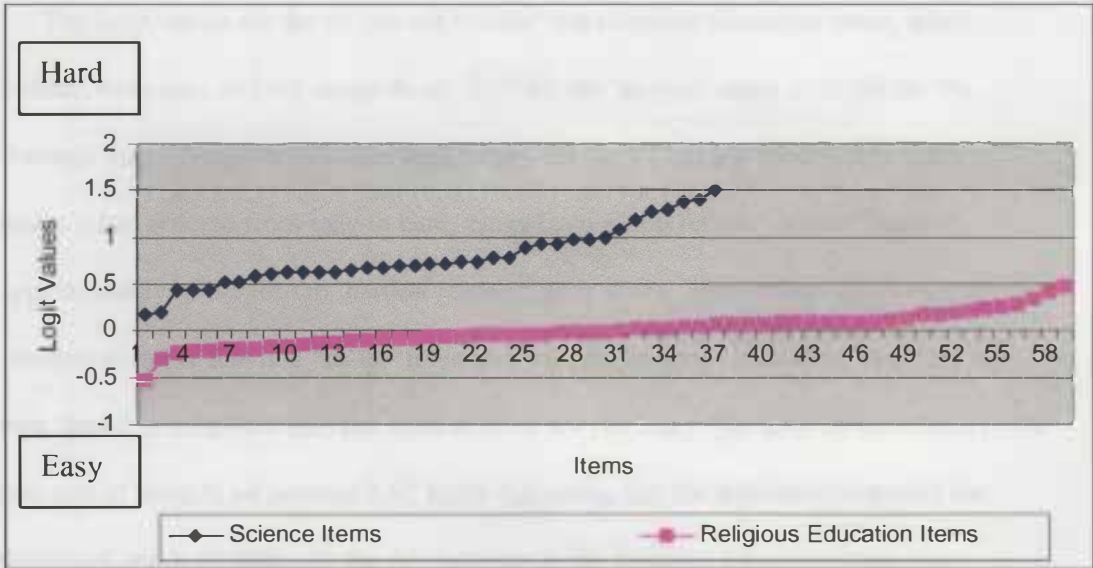


Figure 6.9. Logit values of 'belief on the basis of other reasons' of science items and religious education items

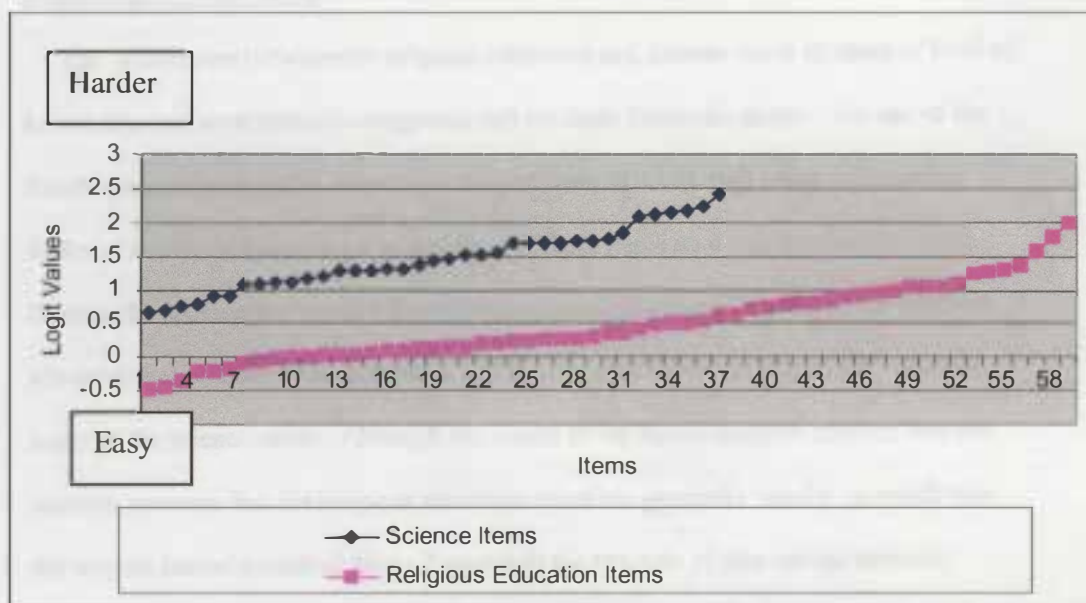


Figure 6.10. Logit values of ‘non-belief’ of science items and religious education items

The logit values for the 59 ‘do not believe’ the religious education items, when ordered from easy to hard, range from -0.47 for the ‘easiest’ items to $+2.00$ for the ‘hardest’ item (Figure 6.10). The logit values for the 37 ‘do not believe’ the science items, when ordered from easy to hard, range from $+0.66$ for the ‘easiest’ items to approximately $+2.41$ for the ‘hardest’ item (Figure 6.10). This pattern indicates that the students perceive that it is ‘easier’ to believe that the religious education items are not true, than it is to believe that the science items are not true. The level of separation of the two sets of items is on average 0.97 logits indicating that the difference between the perceived levels of difficulty for this category is the highest of the five categories. Generally, the difference between the two sets of logit values gradually increases from approximate 0.90 logits for the ‘easiest’ items to almost 2.00 logits for the ‘hardest’ items. The percentage response of the students to these items (Appendix 7, Figure E) supports the pattern evident from the logit values. The pattern (Figure 6.10) indicates that students perceive that the difference in level of difficulty of not believing the items tends to increase as the items become ‘harder’ to not believe.

Differences between items

The differences between the religious education and science items in terms of level of knowledge and acceptance is recognised and has been discussed above. The use of the Rasch measurement model overcomes the problems of comparing items representing different knowledge allowing a comparison of these items on a single value free scale. Despite the differences between the religious education and science items, the religious education items from sections A and B have logit values similar to the values of many of the science items. Although the results of the Rasch analysis confirm that the students perceive that the religious education items are generally 'harder' to recall than the science items (described above Figure 6.6) the two sets of data are not mutually exclusive. The 37 religious education items have the same level of difficulty as 16 of the science items. The students seem to perceive that over half of the religious education items have a similar level of difficulty as almost half the science items. This observation supports the model that suggests that many of the religious education items (particularly those in sections A and B) represent 'knowable content', and that the Rasch analysis indicates that the students recognise this similarity and respond accordingly.

In addition to differences in type of knowledge differences in level of acceptance between the religious education and science content also exist. The results (Figures 6.6 and 6.7) indicated that the students do perceive that it is harder to believe the religious education items than the science items on the basis of two measures – having been provided with evidence (Figure 6.7) and on the basis of trust (Figure 6.8). While these differences are apparent (and have been outlined above) it is also evident that there are religious education items that are perceived as being as 'easily' believed as the science items. Figure 6.7 indicates that there are 29 religious education items that are as 'easily' believed (on the basis of evidence) as the science items. Similarly, there are 36 religious education items that the students perceive are as 'easily' believed (on the basis of trust) (Figure 6.8) as the science items. This observation supports the model that suggests that many of the religious education items (particularly those in sections A and B) represent

'knowable content' and as such will be treated differently to items that do not represent this level of knowledge.

In addition to the differences between the religious education and science items, the differences within the religious education and science items must also be recognised. The difference between the 'hardest' and 'easiest' religious education item is 1.6 logits and the difference between the 'hardest' and 'easiest' science item is 2.0 logits indicating that the students perceive that differences in level of knowledge and ease of acceptance are evident within the stem items themselves. The differences evident within the science items is actually greater than the differences within the religious education items.

Summary of findings

The findings of the Rasch analysis can be summarised, for clarity purposes, with ten brief statements:

- I. The Rasch analysis indicates that a scale could be created with an excellent Item Separation Index;
2. The Rasch analysis indicates that a proper linear scale to the standard required by Rasch measurement experts could not be created, suggesting that;
 - i. student responses to the items are not conceptually ordered;
 - ii. the validity of the Rasch-created scale data is compromised.
3. Extensive efforts to resolve this issue are not successful, but the patterns evident from the Rasch analysis do assist with an understanding of student beliefs of learning in religious education and science. The Rasch analysis, corroborated by the patterns evident in chapter 5 and the percentage response rates to items suggest the following findings can be made;
4. Generally, the order of difficulty, from easy to hard of the religious education items is; 1. recall, 2. evidence, 3. other and 4. trust;
5. Generally, the order of difficulty, from easy to hard of the science items is; 1. recall, 2. evidence, 3. trust and 4. other;

6. The response of the students to the science items is different to their response to the religious education items;
7. The logit scale values for the religious education items suggest that there are two distinct groups of religious education items, with differing ordered responses.
 - i. Group A religious education items have an ordered pattern from easy to hard of 1. recall, 2. evidence, 3. other, 4. trust and 5. no belief;
 - ii. Group B religious education items have an ordered pattern from easy to hard of 1. recall, 2. other, 3. evidence, 4. no belief and 5. trust;
8. Rasch analysis enables a comparison of the degree of difficulty of science and religious education items on the same scale. It is harder to recall religious education items than to recall science items. It is harder to believe religious education items on the basis of evidence, than to believe science items on the basis of evidence. It is harder to believe religious education items on the basis of trust, than to believe science items on the basis of trust. It is easier to believe religious education items on the basis of other reasons, than to believe science items on the basis of other reasons. It is easier to not believe religious education items than to not believe science items;
9. Rasch analysis indicates a relationship between the level of recall and the basis of belief of science items. As the level of difficulty of recall of science items increases, it is harder to believe the items, it is easier to believe the items on the basis of other reasons and harder to believe the items on the basis of evidence. The degree of difficulty of believing the science items on the basis of trust remains fairly constant as the level of difficulty of recalling science items increases; and,
10. Rasch analysis indicates that the relationship between the level of recall and the basis of belief of religious education items is more complex than the relationship between recall and belief of science items.

CHAPTER SEVEN

ADDITIONAL RASCH MEASUREMENT ANALYSES

Introduction

The initial analysis with the RUMM program using all 480 items provides two clear results. One, the Student Separation Index (akin to a Cronbach Alpha) is excellent and two, the absence of a 'top quality'. The absence of a 'top quality' raises two issues. One, that the student responses to the items are not consistent, in that 'good' students, with high scores, who are able to answer the hard questions can not consistently answer the easy questions, and that 'poor' students, with low scores, are able to answer some of the hard questions positively. Two, as a result, the validity of the Rasch-created scale is compromised, even though the Student Separation Index (reliability) is excellent. The absence of a 'top quality' scale prompted a series of further analyses in an attempt to overcome the problem and to understand more fully why the students are responding to the items as they are. A number of separate Rasch analyses were done without any success in being able to construct a proper interval-level scale to the standard required by Rasch measurement experts. The separate analyses included the 185 science items alone, the 295 religious education items alone, several subcategories that are evident within the science and religious education items (biological and physical science stem-items and each of the four categories within the religious education stem items), selected items that indicate good individual item chi-squared probability in a combination of stem-items and/or a selection of items (such as 'evidence' and 'trust') and, finally, the elimination of individual student responses that indicate extreme response patterns. Despite extensive efforts to reconfigure the stem-items and items themselves, and eliminate extreme answers in each of the analyses, the various test-of-fit statistics indicate that a 'top quality' scale was not possible in any of the cases.

As a result of these investigations, 22 analyses were carried out. The previous chapter discussed the results of the analysis that included all 1418 responses to the 480 items.

Reporting on the additional 21 analyses would not add significantly to our understanding of this thesis and, as the results of each additional analysis produce similar data, the

repetition associated with such a report would serve little purpose. A description of a selection of these additional analyses though, may be instructive for the reader and may also provide direction for further research in this field.

Table 7.1. Summary test-of-fit statistics for the science items. (Response categories = 5, No. of items = 185, No. of students = 1418)

Summary Test-of-fit Statistics				
	Items		Persons	
	Location	Fit Residual	Location	Fit Residual
Mean	0.000	-0.245	-0.950	-1.029
SD	1.115	5.044	0.874	3.231
Complete data DF =	0.993		Complete data DF =	3968.000
Item-trait Interaction			Reliability Indices	
Total Item Chi-Square	22674.9		Separation Index	0.950
Total Deg. of Freedom	1665.000			
Total Chi-Square Prob.	0.000			
Likelihood-ratio Test			Power of Test-of-fit	
			Power is excellent (Based on Sep. Index of 0.950)	

Notes to Table 7.1

1. The item-student interaction indicates the degree to which students answer items of different difficulty in a logical and consistent manner. When the data fit the measurement model, the fit statistic has a mean near zero and a SD near 1. A negative fit statistic indicates that the data fit the model very closely. A positive fit statistic indicates that some 'noise' is present. The item-fit statistic relates directly to the consistency of the individual student and item response patterns and, hence, to whether there is conformity to the measurement model. In this case it is low.
2. The item-trait interaction indicates the consistency of the item difficulties across the range of different student measures on the scale. When the measure is unidimensional, the item-trait interaction (a chi-square) has a probability greater than 0.01. In this case the total item chi-square probability is <0.01, indicating that, while a dominant trait may be present, the measure is not unidimensional and there is low consistency of the item difficulties across the different student measures.

Science items

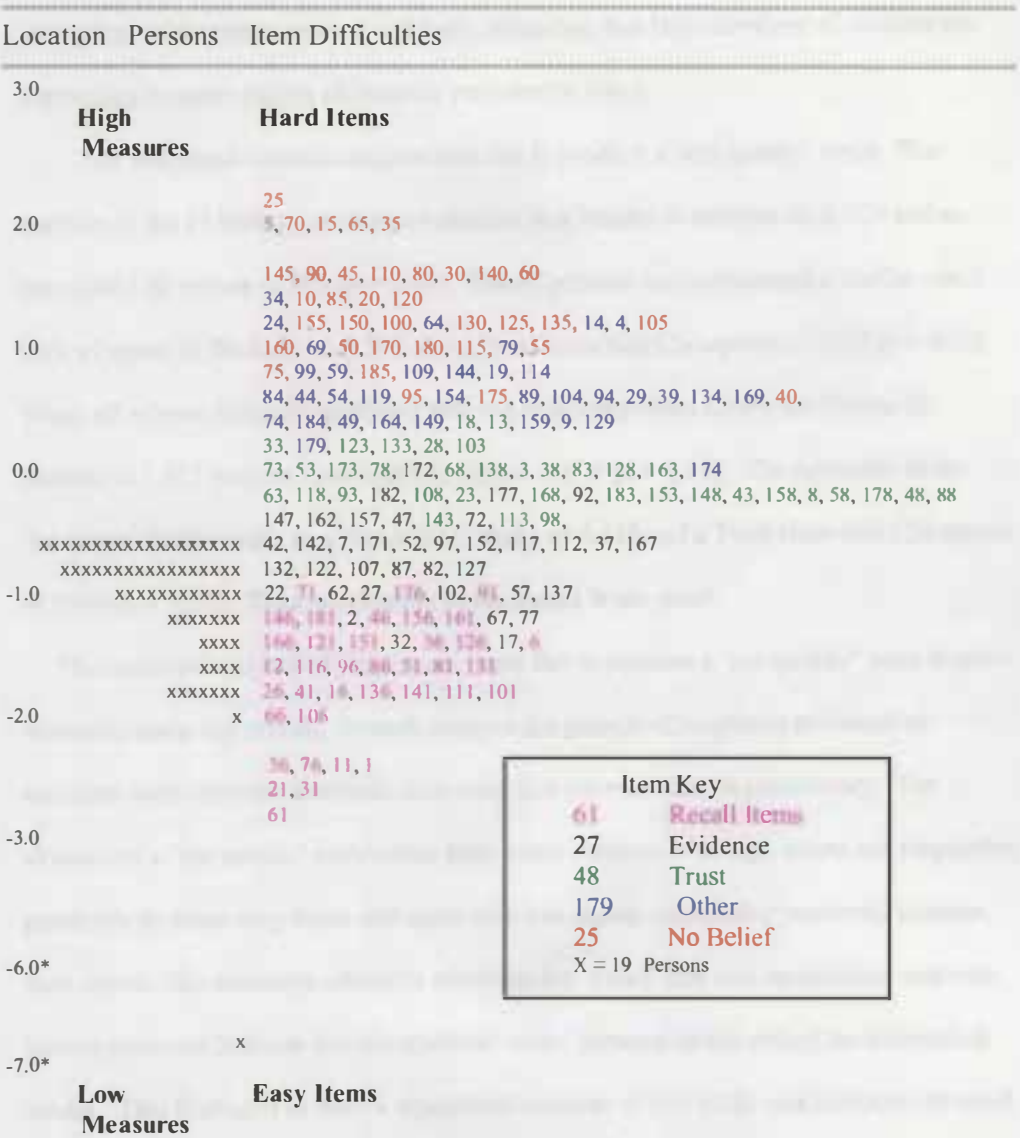
The analysis of the complete set of items failed to produce a 'top quality' scale. It was therefore decided to analyse the science items separately from the religious education

items to ascertain whether the absence of a 'top quality' scale is the result of 'noise' present in the religious education data that is related to potential variation in student belief patterns. The results of this analysis are presented in Table 7.1 and Figure 7.1. The 185 science items are also broken into separate categories grouping items related to biology and the physical sciences as well as analyses of all science stem items with recall items alone and with recall and 'evidence' alone. The results of these additional analyses prove little different to the analysis of the complete science data, so for brevity and space reasons only one analysis is reported in this section.

Figure 7.1 locates all 185 student measures of science recall and belief and the item difficulties on the same scale. Each 'x' represents 19 students. The item difficulties and the student measures are calibrated on the one scale. The scale is measured in logits which are the log odds of students responding positively to each item. The majority of student measures range from -2.0 to -0.6, although a single cluster of respondents is located at -6.8 logits. (This 'outlier' appears to represent an anomaly for this set of data.) The item difficulties range from -2.8 to +2.2. The ranges of the item and person difficulties indicate that the targeting of the items is not as good as it could be, the items are on the hard side. The student measures also indicate a high level of 'clumping' indicating that students are responding to the items in a similar manner. The easy items are at the bottom right of the scale and the hard items are at the top right of the scale.

The Summary Test-of-Fit Statistics for the 185 science items are given in Table 7.1. The item fit statistic has a mean of -0.2 and a standard deviation of 5.0. The person fit statistic has a mean of -1.0 and a SD of 3.0. These statistics are not close enough to 0 and 1 to provide a strong fit to the measurement model. The item-trait interaction probability is 0.00 and indicates that, while a dominant trait may be present, the measure is not unidimensional and there is low consistency of agreement amongst the students as to which items are easy and which are hard. Students with low scores seem to have 'reasons' why they can believe the hard items and yet do not believe the easy items, and students with high scores have reasons why they respond negatively to the easy items. The formation of a Reference Group to discuss the students' thought processes and

reasoning sheds some light on this result, but this pattern of responses may require further investigation in subsequent research.



* Note change of scale to locate all persons data.

Figure 7.1. Recall and Belief Scale of 185 Science Items with Student Measures and Item Thresholds Calibrated on the Same Scale. (N = 1418 persons)

The colour coding used in Figure 7.1 clearly illustrates the high level of item separation evident in the data (Table 7.1). The separation of the recall and three ‘belief’ items into quite distinct groups (although some merging is expected and present) supports the conceptual ordering of the model. The recall items are ‘easier’ than the ‘evidence’ items, the ‘evidence’ items tended to be easier than the ‘trust’ items, which are in-turn

'easier' than the 'other' belief items. Only 9 'evidence' items (47, 72, 92, 147, 157, 162, 172, 177 and 182) are too 'difficult' for any of the students to respond positively to. The consistency of the student response to the items is also evident in Figure 7.1 by the 'clumping' of measures around -1.0 logit, indicating that large numbers of students are responding to some groups of items in very similar ways.

The additional science analyses also fail to produce a 'top quality' scale. The analysis of the 28 biology stem items resulted in a Person fit statistic of -0.618 and an Item-trait Chi-square of 803 ($p = 0.00$). The 46 physics items produced a similar result with a Person fit Statistic of -0.592 and a Total Item-trait Chi-square of 1675 ($p = 0.00$). When all science items are included with the recall responses alone, the Person fit Statistic is 1.013 and the Item-trait Chi-square is 904 ($p = 0.00$). The inclusion of the 'evidence' items results in a Person fit Statistic of 0.413 and a Total Item-trait Chi-square of 3644 ($p = 0.00$). Thus, conformity to the model is not good.

The series of analyses of the science items fail to produce a 'top quality' scale despite extensive trials and retriels. In each analysis the pattern of responses produces an excellent item separation statistic indicating that the reliability is satisfactory. The absence of a 'top quality' scale arises from some students with high scores not responding positively to some easy items and some with low scores responding positively to some hard items. The extensive efforts to eliminate the 'noise' that this inconsistent response pattern produces indicate that the students' belief patterns do not reflect the conceptual model. This finding is in itself a significant outcome of this study and indicates the need for additional research into the students' metacognition and how we teach students to believe (on the basis of evidence).

Religious education items

As is described in Chapter 1, the 59 religious education stem items represent four groups of items; one 'Discovering Human Potential'; two, 'Accepting Human Weakness'; three, 'Potential Offered by Christian Salvation' and four, 'How Catholics Accept this Potential'. The conceptual model predicts that the first two groups of items represent

types of knowledge that are 'easier' to provide evidence that they are true and thus 'easier' for students to believe and learn. For example, Item 6 – "Just love leads to peace" can be demonstrated to students by using their own personal experiences of being treated fairly, or through many examples in society, where justice does lead to peace. The latter two groups represent types of knowledge that are less easily demonstrated to the students because they tend to represent concepts that require personal experiences for the concept to be accepted as true. For example, Item 38 – "God offers salvation through the sacraments of service" is extremely difficult to explain to students unless the student has genuine experiences of God's personal involvement in their lives. Verbin (2000) (Chapter 2), describes the difficulty of bringing students to believe concepts with the example of teaching a child what a duck is, as opposed to teaching the concept 'friendly'. By merely pointing to a duck a child can learn what a duck is. The 'duck' is a concrete image. The same cannot be done with the concept friendly.

Table 7.2. Summary test-of-fit statistics for the religious education section 'Accepting Human Weakness'. (Response categories = 3, No. of items = 70, No. of students = 1418)

ITEM-PERSON INTERACTION				
	ITEMS		PERSONS	
	Location	Fit Residual	Location	Fit Residual
Mean	0.000	-0.432	-0.950	-0.099
SD	0.512	5.955	0.472	1.101
Complete data DF = 0.984 Complete data DF = 2221.000				
ITEM-TRAIT INTERACTION		RELIABILITY INDICES		
Total Item Chi-square	7342.228	Separation Index	0.618	
Total Deg of Freedom	630.000			
Total Chi-Square Prob.	0.000			
LIKELIHOOD-RATIO TEST		POWER OF TEST-OF-FIT		
Chi-Square		Power is REASONABLE		
Degrees of Freedom		[Based on Sep. Index of 0.618]		

While the overall patterns evident in the data support the conceptualised learning model, it is surmised that the absence of a 'top quality' scale (students with low scores are at times responding positively to the hard items and those with high scores did not respond positively to the easy items) is the result of inherent variations in what individual students believe to be true.

It was therefore determined to analyse the religious education items by separate groups. It would not be instructive to describe the results of each analysis as the patterns evident from the series of analyses prove to be similar. Two groups of analyses will be reported in this section to illustrate the results of these additional series of analyses and to provide additional data to direct future research in this area.

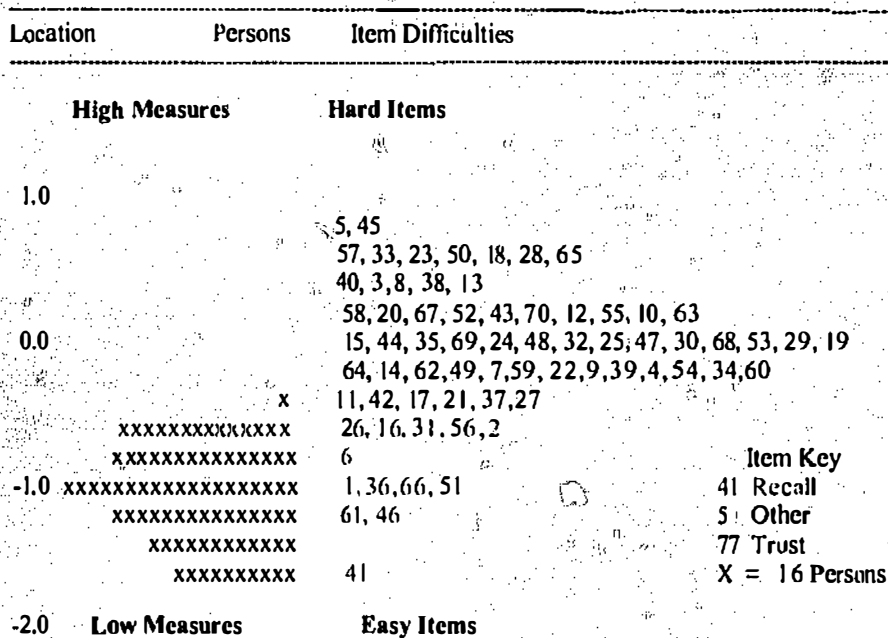


Figure 7.2. Recall and Belief Scale of 70 Religious Education Items (Accepting Human Weakness) Items with Student Measures and Item Thresholds Calibrated on the Same Scale. (N = 1418 persons)

'Accepting human weakness' items

The stem items from the 'Accepting Human Weakness' section of the religious education course were analysed firstly without the science items incorporating all 5 categories, then with 3 categories (Table 7.2, Figure 7.2), with 2 categories incorporating only those items with low chi-square results and then by combining the religious

education items with the science items (Table 7.3 and Figure 7.3). In each instance a 'top quality' scale could not be achieved. In each analysis the item fit statistics indicate that the conceptual order of the items is accurate, but the person statistics continue to indicate that students are not responding to the items in an ordered manner.

Table 7.3. Summary test-of-fit statistics for the religious education section 'Accepting Human Weakness' (14) and the science items (37). (Response categories = 3, No. of items = 153, No. of students = 1418)

ITEM-PERSON INTERACTION				
	ITEMS		PERSONS	
	Location	Fit Residual	Location	Fit Residual
Mean	0.000	-0.032	0.973	-0.298
SD	0.608	0.694	0.350	2.159
Complete data DF = 0.992 Complete data DF = 0902.000				
ITEM-TRAIT INTERACTION			RELIABILITY INDICES	
Total Item Chi-Square	2869.376		Separation Index 0.629	
Total Deg of Freedom	1377.000			
Total Chi-Square Prob.	1.000			
LIKELIHOOD-RATIO TEST			POWER OF TEST-OF-FIT	
Chi-Square	Power is REASONABLE			
Degrees of Freedom	[Based on Sep. Index of 0.629]			

Table 7.2 summarises the item-person interaction for the 70 items taken from the 'Accepting Human Weakness' section of the religious education course. The Persons Location statistic is -0.95 and the total item chi-square is 7342 indicating the absence of a 'top quality' scale. A second analysis was carried out with this data with the 42 items with high chi-square values removed. The result of this analysis is a decrease in the total item chi-square to 458.5, as would be expected having removed the items with high chi-square values, but at the same time there is an increase in the 'person location statistic' to -1.363. A 'top quality' scale is therefore still not achieved. The inclusion of the science

items (Table 7.3) did not resolve the absence of a 'top quality' scale as the 'person location statistic' remained at .97 and the total chi-square is 2869.

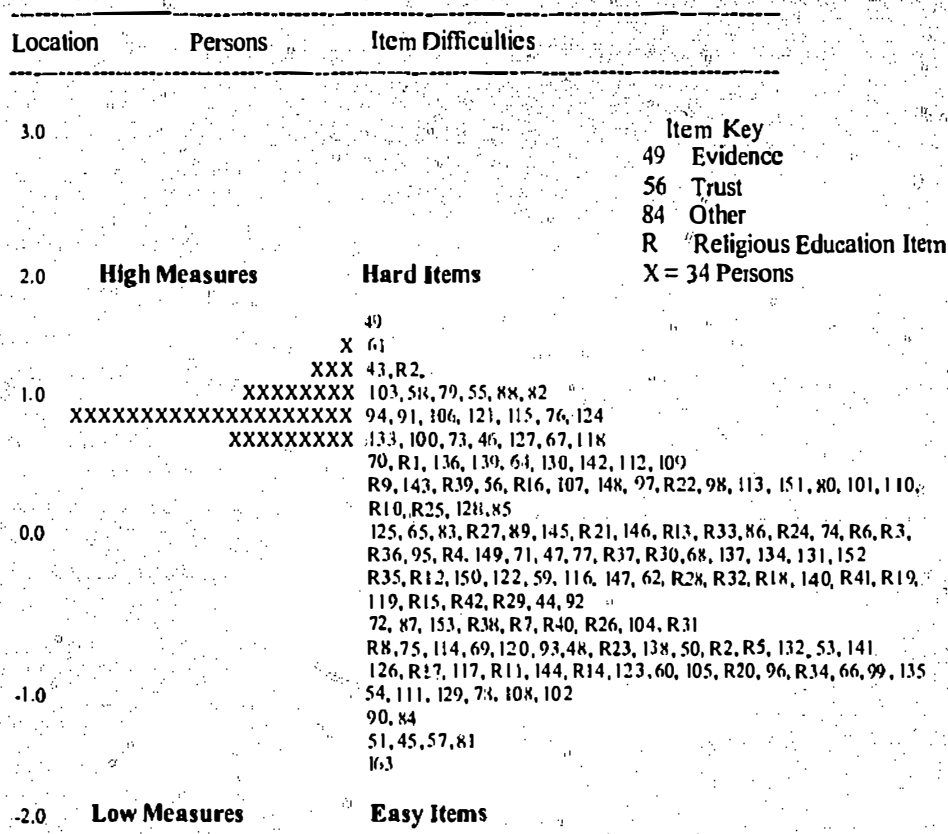


Figure 7.3. Recall and Belief Scale of 153 Science and Religious Education Items (Accepting Human Weakness) Items with Student Measures and Item Thresholds Calibrated on the Same Scale. (N = 1418 persons)

The pattern of responses to these sets of items is evident in Figures 7.2 and 7.3. In each instance the high degree of item separation is clear (the colour coding indicates the groups of items) and demonstrates the high level of correspondence between the conceptual model and the actual ordering of the items. The patterns evident also indicate that the students are responding to the items in a similar manner resulting in a high degree of 'clumping'. Generally too there is a poor targeting between the person measures and the item difficulties suggesting that the items are easy. This poor targeting is a result of the students responding in a similar manner to each other for items that are easy to recall

being taught the items and for items that are easy to believe on the basis of evidence.

This aspect is not evident in Figure 7.2, where the item difficulties for the 'other' and 'trust' items are shown to be hard with no students responding positively to the items.

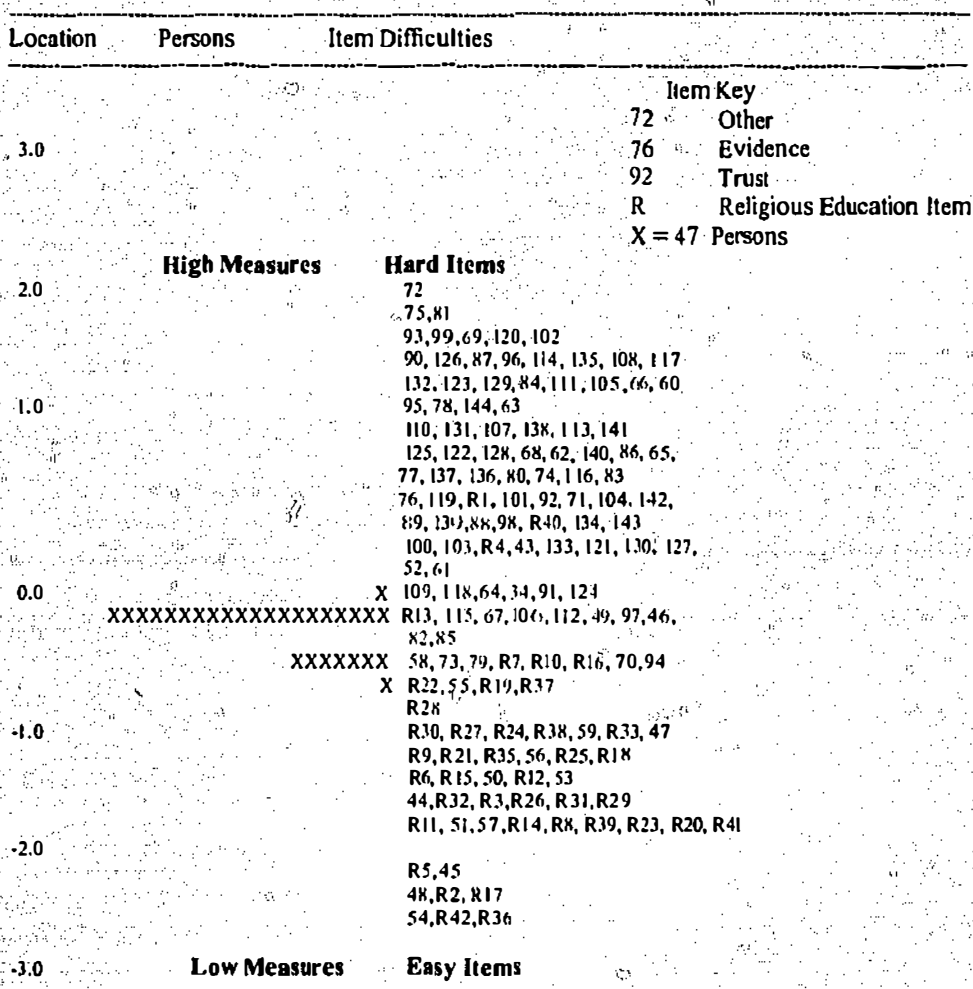


Figure 7.4: Recall and Belief Scale of 144 Science and Religious Education Items (How Catholics Accept Their Potential) Items with Student Measures and Item Thresholds Calibrated on the Same Scale. (N = 1418 persons)

The pattern of responses to the 'Accepting Human Weakness' items are similar to the patterns evident from the analysis of the science items. The conceptual order of items is supported by the data and the variation in student responses to the hard and easy items results in a response pattern that does not generate a 'top quality' scale.

'How Catholics accept their potential' items

Table 7.4 summarises the item-person interaction for the 55 items with the best fit values and all 5 categories, taken from the 'How Catholics Accept Their Potential' section of the religious education course. As with all previous analyses the item separation Index is good and the 'power of test-of-fit' is good. The Person fit Statistic is -0.4 ($SD = 1.8$) and the item fit statistic is -0.9 ($SD = 7.5$). The total item chi-square is 7552 ($p = 0.000$), indicating the absence of a 'top quality' Rasch scale.

Table 7.4. Summary test-of-fit statistics for the religious education section 'How Catholics Accept Their Potential'. (Response categories = 5, No. of items = 55, No. of students = 1418)

ITEM-PERSON INTERACTION				
ITEMS			PERSONS	
Location		Fit Residual	Location	Fit Residual
Mean	0.000	-0.940	-1.000	-0.439
SD	0.844	7.457	0.689	1.770
Completedata DF= 0.980 Completedata DF= 1638.000				
ITEM-TRAIT INTERACTION			RELIABILITY INDICES	
Total Item Chi-Square	7552.395	Separation Index	0.765	
Total Deg of Freedom	495.000			
Total Chi-Square Prob.	0.000			
LIKELIHOOD-RATIO TEST			POWER OF TEST-OF-FIT	
Chi-square		Power is Good		
Degrees of Freedom		[Based on Sep. Index of 0.765]		

A second analysis was carried out with these data with 70 religious education items from the 'How Catholics Accept Their Potential' section combined with the 37 science items with two response categories. The result of this analysis is a total item chi-square to 3748.67 ($p = 0.000$) (Table 7.5). The Person fit statistic is 0.4 ($SD = 2.3$) and the Item fit statistic is -0.06 ($SD = 1.04$). While these indicate a reasonable fit to the measurement model, the Item Separation Index is only 0.34 and is poor. A 'top quality' scale is therefore still not achieved. The pattern of responses to this set of items is evident in

Figure 7.4. The low degree of person separation is clear (the colour coding indicates the groups of items) and demonstrates that there is insufficient variation in student responses to the items.

Table 7.5. Summary test-of-fit statistics for the religious education section 'How Catholics Accept Their Potential' (70) and the science items (74). (Response categories = 2, No. of items = 144, No. of students = 1418)

ITEM-PERSON INTERACTION				
	ITEMS		PERSONS	
	Location	Fit Residual	Location	Fit Residual
Mean	0.000	-0.060	-0.142	-0.391
SD	1.136	1.039	0.269	2.302
Skewness	1.965	0.102		
Kurtosis	4.554	-0.326		
Correlation	-0.022	0.046		
Complete data DF = 0.991 Complete data DF = 9109.000				
ITEM-TRAIT INTERACTION			RELIABILITY INDICES	
Total Item Chi-Square	3748.671		Separation Index	0.337
Total Deg of Freedom	1296.000			
Total Chi-Square Prob.	0.000			
LIKELIHOOD-RATIO TEST		POWER OF TEST-OF-FIT		
Chi-Square		Power is TOO LOW		
Degrees of Freedom		[Based on Sep. Index of 0.337]		

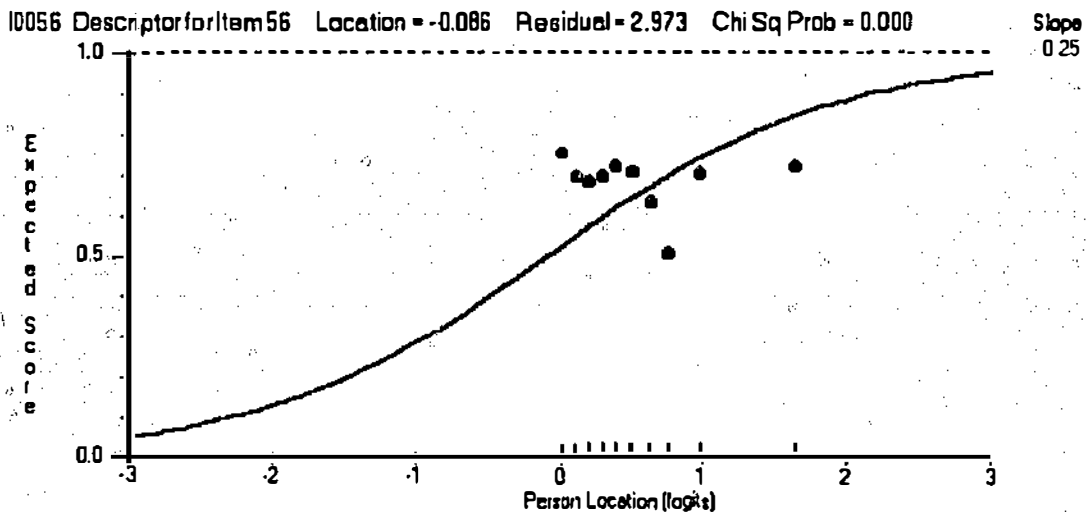


Figure 7.5. Student response patterns to item 56 of the data analysis of 'Accepting Human Weakness' religious education items showing 'person location' and 'line of best fit'.

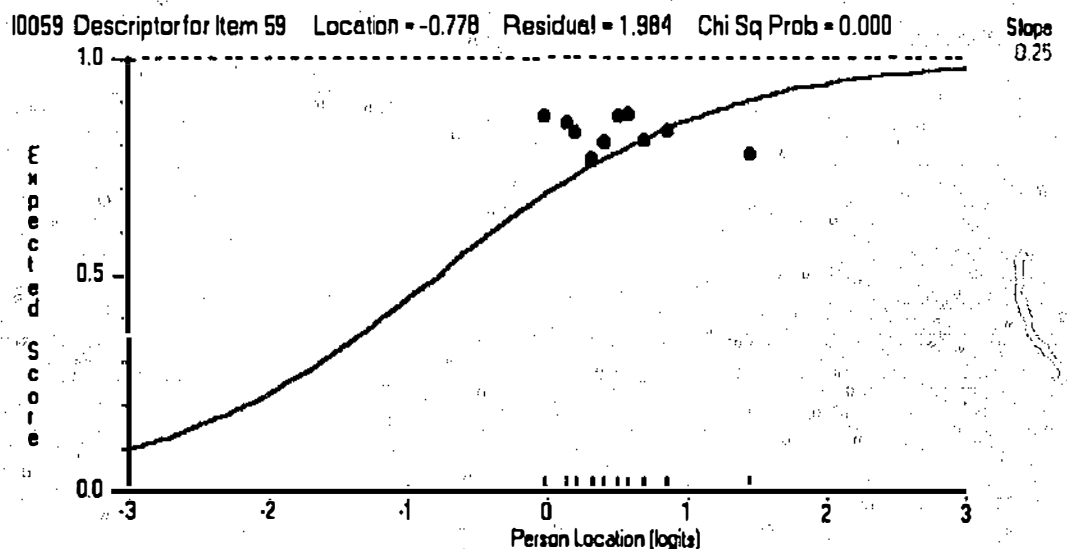


Figure 7.6. Student response patterns to item 59 of the data analysis of 'Discovering Human Potential' religious education items showing 'person location' and 'line of best fit'.

The analysis of the responses to the 'How Catholics Accept their Potential' items did not produce a 'top quality' scale and, in this sense, is similar to the previous analyses.

The results that indicate that the students do perceive that these items represent a different

'type' of knowledge and so respond in a manner that is less ordered than the conceptual model predicted. This outcome is significant and warrants further investigation in subsequent research.

The reason for the absence of a 'top quality' scale in the data is further evidenced in Figures 7.6 and 7.7. These figures show the location of student responses to individual items compared with a 'line of best fit' generated from the Rasch analysis which indicates the conceptual location of student responses had the responses produced a 'top quality' scale. As can be seen in each instance, the location of actual values does not correspond sufficiently closely to the conceptual model.

Summary of findings

The findings of the Rasch analysis can be summarised, for clarity purposes, with the following brief statements:

1. The Rasch analyses indicate that a scale can be created with a good Item Separation Index,
2. The Rasch analyses indicate that a proper linear scale to the standard required by Rasch measurement experts can not be created, suggesting that,
 - a. student responses to the items are not conceptually ordered;
 - b. the validity of the Rasch-created scale data is compromised.
3. Extensive efforts to resolve this issue are not successful, but the patterns evident from the Rasch analysis do assist with an understanding of student beliefs of learning in religious education and science,
4. Generally, the order of difficulty, from easy to hard of the religious education items is; 1. recall, 2. evidence, 3. other and 4. trust,
5. Generally, the order of difficulty, from easy to hard of the science items is; 1. recall, 2. evidence, 3. trust and 4. other,
6. The absence of a 'top quality' scale is not isolated to the religious education items alone, as similar problems occurred with the science items;

7. Irrespective of the nature of the religious education items (sections A, B, C, or D), or the science items, the response of the students does not produce a 'top quality' scale.
8. The Person Location Statistics for individual items, when compared to the 'line of best fit' generated by the RUMM programme indicates a broad range of responses to items, whose fit to the measurement model is not sufficiently good;
9. Further research into the students' metacognition and epistemology of 'belief' of content based on evidence is necessary.

CHAPTER EIGHT

SUPPLEMENTARY RESULTS FROM THE REFERENCE GROUP

Introduction

The structure of the questionnaire reflects the initial conceptual model of the difficulties of the 59 religious education stem items and the 37 science stem items ordered from easy to hard. The ordering of the items provides a logical structure for the questionnaire that enables the student responses to the ordered items to be analysed within the framework of the measurement model. The analysis of the survey results though, provide data that conflicts with the initial conceptual model and the underlying assumptions made regarding the ordering of the items. The results indicate that the students are not responding to the items in a manner that is consistent with the initial conceptual model. A detailed investigation of the pattern of individual students' response patterns is therefore necessary. While an investigation of the pattern of individual student responses would provide an additional level of understanding of the data, an understanding of the thinking behind the student responses would only be possible by talking to individual students about their responses. As the responses to the questionnaire are anonymous, a Reference Group of 19 year 11 students from one of the study schools was convened.

The Reference Group

The problems associated with convening a Reference Group (regular meetings, in depth discussions and the need to have all members present for each meeting) precludes purely randomly selected students. As has been described above, the Reference group was formed from a larger group of randomly selected students from one of the 'test' colleges. The students were given the opportunity to withdraw from the Reference Group before the discussions began, leaving the 19 willing students to form the Reference Group. The author recognises that 19 students may not necessarily be a representative group of the 1418 students who participated in the initial questionnaire and that the 19

students involved in the Reference Group do not represent a purely random sample. To ensure that the 19 students involved in the Reference Group do not represent an anomalous grouping that in some way hold extreme views divergent from the study population a detailed analysis of the students' faith profile was completed. The purpose of the reference group was to delve more deeply into the thinking behind the student responses to the items to add information to the patterns evident from the data analysis rather than provide a representative sample of comments and responses.

Qualitative data analysis

The methodology utilised for the Reference Group was an open discussion format based on items that the Rasch analysis indicated are easy and hard to believe. Taking each item in turn, the students were asked to consider, firstly, whether they felt the item is easy or hard to believe and then, secondly, why they thought it easy or hard to believe. After a period of time to consider their responses the students were asked whether they had sufficient time to consider their response and then were asked to share their responses. The Reference Group met three times and their responses were recorded for subsequent transcription and analysis. The author's involvement in the Reference Group was strictly limited to keeping the discussions on track and, at times, prompting students to clarify their reasoning.

The student responses were analysed utilizing the process outlined by Huberman and Miles (2002). Three levels of responses were analysed. One, each question was analysed for its content to determine central themes that may be present in the responses so that categories of responses could be identified; Two, the responses were also categorised according to the students' stated 'faith profile' and three, on the basis of whether the items were easy or hard to believe. Through this process, three categories of responses were created.

Once all responses were categorized and the central themes noted, the responses were read and re-read to ensure that the identified themes were true to the student responses. This process of comparing responses between the three categories and within each of the

categories involved looking for similarities and differences between the responses. In this manner, the categories of responses were refined to the point that the data could be easily reported and the central patterns of responses described.

Faith profile of the Reference Group

To gain an insight into the Reference Group students' religious background, the students were asked two initial questions. The first question was - "How strong would you say is your belief in God?" The students were asked to indicate the 'strength' of their belief on a five-point scale where 1 represented "not at all", 2 represented "not sure", 3 represented "somewhat strong", 4 represented "quite strong" and 5 represented "very strong". The question "How strong would you say is your belief in God?" was deemed important to ascertain because it was felt that the strength of a student's belief in God may have an effect on that student's responses to the questions in the main survey. A student with a very strong belief in God, for example, may indicate that it is quite easy to believe in the religious education items. The student with a very strong belief in God may perceive explanations given by the religious education teacher as clear evidence that the item is true. A student who has no belief in God at all, on the other hand, may not perceive the teacher's explanations as evidence at all. This question was also asked to ensure that the students in the Reference Group have a wide religious background and thus could be accepted as representative of the study population. The propensity of students to accept evidence as proof that something is indeed true is apparent in many aspects of teaching, and is not limited to the content of religious education. For example, a student in a health class who has a strong belief that smoking is dangerous to your health may easily accept the 'evidence' presented by the teacher. A student with the opposite belief would find the same evidence less convincing.

In response to the question - "How strong would you say is your belief in God?" one of the students indicated that he/she did not believe in a God at all, six indicated that they are not sure that a God exists, five indicate that their belief in God is 'somewhat strong', six indicated that their belief in God is 'quite strong' and two indicated that their belief is

'very strong'. The pattern of responses to this question indicates that the students in the Reference Group represent a broad spectrum of faith commitment, and in so doing, may be representative of the 1418 students in the main survey.

The second question the students were asked was -- "If you believe that God exists, how strongly would you say this belief affects the way you live your life. This question was deemed to be important because it was felt that belief and action might not necessarily be strongly correlated. Students who say that they have a strong belief that God exists may not feel that this belief affects their lives. Students may thus act in a manner that does not reflect their beliefs. Such students may respond quite differently to the questionnaire items than the students who do believe in God and do believe that their belief in God affects the way they live their lives.

In response to this question, one student indicated that his/her belief in God does not affect the way he/she lived his/her life. This student indicated that he/she is 'not sure' whether he/she believes in God. Five students indicated that they are 'not sure' whether their belief in God affects the way they live their lives. Of these five students, three indicated that they are 'not sure' whether they believe in God, and hence, their response to the question regarding the effect of a belief in God on their life choices closely reflects the strength of their belief in God. Two of the five students indicated that they see their belief in God as 'somewhat strong'. Nine students indicated that their belief in God affected the way they lived their lives 'somewhat'. Two students indicated that their belief in God as 'somewhat strong' and another two as 'not sure'. Four students indicated that their belief in God is 'quite strong' indicating that their belief in God is 'stronger' than the impact of this belief on their lives and one student indicated that his/her belief in God is 'very strong'. Four students indicated that they believe that the affect of their belief in God on their lives is "quite strong". Three of these students have a 'quite strong' belief in God and one indicated that their belief in God is "very strong".

Seven students indicated that their belief in God is 'stronger' than the affect of this belief on their lives. Two indicated that the affect of their belief in God on their lives is

'stronger' than their belief in God and ten students feel that the strength of their belief in God is about the same as the strength of the affect of this belief on their lives.

The pattern of responses to this second question indicated that the students in the Reference Group represent a broad spectrum of faith commitment, and may therefore be considered as being a representative group of the 1418 students in the original survey.

Student responses

Reasons from the Reference Group

The use of a selected sample of specific items from the questionnaire provides the basis for discussions with the students from the Reference Group to gain an insight into the students' reasoning for their responses to the items. The results of these discussions enabled a considered response to the differences between the conceptual ordering of the items and the observed ordering of the items. A more generalised outline of the discussions that arose in the Reference Group will then follow providing additional support for the conclusions evident from the specific example described. To distinguish the responses of the Reference Group students from the student responses to the open-ended questions, the Reference Group students will be tagged with the code 'RG' followed by an identifying number, eg RG # 1 and so on.

Item 13 (Moral conscience does not determine what is right and what is wrong) is shown to be one of the easy items by the Rasch analysis. There is general agreement, within the Reference Group, that one reason students say the item is hard to believe is because students believe that an individual can decide what is right and what is wrong and that it is not moral conscience that determines what is right. One student in the Reference Group, while stating that "My moral conscience determines for me what is right or wrong", recognised that this belief could result in divergent views, as to morality, with the statement, "Sometimes what I believe is right or wrong conflicts with the beliefs of others" (RG Student # 1). Another student (RG Student # 2) explained that stem item 13 is hard to believe because "you can justify it in your head, you feel that it is right",

supporting the opinion of student RG#1, suggesting that some young people do believe that their conscience is the determining factor in deciding what is right or wrong.

The proportion of students in the Reference Group who feel that item 13 is indeed hard to believe is very similar to the 62% of the students who indicated in the questionnaire that they do not believe that stem item 13 is true. The Reference Group students who find stem item 13 difficult to believe represent a full spectrum of religious commitment, including several students who feel that they have a very strong belief in God, and that their belief has a strong influence in their lives, several whose belief in God is strong, some who are not sure whether God exists, and two who indicated that they did not believe in a God at all.

An equal number of students in the Reference Group feel that stem item 13 is easy to believe. These students explain that one's conscience can't possibly determine what is right or wrong because "we learn from others as we grow", in particular our parents, who "teach us what is good and bad" (RG Student # 3), that "people may not have a correct sense of morality" (RG Student # 4), and several, who point out that "people have different opinions about what is right and wrong", and that some people's consciences are not correctly formed. The Reference Group students who find item 13 easy to believe also have a broad range of religious commitment, including those who have a very strong belief in God, those with a strong belief in God, and those who are not sure (no students in this group said they did not believe that God exists).

The Reference Group discussion clearly indicates that students can have very divergent reasons for believing a particular item. Students hold strong reasons why they believe that the item is true or not and are able to verbalise their reasoning. Although Item 13 is classified as an easy item in the Rasch analysis, those who feel that it is actually a hard item to believe have sound reasons for this belief. If the responses evident in the Reference Group are representative of how the study population responded to the items, the absence of a 'top quality' scale can be understood in the context of student metacognition. Those who think that Item 13 is easy to believe have sound reasons for this belief, as do those who feel that it is hard to believe. An objective observer may

argue the merits of the students' logic and challenge its basis. Nevertheless, the students' perception that their reasoning is valid cannot be ignored.

Item 27 – "God seeks to protect people against behaviours that prevent them from following their vocations" is one of the 'hardest' religious education items to believe, with 27% of the 1418 students surveyed indicating that they believe that the item is true. Five (26.3%) of the students in the Reference Group said that they find this item easy to believe.

Of the group of five students who indicated that they are 'not sure' whether a God exists or not, indicated that they find the item hard to believe. Student RG#3 explains the reason for saying the item is difficult to believe because "I don't believe he (God) does (seeks to protect people against behaviours that prevent them from following their vocations) because he leaves people alone to do their own stuff". Student RG#5's reason for saying that the item is difficult to believe is "well I haven't actually experienced any of God's work". Student RG #4's reason for saying that the item is hard to believe is "I don't believe that God exists. I have to see him to believe he is true". In the three cases, the students said the item is difficult to believe essentially because of 'lack of evidence to the contrary, in that, student RG#3 believe God leaves people alone and so does not help, student RG#5 has not experienced any evidence to suggest that God actually does help people, and student RG#4 has no evidence that God exists in the first place.

Of the five students who felt that their belief that a God exists is "somewhat strong", three indicated that item 27 is easy to believe. One of the students (RG Student # 9) could not give a reason but merely said "I just feel that it is true". The other two students' reasons for believing that item 27 is easy to believe seemed to be based on a belief that God does exist and their perception that "God wants us to be happy. He helps us follow our vocation, not prevents us from finding it" (RG Student #11). Of the two who said that item 27 is hard to believe, one student's reason is similar to those described above – "I don't experience God on a personal level" (RG Student #10) and hence find it difficult to believe that God "seeks to protect people". The second student who said that believing that item 27 is hard based her answer on the fact that, as "we all make our own

judgments and some people never fulfill their vocations" (RG Student #8). God can't be seeking to help people otherwise people would fulfill their vocations. Of the eight students who felt that their belief that a God exists is "quite strong" or "very strong", two said that item 27 is easy to believe. Both students (RG Student #17 and RG Student #18) based the reasons for their belief on the fact that "throughout the bible God places messages in stories that show how God wants people to work and strive for their potential". One of the students who felt that his belief that a God exists is "quite strong" explained why he felt that item 27 is hard to believe through a series of questions – "why do you see people living on the street and people dying of disease and lack of food, people that die from overdoses etc. What about the people that rape or kill? What about their vocations? Why doesn't God help them?" (Student RG#14). Another student who also feels that her belief that a God exists is "quite strong" explains why she found item 27 difficult to believe. She said "I find this hard to believe because how could God do this when there are so many people in the world and how often do people know what God is intending for them and sometimes don't fulfill their vocation. Also, how could God communicate or show that he's protecting people against behaviours that prevent them from their vocations and if he does give a sign, how will they know?" (Student RG#12).

While item 27 is one of the 'hardest' religious education items to believe, the students in the Reference Group who do say that it is easy to believe have 'reasons' why they feel that the item is true and easy to believe. Similarly, the 73.7% of the students in the Reference Group also have their own 'reasons' why item 27 is hard to believe. In each case, the reasons the students give for their belief that the item is easy or hard to believe is predominantly (only one student's reason is "I just feel that it is true") based on the 'evidence' their life experiences have given them. To two students in the Reference Group, bible stories are sufficient evidence, while others could not accept this as evidence. Some students point to the bad things that evil people do as evidence that God does not seek to protect people against behaviours that prevent them from following their vocations. Others point out that despite the presence of evil in the world, God "wants us to be happy and so seeks to help us always." (RG Student #7). Again, while some

students said that they have seen no evidence of God seeking to help people, those who find item 27 easy to believe could not understand how these students have not seen the evidence of God helping people to follow their vocations. While all the students who said that they find item 27 easy to believe also indicate that their belief in God is "somewhat strong", "quite strong" or "very strong", a strong level of belief in God does not automatically result in students finding the items easy to believe. Finding item 27 easy to believe seem to be based mostly on the students' acceptance of life experiences as evidence that item 27 is true.

The findings from the Reference Group discussions provide valuable insights into the thinking behind the students' survey responses, particularly where those responses do not reflect the conceptual ordering of the items.

Student RG#18 indicates that he feels that his belief in God is "quite strong" and that his belief in God does affect the way he lives his life. On the basis of his 'strong' religious commitment and on the basis that he said that item 27 (one of the hardest items to believe) is easy to believe, it may have been assumed that he would also find it easy to believe the other hard items are 'easier' still to believe than the items that are deemed to be easy to believe. This is not the case. The student was not able to say that he is able to believe any of the other hard items (items 29, 7, 36, 13, 17, 45, 15, 16, and 8) discussed by the Reference Group. The reason he gave is "we can't see God helping us". This statement seems to indicate a lack of consistency in his responses because he is very clear that the reason he finds item 27 easy to believe is because "the bible says that this is true" (student RG#18). In addition to this apparent 'anomaly', student RG#18 said that he finds two of the easy items (Item 51 – "the seventh commandment means respecting the property of others" and Item 53 – "the fifth commandment forbids the deliberate killing of human life") difficult to believe because he "did not understand what the item actually meant." After further discussion within the reference group, the other students were able to provide a clear enough explanation as to the meaning of the two items in question. This discussion then enabled student RG#18 to revise his initial statement, but his first response indicates a possible source of the inconsistency evident in the survey responses.

This type of response is quite common in the discussions of the Reference Group. A typical example of this thought process at work is student RG#15 who believes that item 40 – “God demands respect for human life through the fifth commandment (don't kill)- is hard to believe because “God may demand, but no one listens” (RG Student #15). Student RG#15 happily changed her mind after the other students explained that ‘it didn’t matter that no-one listens!’

The pattern of responses of the Reference Group to the items under discussion indicates no clear relationship with the students' personal statements of their faith commitment. Students, who said they have a strong faith, and that their belief in God influences their lives, are no more likely to indicate belief in the religious education items than the other students. The absence of an apparent relationship between religious belief and belief that items from the religious education course are true, indicates that the students do not merely accept the veracity of the content of the religious education course on the basis of ‘faith’ or because they are active Catholics. Student responses indicate that their acceptance of items from the religious education course is based on reasoning founded on personal experiences and evidence.

RG Student #18 demonstrates similar inconsistencies in the pattern of his responses for the science items. He is able to say he believes that some of the hard science items are true, but at the same time is not able to say he believes some of the easy science items. For example, one of the ‘hardest’ science items to believe is item 37 – “the speed of light is about 300 million meters per second”, with 11.4% of the students saying they did not believe that this item is true. RG Student #18 said that this item is easy to believe because “when you make a light come out, we can see it go very fast”. Despite the lack of logic in this reason, the student appeared to be quite sincere and believes that his ‘logic’ is valid and that the ‘evidence’ he has experienced in his life is evidence enough to make item 37 easy to believe.

RG Student #17 indicates that all science items, discussed by the Reference Group, are easy to believe. For a number of the science items his ‘reason’ for believing that the item is easy to believe is because “ Mr ... taught me that last year” (student RG#17). For one

item, number 5 – “an atom is made up of protons, neutrons and electrons”, the student states that “I don't know exactly what an atom is, but last year I learned a scientific theory from my year 10 science teacher that this is true” (student RG#17). This student's comments mirrors the results of the survey responses which indicates that students are prepared to believe that science content is true on the basis of what their teacher says but are not quite so 'trusting' of their religious education teachers.

The 'reasoning' used by students to justify their belief that the science and religious education items are true appears to be very similar in that the reasoning used to justify belief is often objectively not logical or indeed valid – “I believe that the speed of light is.... because of how quickly a light turns on” is typical of the reasoning used. The Reference Group discussion therefore reveals a level of metacognition that can account for the absence of a 'top quality' scale in the Rasch analysis. It would seem that belief that items are true – both the religious education and science items – can be a very personal variable that relates to the individuals' experiences of the world around them. Individual students may therefore not respond to the questionnaire items in a manner predicted by the conceptual model or the overall patterning evident in the Rasch analysis. Students who have high scores may have (to themselves) sound reasons why they cannot believe the easy items and those with low scores may have sound reasons why they can believe hard items.

Summary of findings

The discussions with the students from the Reference Group allows an insight into the thinking behind the results of the data analysis, and thus enabled a clearer explanation for the absence of a 'top quality' scale, and provided additional data to respond to the research questions established for this thesis. A brief statement of each of the findings provides a useful summary for the reader.

1. Students' beliefs in the content of the religious education course are often reliant on evidence, such as life experiences and so on;

2. Some students are prepared to say that they believe that a religious education item is true, based on statements such as "I just feel that it is true", indicating belief on the basis of faith;
3. Students strongly declared that many of the science items are true on the basis of evidence;
4. The 'evidence' the students referred to as 'proof' that a particular religious education or science item is true, is at times more closely akin to a 'half-truth' than genuine evidence itself, and yet, the student is genuine, and is firm in his/her belief that the evidence proffered indicates the veracity of the item;
5. In the case of the science items, the belief that the items are true is based on faith in their teacher, while the faith that the religious education items are true, tends to be more based on an 'inner feeling' that the item is true. The reliance on faith is strong in both instances, but the source of that faith is quite different. The students commented on this difference, often referring to their perception that the religious education teacher did not accept the veracity of the religious education content, but taught the subject because they are paid to do so. The science teacher, on the other hand is somehow different, and only taught what is true;
6. Students rely on a broad range of 'reasoning' when justifying their belief in 'knowable content'. The reasons appear valid to the student, but after discussions with, and clarifications from, other students, the strength of a student's conviction often wavered;
7. Some students 'saw' evidence through 'eyes of faith', while other students could not 'see' the 'evidence' proffered in the same light;
8. The students' perceptions of the validity of the items, indicates that they treat the religious education items quite differently to the science items, 'seeing' the latter as representing objective concrete knowledge, while the

validity of the former is perceived as relying on a personal faith stance;
and,

9. The students firmly believe that their responses to the items are reasoned and logical. The reason for the absence of an ordered response to the items appears to be the result of a 'faith' dimension. For example, students, who said that they do not believe in God, find it very difficult to indicate that they believe any of the easy items that refer to God.

CHAPTER NINE

RESEARCH QUESTIONS, DISCUSSION, SUMMARY OF FINDINGS AND IMPLICATIONS

The results of this study, as set out in chapters five to eight, indicate that a clear response to each research question can be made. In this chapter some discussion about student beliefs is presented and then the research questions are answered and discussed. This is followed by a discussion of the implications of the findings of this study, as they relate to classroom teachers and educational theorists.

Problems with student belief

The students' responses to the open ended questions in the questionnaire and during the discussions with the Reference Group indicate that student belief patterns may not reflect a logical or ordered pattern. The pattern of responses which supports the research (Pajares, 1992, Hogan, 2000) indicates that some students may not be able to discern the difference between knowledge and belief. A second observation reflects the work of Hofer and Pintrich (1997) and indicates that some students' beliefs regarding the nature of knowledge can affect their learning behaviour.

One problem relates to some students' comprehension of the nature of knowledge. Some students indicate that they believe that scientific knowledge is concrete, and as such, is factual which supports the research (Talbot, 2000). These students may not understand the difference between scientific fact, hypothesis or proposition and nor may they fully understand the part belief plays in scientific endeavour and as a result of this understanding respond to the questionnaire items on this basis. As a result of these epistemological beliefs the response of students to science content may be that they believe that most science items are factual, and that they believe that the items are true because they believe that they have evidence that the items are true. The students may not have actually been provided with evidence (ie. it is probably not possible to demonstrate the speed of light in the classroom and yet almost 30% of the students indicated that their teachers did show them the evidence to prove that this item is true).

In this manner knowledge may be seen as a subjective construct that is more closely aligned to what one would nonnally presume is belief.

The close link between belief, epistemology, knowledge and learning, that appears in the students' responses, relates to the interconnection between belief that content is true on the basis of having evidence, belief based on trusting a significant other (teacher, text, parent) or believing that something is true 'just because it is'. Some students appear to be more open to accepting that something is true because they "can see it" (ie. one student conunented that they 'know' that the speed of light is 3×10^8 m/s because they can see light travelling quickly when you flick on the switch!). Other students appear to realise that some things cannot be proven in a classroom, but are prepared to believe that the item is true because they trust their teacher to teach the truth, while others just accept it as true purely on the basis of 'faith'. In this manner belief that science content is true can sometimes be like belief that religious education items are true.

The Rasch measurement model calibrates the item difficulties, the item perspectives and the person measures on the same scale and enables the differences in perception of belief to be measured.

Research questions and discussion

Research questions 1 and 4: What 'knowable content' from the religious education and science courses do students recollect being taught?

Of the 1418 students surveyed, only 170 could recall being taught the majority of the religious education items while 539 students are able to recall the same level of the science items. The results of the analysis of the data indicate that the ability to recall religious education items is far lower than the ability to recall science items. This result supports the findings of Barry and King (1993), MacDonald (1988), Moore (1991) and Dorman (1995) and Cox (1996) who indicated that students tend to put less effort into learning in the religious education classroom than their other subjects. The results also support the findings of Ozorak (1989), Reich (1997), Puolimatka and Tiiri (2000), Stolltenwerk (1999) and the NCEC (1991) who indicated that students do not value

religious education and as a result do not invest significant time and effort into learning the content of this subject.

Although the results of the analysis suggest that the students perceive that the religious education items are generally harder to recall than the science items, the two sets of items are not discontinuous. The results indicate that 37 religious education items are as easily recalled as 16 of the science items. The model predicts that not only would the 'knowable content' of the religious education items be perceived differently to the 'knowable content' of the science items but that the 'knowable content' of the religious education items would be more similar to the science items than the 'less knowable' religious education items. The results of the analysis have support this.

Research questions 2 and 5: What 'knowable content' from the religious education and science courses do students believe on the basis of evidence?

The level of belief of the science and religious education items are different. An item such as "Human blood contains white blood cells that help fight disease" (Science Item # 1) is more easily accepted as true than items such as "God offers salvation through the sacraments" (Religious Education Item #47) because the former can be more easily demonstrated in the classroom to the students than the latter. The Rasch measurement model allows for a 'value free' comparison of such different items and calibrates item difficulties on the same scale together with the person measures.

Of the 170 students who indicated that they could recall between 83% and 100% of the religious education items, 160 students indicated that they believe an average of 39% of the items as a result of having been provided with evidence. These students not only could recall the highest number of religious education items, but they also indicate that they believe (as a result of having been provided with evidence), the highest percentage of any of the categories of recall. Of the 539 students who indicated that they could recall over 83% of the science items, 469 students also indicated that they believe an average of 53.8% of the items as a result of having been provided with evidence during the teaching of those items. Not only is the number of students who can recall 83% or more of the

science items much larger than the numbers who can recall a similar number of the religious education items, but the number of students who believe that the items are true (as a result of having been provided with evidence) is larger, and the average number of items that these students believe shows a similar level of difference.

At each level of recall the difference between the levels of belief in the religious education and science items is quite evident. Fewer students are grouped into the categories that represent lower levels of recall of the science items than are represented in the same categories of the religious education items.

There was a tendency for the students with increasing levels of recall, to indicate higher levels of belief (as a result of having been provided with evidence) of the religious education items. The students who could recall the fewest items indicated that they believe (as a result of having been provided with evidence) on average 16.8% of the items, rising to 39.0% of the items when they could recall between 83% and 100% of the items. A similar pattern appears in the levels of belief that the science items are true, in that as the level of recall increases, the level of belief also tends to increase.

By grouping the students into categories of increasing percentage of items believed, another difference between the responses to the religious education and science items is apparent. There are 575 students (41%) who indicated that they believe (on the basis of evidence) less than 29% of the science items while 1060 students (75%) indicated belief in the same percentage of religious education items. There are 214 students who indicated that they believe (on the basis of evidence) over 83% of the science items and only 4 students who indicated that they believe (on the basis of evidence) the same level of religious education items. The numbers of students who indicated that they believe the science items on the basis of evidence tends to remain fairly constant across the categories of belief. The contrast in the data of belief in the science and religious education items is once again quite clear.

Although the results of the analysis support the view that the students perceive that the religious education items are harder to believe than the science items, the two sets of items do not form two discontinuous sets of data. The results indicate that 29 religious

education items are as easily believed as the science items. The model predicts that not only would the 'knowable content' of the religious education items be perceived differently to the 'knowable content' of the science items but that the 'knowable content' of the religious education items would be more similar to the science items than the 'less knowable' religious education items. The results of the analysis have supported this.

The results of this thesis support the findings of previous research by Pajares (1992), Hogan (2000), Kardesh (1996) and Hofer & Pintrich (1997) who suggested that knowledge and belief are closely intertwined, and as a result, 'scientific knowledge' is seen as concrete knowledge. As such, there is a prevailing tendency to believe the content of the science classroom (Carey, 2001, Radford, 1999, Cush, 1999, Bell et al., 2000).

Research questions 3 and 6: What 'knowable content' from the religious education and science courses do students believe on the basis of faith?

The level of belief of the science and religious education items is different. An item such as "Human blood contains white blood cells that help fight disease" (Science Item# 1) is less easily accepted as true on the basis of faith than items such as "God offers salvation through the sacraments" (Religious Education Item #47) because the latter can be more easily explained in terms of faith to the students than the former. In this study, faith is subsumed in answers as 'belief for reasons other than evidence and trust' and, in this section, results for the three types of answers are composed. The Rasch measurement model allows for a 'value free' comparison of such different items in terms of their 'difficulty' on a linear scale.

When considering the basis of their belief in the religious education items, the responses of the students tends to be fairly equal in each of the three categories of belief. This pattern of response is evident in each of the categories of recall but one example can demonstrate the typical pattern. The students who could recall the majority of religious education items indicated that they believe 39% of the religious education items (as a result of being given evidence), 21.5% of the items (as a result of trusting their teacher),

21.4% (for some other reason), and 13.6% students indicated that they do not believe any of the items.

By contrast, a different pattern is evident in the student responses to the science items. The tendency was for a majority of students in each category of recall, to indicate that they believe (as a result of being given evidence) a majority of the items. For example, in the highest category of recall of science items, the students indicated that they believe 53.8% (as a result of being given evidence), 26.8% (as a result of trusting their teacher), 8.4% (for other reasons) and 3.2% of the items are not true. A similar pattern of belief is apparent in the remaining six categories of recall.

A similar number of students, 893 students and 863 indicated that they believe (on the basis of trust) less than 29% of the science items and religious education items respectively. There are 53 students who indicated that they believe (on the basis of trust) over 83% of the science items and only 11 students who indicated that they believe (on the basis of trust) the same level of religious education items. There are 1232 students who indicated that they believe (on the basis of trust) less than 55% of the science items and 1344 who indicated the same level of belief (on the basis of trust) in the religious education items. There are 186 students who indicated that they believe (on the basis of trust) more than 55% of the science items and 74 who indicated the same level of belief (on the basis of trust) in the religious education items. The contrast in the data of belief in the science and religious education items is once again quite clear.

A similar number of students, 1211 and 1093 indicated that they believe (for other reasons) less than 29% of the science items and religious education items respectively. There are 12 students who indicated that they believe (for other reasons) over 83% of the science items and only 8 students who indicated that they believe (for other reasons) the same level of religious education items. There are 1392 students who indicated that they believe (for other reasons) less than 55% of the science items and 1364 who indicated the same level of belief (for other reasons) in the religious education items. There are 26 students who indicated that they believe (for other reasons) more than 55% of the science items and 54 who indicated the same level of belief (for other reasons) in the religious

education items. The contrast in the data of belief in the science and religious education items is once again quite clear.

Generally more students indicated that they believe more science items on the basis of evidence and trust than indicated belief in the religious education items for those two reasons. Fewer students indicated belief in the science items on the basis of 'other' factors (faith) but more students indicated that factors other than trust and evidence are the reason they believe in the religious education items.

Although the results of the analysis support the perception that the religious education items are harder to believe than the science items, the two sets of items do not form two discontinuous sets of data. The results indicate that 39 religious education items are as easily believed as the science items. The model predicts that not only would the 'knowable content' of the religious education items be more difficult to believe than the 'knowable content' of the science items, but that the 'knowable content' of the religious education items would be more similar in difficulty to the science items than the 'less knowable' religious education items. The results of the analysis support this.

The results support previous research (Brickhouse et al., 2000) that indicated that most students appear to readily believe that content is true on the basis of the authority of their teacher and their texts. The students' responses to the open ended survey questions and in discussions (Reference Group) indicated that there is a tendency for some students to trust their science teacher to teach them what is true but to not trust their religious education teacher. (There is a perception amongst some students that their religious education teachers do not always believe the content they are teaching but teach the content because it is their job to do so!)

Research question 7: Can students' recollection of 'knowable content' from the religious education course, their beliefs of this content as based on evidence, and their beliefs of this content as based on faith, be modelled and aligned on a scale from easy to hard, using a Rasch Measurement Model?

The initial analysis with the RUMM program using all 480 items provides two clear results. One, the Separation Item Index is excellent and two, the absence of an acceptable scale at the highest level of Rasch measurement.

The absence of a 'perfect' scale raised two issues. One, that the student responses to the items are not consistent, in that some 'good' students are able to answer some hard questions positively but are not consistently answering the easy questions positively, and that some 'poor' students are able to answer some of the hard questions positively. Two, the unidimensionality of the scale, in spite of the excellent Item Separation Index is, as a result, compromised. The absence of a 'perfect' scale prompted a series of analyses in an attempt to overcome the problem. Twenty-two separate Rasch analyses were done without any success in being able to construct a proper interval-level scale, acceptable at the highest level of measurement. The separate analyses included the 185 science items alone, the 295 religious education items alone, several subcategories that are evident within the science and religious education items (biological stem-items and each of the five categories within the religious education stem items), selected items that indicate good individual item chi-squared probability in a combination of stem-items and/or a selection of items (such as 'evidence' and 'trust'), and finally the elimination of individual student responses that indicate extreme or random patterns. Despite extensive efforts to reconfigure the stem-items and items themselves, in each of the twenty-two analyses, the various test-of-fit statistics indicate that a 'perfect' scale was not possible in any of the cases.

The findings of this thesis contribute to an understanding of the relationship of epistemology across domains. While the research in this field is still inconclusive (Schommer & Walker, 1997, Hofer & Pintrich, 1997, and Hogan, 2000), the results of this thesis indicate that epistemology tends to not be constant across domains. There appears to be a variation in the beliefs the students hold regarding the content of their science classes and their religious education classes. In addition, the results indicate that the students' epistemology of knowledge *within* a domain also varies in that different 'types' of religious education knowledge are treated differently.

The literature also indicates that there is evidence that the complexity of a students' epistemology changes over time (Perry, 1970, Hofer, 1997, Baxter 1992, Kuhn, 1993). The results of this thesis indicate that students are responding to the items differently.

Some students were able to respond positively to the hard items and yet not respond positively to the easy items. The possibility arises that students with different faith experiences, different metacognition and a different epistemology may respond differently to items. This result may require further investigation to clarify the significance of this result.

The student belief scale

While the analysis does not result in a 'perfect' scale, other collaborative evidence that arose from other phases of analysis supports the logit scale values. On this basis, a brief discussion of the results of the Rasch analysis can assist with enhancing our understanding of student perceptions regarding belief in the content of science and religious education items.

It is expected that the item-perspectives, in order of difficulty from easy to hard, would be 'Recall' (easiest) – this is reflected in the average logit value of -0.83 for the religious education items and -1.63 for the science items, 'Belief – based on evidence' – reflected in the actual average logit value of -0.06 for the religious education items and -0.76 for the science items, 'Belief – based on trust of the teacher', 'Belief – based on other reasons' and 'Non-belief' at the 'hardest end of the difficulty scale. The results of the Rasch analysis indicate that the conceptual ordering of the items is reflected in the students' responses for the science items, but the actual ordering of the religious education category items placed 'Belief – based on other reasons' third in the order of difficulty (logit value of $+0.01$) not fourth, and 'Belief – based on trust of the teacher' as the 'hardest' category (logit value of $+0.06$) rather than third in the order of difficulty. As is explained above, the results of the Rasch analysis can only be used as an indicator of a pattern. The ordering of items, as indicated by the average logit values, is corroborated though, by the percentages of students who respond to each item. The average percentage of students who indicated that they could recall the 59 religious education items, (47.9%) being higher than the average percentage who indicated that they believe that the items are true (28.4%) indicates that on average, the students find it 'easier' to recall the religious

education items, than believe that the items are true. The ordering indicated by the logit values of the other items is also supported by the percentage responses to these items. The initial results of the Rasch analysis though do indicate that further analysis of the data is essential, and that the students' response to the religious education items is not only different to what was expected, but also different to the students' responses to the science items. Further research in this area will therefore be essential.

The Rasch analysis of the 480 items would allow a comparison of the religious education and science items on a single scale of item difficulty, if it could be shown that a 'top quality' scale had been constructed. As no 'perfect' scale could be created, a comparison of the religious education and science items on a single scale of item difficulty relies on the collaborative evidence of the additional phases of analysis. The results indicate that the student responses to the religious education items are different to their response to the science items. The average logit values indicated that the students find it 'very much easier' to say that they could recall the science items (logit value of -1.63) than the religious education items (logit value of -0.83). The results also indicated that the students find it 'very much easier' to believe the science items (logit value of -0.76) on the basis of evidence, than to believe the religious education items (logit value of -0.06), and easier to 'not believe' the religious education items (logit value of 0.49) than to not believe the science items (logit value of 1.45). The results indicated that the students find it 'harder' to believe the religious education items (logit value of 0.50) on the basis of trust than the science items (logit value of 0.01). As has been noted above, the item category - 'Belief - based on other reasons' - is more important as a factor in the students' belief of the religious education items (logit value of 0.50) than it is for the science items (logit value of 0.79), not only as a comparison of the level of difficulty, but also as this factor ranks third in order of difficulty for the religious education items, and fourth for the science items.

The Rasch analysis indicates clear differences in how students perceive the science and religious education items. The differences though do not indicate that the two sets of items represent discontinuous domains. The level of difficulty of recalling and believing

approximately half of the religious education items is the same as many of the science items. The structure of the religious education course indicates that items from sections A and B of the religious education course represent 'knowable content'. The Rasch analysis indicates that this is true and that the students perceive the items as such.

The range of logit values for the religious education items is actually less than the range for the science items, indicating that the religious education items represented a smaller range of difficulties of items and levels of acceptance than is evident for the science items.

Student belief patterns of science content

A comparison of the students' perception of the level of difficulty of being able to 'recall' each science item and the level of difficulty of believing each item as the result of 'evidence', 'trust' and 'other' factors is possible using the results of the Rasch analysis collaborated by the additional phases of analysis. (The Rasch analysis did not produce a 'perfect' scale for the science items. The conclusions discussed in this section are based on the general patterns evident from the logit values and corroborative evidence from the students' responses to the items.) The percentage of student responses to the items closely mirrors the pattern evident from the logit patterns. In addition, the rank order of the science items according to the logit values is almost the same as the rank order of the items according to the percentage responses with a Spearman correlation co-efficient of 0.93 ($N = 37$) and a level of significance of $p < 0.001$.

As the level of difficulty of the 'Recall' items increases, the logit values for the 'Do not believe' items (I do not believe that the items are true) indicate two patterns. One, that it is 'harder' to not believe the science items are true than it is to recall being taught the item and two, that as it becomes 'harder' to recall science items, it becomes 'easier' to believe that the items are not true. This second trend is also evident in the pattern of logit values for 'other reasons' (I believe the items for 'other' reasons) is also evident.

The separation of the logit values for the five sets of stem items is quite clear, with each set of logit values becoming more 'positive' (ie indicating decreasing level of

difficulty) indicating that the results support the model. The model predicts that student responses to the four 'belief' items (I believe the items because of 'evidence', because I 'trust' the teacher, because of some 'other' factor or I 'do not believe' the item) would indicate that it is 'easier' to believe the items because of 'evidence', somewhat 'harder' to believe as a result of 'trust', harder still to believe the items for 'other' reasons and 'harder' still to 'not believe' the items.

Student responses to the science items indicated that not only is it 'harder' to believe the science items, on the basis of 'evidence' than it is to recall the item, but generally, as items become 'harder' to recall, it also becomes 'harder' to believe the item on the basis of evidence. Therefore, while the general trend of the order of difficulty of the 'recall' and 'belief' (on the basis of evidence) fits the model, some individual item difficulties indicate some minor variations to the model.

The logit values of the 'trust' items indicated little variation from easy to hard across the range of items. The range of logit values is approximately 0.75, indicating relatively small variations in the level of difficulty of the items. This pattern indicates that while the items became 'harder' to recall, and 'harder' to believe on the basis of 'evidence', the student responses to the items indicate that the level of difficulty of believing the items on the basis of 'trust' is quite uniform. While the correspondence between the order of difficulty, as determined by the logit values and the order as determined by the percentage values is not perfect, the strong similarities between the two sets of data suggest that the conclusions drawn from the data can be relied upon.

Student belief patterns of religious education content

The item-trait statistic indicates that the students' responses to the items do not fit the measurement model but that corroborative evidence for the patterns evident from the logit values do indicate that the patterns evident from the Rasch analysis may provide useful data. The patterns evident using the percentage of student responses to the items closely mirrors the patterns evident from the logit values, and in addition, the rank order of the religious education items according to the logit values is almost the same as the rank

order of the items according to the percentage responses with a Spearman correlation coefficient of 0.64 ($N = 59$) and a level of significance of $p < 0.001$.

A comparison of level of difficulty of the religious education and science items

Despite the concern that the Rasch analysis failed to generate an item – trait statistic that would indicate that the students' responses to the items were influenced by a single trait, it did seem that a dominant trait (involving both science and religious education) was present. The proportion of observed variance considered to be true was 90%, and is high. This statistic, together with the clear similarity between the patterns evident from the logit scale values corroborated by the percentage responses, suggests that the Rasch analysis does add to the results of this thesis.

By ordering the 'recall' logit values from easy to hard, a comparison in the degree of difficulty of the science items and religious education items is possible. The logit values for the 59 recall religious education items range from -1.53 to -0.01 , while the logit values for the 37 science recall items range from -2.63 to -0.64 . The clear separation of the two sets of logit values indicates that the level of difficulty of the recall religious education items is perceived as being more difficult than the level of difficulty of the recall science items.

The logit values for the 59 'belief on the basis of evidence' religious education items, when ordered from easy to hard, range from -1.55 for the 'easiest' items to $+0.67$ for the 'hardest' item while the logit values for the 37 'belief on the basis of evidence' science items, when ordered from easy to hard, range from -1.71 for the 'easiest' items to approximately -0.03 for the 'hardest' item. Again, the clear separation of the two sets of logit values indicates that the level of difficulty of the religious education items is perceived as being more difficult than the level of difficulty of the science items.

The logit values for the 59 'belief on the basis of other reasons' religious education items, when ordered from easy to hard, range from -0.52 for the 'easiest' items to $+0.49$ for the 'hardest' item (Figure 6.9). The logit values for the 37 'belief on the basis of trust' science items, when ordered from easy to hard, range from $+0.19$ for the 'easiest'

items to approximately +1.51 for the 'hardest' item. Generally, the level of separation of the two sets of items increases from 0.7 logits for the 'easiest' to 1.4 logits for the 'hardest' items. The pattern indicates that students perceive that the difference in level of difficulty in believing the items on the basis of 'other' reasons tends to increase as the items become 'harder' to believe. The difference in the level of difficulty between the religious education and science items for this category of belief is quite high, being the second highest average (0.77 logits) difference.

The logit values for the 59 'do not believe' the religious education items, when ordered from easy to hard, range from -0.47 for the 'easiest' items to +2.00 for the 'hardest' item. The logit values for the 37 'do not believe' the science items, when ordered from easy to hard, range from +0.66 for the 'easiest' item to approximately +2.41 for the 'hardest' item. This pattern indicates that the students perceive that it is 'easier' to believe that the religious education items are not true than it is to believe that the science items are not true. The level of separation of the two sets of items is on average 0.97 logits indicating that the difference between the perceived levels of difficulty for this category is the highest of the five categories. Generally, the difference between the two sets of logit values increases from approximate 0.90 logits for the 'easiest' items to almost 2.00 logits for the 'hardest' items. The pattern indicates that students perceive that the difference in level of difficulty of not believing the items tends to increase as the items become 'harder' to not believe.

Research questions 8 to 10: Can students' recollection of 'knowable content' from the science course, their beliefs of this content as based on evidence, and their beliefs of the content as based on faith, be modelled and aligned on the same scale as that in 7 above from easy to hard, using a Rasch Measurement Model? Can the 'difficulties' of the items relating to the 'knowable content' of the religious education and science courses be modelled and aligned on a scale from easy to hard and calibrated on the same scale as in 7 above, using a Rasch Measurement Model? Can a model be devised to explain students' beliefs of the 'knowable content' of the religious and sciences courses, based on

what students recollect being taught in class, what they believe on the basis of evidence, and what they believe on the basis of faith?

A comparison of the patterns of the student responses to the religious education and science items is possible by comparing the average percentage levels of recall and belief/non-belief, for each of the categories of recall. The students who could recall between 83% and 100% of the religious education items indicated that on average they can recall 92.4% of those items. Generally for each category of recall, the students indicated that they believe that more science items are true than religious education items, as a result of being shown evidence and as a result of trusting their science teacher. For example, the category of students who could recall between 83% and 100% of the science items indicated that they believe 54.1% (as a result of evidence) and 27% (as a result of trust) of the science items, and in comparison, believe 38.9% (as a result of evidence) and 21.5% (as a result of trust) of the religious education items. In each category of recall the students indicated that they believe more of the religious education items for some 'other' factor. The example of the students in the highest category of recall illustrates this pattern in that they indicated that they believe 21.4% (as a result of 'other' reasons) of the religious education items in comparison to 8.3% of the science items. The students tended not to believe more of the religious education items than science items in each category of recall. In the highest category of recall, for example, the students indicated that they did not believe 13.6% of the religious education items in comparison to 3.2% of the science items. The data quite clearly indicates that there are differences between the patterns of belief and recall of the science and religious education items.

The model predicts that student learning may be enhanced when students perceive that their teachers have provided evidence that indicates that the content was true. The model therefore suggests that there is a relationship between learning and belief. If an item of content is believed then the learning may well be enhanced. This study utilises three 'reasons' for belief - one, having been provided with evidence to 'prove' that the item of content is true; two, trust that the teacher will teach only what is true and three, belief that arises for some 'other' reason that the student cannot explain.

By calculating the percentage of students responding to each category it is possible to describe the relationship between the categories of recall and belief. The percentage of students who indicated that they can recall each science item and the percentage of students who indicated belief in the item correlates ($r = 0.87$) quite strongly to significant level ($p < 0.001$) for 'evidence', 'other' and 'non-belief'. Items that a high percentage of students indicated that they can recall are also believed on the basis of evidence by a high percentage of students. The reverse relationship between the level of recall and belief for 'other' reasons, and for recall and non-belief, is also a strong indication that the science items, for which a high percentage of students indicated that they can recall, tend to be the items that few students indicated that they believe on the basis of 'other' reasons, or that few students indicated that they do not believe. The relationship between recall and believing the items on the basis of 'trust' though, is not strong ($r = 0.25$) and indicates that the items, for which a high percentage of students indicated that they can recall, tend not to be the items that students indicated that they believe on the basis of 'trust'.

The percentage of students who indicated that they can recall each religious education item and the percentage of students who indicated belief in the item correlate ($r = 0.80$) quite strongly at a significant level ($p < 0.001$). Items, that a high percentage of students indicated that they can recall, are also believed on the basis of evidence by a high percentage of students. The reverse relationship between the level of recall and non-belief is also strong, indicating that the religious education items that a high percentage of students indicated that they can recall tend to be the items that few students indicated that they do not believe. The relationship between recall and believing the items on the basis of 'trust' and 'other' reasons though is not strong ($r = 0.07, p < .31$) and indicates that the items, for which a high percentage of students indicated that they can recall, tend not to be the items that students indicated that they believe on the basis of 'trust'.

The fit between the model and the religious education items

The lack of a consistent pattern of student responses for the religious education items contrasts with the pattern of student responses to the science items, where the ordering of

all items does reflect the model. The model predicts that the students would indicate that it is 'easier' to recall the items than to believe that the items are true. This aspect of the model is born out by the students' responses because, for each item, the students are able to recall being taught the items more easily than they are able to indicate that they believe the items.

The model predicts that when the students consider whether they believe the items, and the basis for any belief, they would find it 'easier' to believe any item if they perceive that their teacher had provided evidence that the item is indeed true. This aspect of the model is found to be true for 27 of the 59 items. Of the remaining 32 items, there are 20 items for which the students indicated that the main 'reason' for their belief in the items is not evidence but rather 'other' reasons. There are 13 items where the percentage of students who do not believe that the items are true, is higher than the percentage of students who indicated that the items are true on the basis of evidence, trust or other reasons.

The learning model predicts that when they consider whether they believe the items and the basis for any belief, and in doing so they perceive that their teacher has not (or cannot) provide evidence that an item is true, they would find that the second 'easiest' reason to believe that an item is true is if they perceive that they trust their teacher to teach what is actually true. Trust as a basis for believing that an item is true is ranked second by the students for only 9 of the 59 religious education items. The students indicated that 'other' is the second 'easiest' basis for believing that an item is true for 39 of the 59 religious education items. As a basis for belief in the religious education items, the students rank 'trust' as the least important reason for 23 of the items. Of the remaining 11 items, the students rank 'evidence' as the second most important reason for believing an item for 9 items and for 2 items the percentage of students who do not believe the item, is higher than the percentage of any of the three 'reasons' for believing that the items are true.

The complex pattern of responses to the religious education items

The student responses to the religious education items are more complex than their responses to the science items indicating that the students perceive that the religious education items are different to the science items. The ordering of responses contrasts markedly with the ordering of responses of the science items. The student belief patterns seem to vary on an item-by-item basis indicating that students treat the religious education items quite differently to the science items.

A close examination of the complex responses to the religious education items indicates that different groupings of religious education items are evident. This finding is significant in that the Rasch analysis has identified different groups of types of content in religious education, where the importance of experience, evidence and other knowledge varies. This significant finding may require additional research in the future.

The religious education items that are 'hardest' to believe on the basis of evidence are more easily believed on the basis 'trust' in their teacher and 'other' factors that the students found that they could not verbalise or easily explain. Many students found these items difficult to believe and the relationship between evidence, trust and 'other' factors varied considerably from item to item. The order of separation from easy to hard for these items is 'recall', 'other', 'evidence' 'do not believe' and 'trust'. These items tend to be the stem items from sections C and D of the religious education course and represent less 'concrete' forms of knowledge. Items that are more 'easily' believed on the basis of evidence demonstrated a clearer pattern of relationship between evidence, trust and 'other' factors such that a clear separation of these factors is evident. The order of separation from easy to hard for these items is 'recall', 'evidence', 'other', 'trust' and 'do not believe'. These items tend to be the stem items from sections A and B of the religious education course and represent more 'concrete' forms of knowledge that show a pattern of response that is quite similar to the pattern of response to the science items.

A comparison of level of difficulty of the religious education and science items

Utilising percentage response rates to provide corroborative data to support the patterns evident from the imperfect Rasch analysis, it is possible to compare the students' perception of the degree of difficulty of the science items and religious education items. The percentage values for the 59 recall religious education items and the percentage values for the 37 science recall items indicated a clear separation of the two sets of responses supporting the view that recalling the religious education items is more difficult than recalling the science items. The pattern of responses, therefore, tends to not only indicate that the students perceive that recalling the science items is 'easier' than recalling the religious education items, but they also perceive that the level of difficulty tends to diverge so that the difference between last science item and the thirty-seventh religious education item is approximately 31.5%.

The percentage values for the 59 'belief on the basis of evidence' religious education items, when ordered from hard to easy, range from 15.7% to 60.9% for the 'easiest' item. The percentage values for the 37 'belief on the basis of evidence' science items, when ordered from hard to easy, range from 25.5% for the 'hardest' item to approximately 62.5% for the 'easiest' item. A comparison of the percentage values of the two sets of data indicates a pattern that tends to diverge, beginning at a difference of approximately 10% for the first religious education and science items, and reaching a maximum difference of approximately 30% for the thirty-seventh item indicating that the students perceive that believing the religious education items on the basis of their teacher having given them evidence to 'prove' that the items are true, is more difficult than believing the science items. The difference in the percentage values of the last science item and the thirty-seventh religious education item is in excess of 30%, indicating that the difference in percentage values of the two sets of data increases as the items become 'easier' to believe.

The percentage values for the 59 'belief on the basis of trust' religious education items, when ordered from hard to easy range from 29.6% for the 'hardest' item to 25.9% for the 'easiest' item. The percentage values for the 37 'belief on the basis of trust'

science items, when ordered from hard to easy range from 16.1% for the 'easiest' items to approximately 25.9% for the 'hardest' item. The relationship between the two sets of data indicate that the students perceive that it is 'easier' to believe the science items as a result of trusting the teacher to teach what is true, than it is to believe the religious education items on the same basis. As the items become 'easier' to believe, the difference between the two sets of data tends to remain fairly constant, being approximately 10%.

The percentage values for the 59 'belief on the basis of other reasons' religious education items, when ordered from hard to easy, range from 17.6% for the 'hardest' item to 36.5% for the 'easiest' item. The percentage values for the 37 'belief on the basis of other reasons' science items, when ordered from hard to easy, range from 6.9% for the 'hardest' item to approximately 20.5% for the 'easiest' item. The pattern of the student responses to 'belief on the basis of other reasons' is the reverse of the previous three patterns in that the responses indicate that the students perceive that it is 'easier' to believe the religious education items 'on the basis of other reasons' than it is to believe the science items. Generally the degree of separation of the two sets of items tends to remain fairly constant, averaging approximately 10% for all except the final few science items, where the degree of separation decreases to approximately 6%. The difference between the percentage value of the final religious education and the final science item is approximately 16.5%.

The percentage values for the 59 'do not believe' the religious education items, when ordered from hard to easy, range from 4.5% for the item that are hardest to disbelieve to 37.8% for the items that are 'hardest' to believe. The percentage values for the 37 'do not believe' the science items, when ordered from hard to easy, range from 2.9% for the item that fewest students indicated as not believed to approximately 13.9% for the item that is 'hardest' to believe. This pattern indicates that the students perceive that it is 'easier' to believe that the religious education items are not true, than it is to believe that the science items are not true. Generally the difference between the two sets of data gradually increases from approximately 1.6% for the 'easiest' items to almost 25% for the 'hardest'

items indicating that students perceive that the difference between the two sets of data tends to increase as the items become 'harder' to not believe.

Students' perceptions of the content of their religious education and science classes

The analysis of the student responses to the open-ended questions, the discussions with the Reference Group and the items provide an insight into the students' perceptions of the content of their religious education and science classes. The analysis indicates that there is a level of antagonism towards religious education, especially from those students who have the lowest levels of belief of religious education items. Typical comments included: "religious education is a waste of time", that "science is important and religious education is not. Science is factual and religious education is not". As the level of recall increases, the antagonism toward religious education is somewhat less evident, but the students' comments reveal that they perceive a significant difference between science and religious education with comments such as, "we did less homework in religious education, had less assessments, we weren't expected to do much and all work was simple", and "how could they try and convince and make us read that 'crap' when I know that they probably don't believe in it".

The responses of students who indicated belief in more than half of the religious education items, tend to be more detailed and include positive comments about their experiences in religious education classes including "well both (science and religious education) were taught by teachers who understood, sometimes the work is boring so they made it interesting", "religious education curriculum seemed to be much more interesting", "religion was just about beliefs and not much knowledge", "science was much more focused on remembering formulae and exams", "they are completely different subjects and so I do not expect them to be taught similarly".

It is interesting to note that, irrespective of how the individual teachers perceive their own teaching the students' comments reflected a full range of responses. Teachers who perceive their teaching in religious education as creative, interesting and challenging, received comments from students who wrote that their style is uninteresting,

unimaginative, whereas others who find it inspiring and worthwhile. The same range of comments appeared from students whose teachers felt that they taught as well in religious education as their main teaching area, whose teachers indicated that they put more into their planning and preparation of religious education lessons than their main teaching area, and whose teachers indicated that they approach the teaching of religious education in a quite casual manner. Each teacher had students represented in each of the categories of disbelief described above.

The analysis of the students' comments on the teaching of religious education and science indicates that, irrespective of the level of belief in the religious education, some students report negative experiences in the religious education classroom. Some students indicated that they do not enjoy their religious education classes, they find the work repetitive and uninteresting, and of little relevance to their lives or their futures. In addition, students comment on the perception that the content of their religious education lessons lack academic rigour and is not based on facts or truth, but rather on faith.

There is a change in the tone, content and depth of responses to the open ended questions as the level of belief in the religious education stem items increases, with more students indicating that not only do they enjoy their religious education lessons, but they also feel that they learn from their work in this subject. With increasing levels of belief, students tend to comment on their epistemological beliefs regarding the differences between religious education and science. This level of metacognition is not evident in the comments of students with low levels of belief.

The discussions with the students in the Reference Group indicate that the students tend to perceive the science items quite differently to the religious education items and, their responses provide some evidence that explains the absence of a 'top quality' scale. The students in the Reference Group tended to believe the science items on the basis of evidence or trust. The students' epistemological beliefs regarding science items appear to categorise 'hard to believe' and 'hard to prove' (in a secondary school science classroom) items – ie Item 5: an atom is made up of protons, neutrons and electrons, as plausible and representing concrete knowledge. This finding reflects other research (Songer & Linn,

1991, Schommer, 1995 and Talbot, 2000) who indicated that high school students do tend to perceive science knowledge as concrete and plausible. Items that cannot be easily proven in a high school classroom are still perceived as easily believed, with students saying that their teacher did provide evidence that the item is true or often on the basis of trust ie. 'Mr X taught me that' or "I remember my science book saying it is true'.

The ordering of the items from easy to hard (recall, evidence, trust, other, no belief), as indicated by the logit values, reflects the epistemological beliefs of the students in the Reference Group. The students perceive that the science items represent concrete knowledge and hence must be true. The students are therefore more likely to believe that the items are true and are prepared to accept (albeit tentative logic from an objective view point) evidence as proof that the item is true, or trust their teacher to only teach them content that is true. This perception and response to teaching in the science classroom is reflected in the absence of comments such as "can you prove that sir?" or "where is the evidence Miss?" that is regularly reported emanating from religious education classrooms.

Reference Group students' responses to the religious education items

The discussions with the students in the Reference Group provide an insight into the students' epistemology and metacognition regarding the religious education items, and therefore help to explain the absence of a 'top quality' scale and the complex response to the different religious education items.

Some students in the Reference Group tend to base their belief or disbelief on the basis of 'other' reasons or 'for no reason at all', rather than on the basis of 'evidence' or 'trust' as is evident with the science items. Some students would justify their belief or disbelief with comments such as "I just feel it is true" or "it just is" without offering any substantive reason. The Reference Group students' response to the religious education items was in this way quite different to their response to the science items.

The second difference in the Reference Group responses is evident from the level of belief of the hard religious education items. The responses indicate a variation in 'belief

and 'reason' for the belief/disbelief for the hard items that reflects the complex responses to the religious education evident in the Rasch data. Some students are confident in their belief that the hard religious education items are easy to believe. They perceive that they have evidence to support their belief or are confident that their feeling that the item is true is justified. Others are equally adamant that the item is not true or is hard to believe, but like the students who indicate that the items is easy to believe, cannot provide evidence to support their stance. This variation in response to the religious education items helps explain why the ordering of items from the C and D category is so complex and does not reflect the conceptual ordering of the model. The student responses in the Reference Group indicates that there is a wide variation in personal beliefs regarding the less concrete forms of knowledge (Category C and D items) that is not present in either the science items or the category A and B items.

The variation in responses to the religious education items also provides an insight into the often reported presence in the religious education classroom of comments such as "can you prove that sir?" It seems that student epistemology is that religious education knowledge does not represent concrete knowledge. Some students will therefore seek validation of the plausibility of that content. Some students can look at religious education content with 'eyes of faith' (aspect seeing/religious competency/religious intelligence) that will enable them to 'know' (have reasons) that the content is plausible, others do not. The questioning-- "can you prove that Miss?" is therefore present in the religious education classroom because some content is not perceived as being plausible and concrete and because some students are less likely to 'see' the evidence themselves.

The discussions with students in the Reference Group therefore provide a deeper insight into the epistemology and metacognition of students regarding the content of their science and religious education classrooms. The student responses appear to mirror the Rasch data and provide for a greater understanding as to why the students responded as they did to the questionnaire items.

Teacher comments on the teaching of religious education and science

Some teachers commented on the poor attitude to study and effort in religious education and used phrases such as “few treat religious education seriously”, “students have less respect for religious education”, “most see religious education as unimportant” and “about the only way I could get anything out of them, was through drawing posters and cartoons”. Some teachers reported that they gave less homework, have few tests and fewer assessments, are less content orientated (and more often utilise strategies such as open discussions, debates, role plays and discussions based on videos) than their main teaching area and are more relaxed about teaching religious education.

Contrasting with the majority of teachers who indicated that they approach the teaching of religious education differently, almost 25% of the teachers indicated that they teach religious education in the same way that they teach their other subjects and “set similar amounts of homework”, “expectations about the standard of work and application (of students) are the same”, “maintain the same discipline, dedication and effort”.

Some noticeable differences in the teachers' comments appear when the main teaching area of the religious education teachers also differs. Teachers of quantitative type subjects (mathematics, science, accounting, computing) tend to see clear differences between the way they teach their main teaching area and religious education. A different perception seem to be present amongst the teachers of humanities subjects, who indicated that they feel confident that their teaching skills, developed in their main teaching area, enable them to teach religious education effectively, utilising strategies such as “journal writing, reflective times, ‘right’ brain and creative activities, holistic, integrative and linked to all areas of the curriculum”.

Attempts to account for the poor attitude of some of their students to religious education tend to be quite uniform across many of the teachers. These ‘explanations’ included “few practicing Catholics in my class”, and ‘religious education is seen as irrelevant’. Another teacher pointed out that some students “create ‘mental blocks’ in religious education lessons because they see the content of religious education as different, and yet the same students will share and discuss greatly and write deeply about

spirituality in Year 12 Literature", suggesting that some students are very spiritual and religious, but choose to treat religious education differently to their other subjects.

Individual student responses to the questionnaire

An analysis of individual student responses to the open-ended questions, in conjunction with their responses to the questionnaire items, indicated that some students are aware of the link between their approach to learning in religious education and science and the outcomes of that approach. These students reported that they recognised that they did not spend as much time studying religious education as science and that that decision is based on the perception that science is important and that religious education is seen by some students as less so. This perception and the decision by some students to invest time and effort in science study rather than religious education supports the research by Macdonald (1988), Moore (1991) and Donnan (1995) which indicated that some students exhibit a negative attitude toward learning in religious education classes, and the work of Elliott, et al. (1999) and Marsh (1996) who found that the driving force to succeed in subjects such as science for some students was derived from the desire to get a job.

Some students who indicated that they 'tried hard' in religious education and had a positive attitude to learning in religious education did tend to indicate on their questionnaire that they could recall most of the religious education items but at the same time did not indicate that they believed these items on the basis of evidence. Some students tended to comment that they believe the religious education items not on the basis of evidence (as they did for the science items) but in the basis of other reasons. These students often could not justify their belief but explained that they just believe. Some students were able to verbalise their metacognition regarding religious education and science by explaining that they saw religious education as a subject that helped them with their moral lives whereas science helped them with the real world. In some way these comments support the research (Schommer & Walker, 1995, Hofer & Pintrich, 1997) which indicated that students may utilise different learning processes across

different domains and the general thrust of this thesis which suggests that students treat learning in religious education quite differently to learning in science.

The model predicts that some students who indicate that their belief in God is "strong", and that their belief in God does affect the way they live their lives and who believe the 'hardest' items would find it 'easier' still to believe the items that are deemed to be easy to believe. This is not always the case. Through discussions in the Reference Group, it is evident that the 'reasons' the students give for believing or not believing items appears to lack consistency but, at the same time, the lack of consistency is not apparent to the students and the students appear to be quite sincere and believe that for each item their 'logic' is valid.

The relationship between recall of content taught and belief in that content

The students' responses to the religious education and science items indicate that as the level of recall increases, there is an increase in the level of belief that the items are true. The students who indicated that they could recall none of the items also indicated that they believe, on average, that 65.8% of the religious education items and 88.4% of the science items are true. The group of students who indicated that they could recall the majority of the items indicated that they believe that 86.4% of the religious education items and 96.8% of the science items are true.

Irrespective of the level of recall of stem items, a comparison of the level of belief in the religious education and science items indicates a higher level of belief that the science items are true, than belief that the religious education items are true. The difference in the level of belief for each level of recall indicated that the students believe that 10% more of the science items are true than the religious education items.

There is a general tendency for the percentage of items that students indicated they believe, because they feel that they have evidence to indicate that the item is true, to increase with increasing levels of recall. Students who could recall the majority of items indicated that they believe almost 39% of the religious education items as a result of

having evidence while those with the lowest level of recall indicated belief in almost 17% of the items.

The data indicates that belief in the religious education items, as a result of trusting the teacher to teach what is true, also tends to increase with the level of recall ranging from 12.9% for the lowest category of recall to 21.5% for the category of students who indicated the highest level of recall.

The data indicating belief in the item, for a reason other than trust or evidence, range from 29.3% for the students with the lowest level of recall to 21.4% for the students with the highest level of recall indicating a slight decrease in the level of belief with increasing levels of recall. While the percentage of items that students indicated they do not believe is high for the lowest level of recall (34%) and only 13.6% for the highest level of recall, the intervening categories of recall indicated very similar levels of 'disbelief' ranging from 17.1% to 20.3%.

As with the religious education items, levels of belief that the science items are true (as a result of evidence) tend to show an increase with each higher level of recall, from 25% for those who could not recall being taught any of the science items to 54.1% for those who could recall being taught the most items.

The percentage number of items the students believe as a result of trusting their teacher to teach what is true, for each of the categories of recall, remain more-or-less constant, ranging from 21.4% to 27%. A similar pattern is evident with the percentage number of items believed for some other reason. While the level of belief for the highest category of recall is lowest at 8.3%, the other categories are quite similar, ranging from 14.9% to 19.7%. The percentage number of items the students do not believe to be true are similar (7.6% to 11.6%) for the first six categories of recall but decreased to 3.2% for the group of students who indicated that they could recall the majority of science items.

Implications

Implications for learning

The implications for teachers of religious education of the results of this thesis are therefore quite clear. Student learning is closely associated with how the students perceive the veracity of the content they are presented with in class. It would seem that in the science classroom, the content is readily accepted as valid, because some students perceive that science content represents concrete knowledge. Student perception of the validity of the content of the science lesson has a positive effect on the teaching learning processes at work in the science classroom. Some students perceive that the content of the religious education classroom lacks validity and, as a result, student learning is possibly negatively affected. Some students find it harder to recall and believe the content of the religious education classroom than to recall and believe the content of the science classroom. Some students find it easy to recall and believe religious education content that the teacher shows is true. The association between perception of the validity of content and student learning (and belief) suggests that when teachers of religious education provide evidence to indicate the veracity of religious education content, student learning and belief is enhanced. Teachers of religious education can thus change student perception of the validity of the content of the religious education course, by providing evidence to show that the content is valid, and in so doing can influence learning in the religious education classroom.

Some students' comments regarding their beliefs regarding science and religious education content indicate that some students do rely on surface learning rather than deep learning in the classroom. From an objective point of view the 'reasons' some students used to justify their belief or otherwise of content indicated a lack of depth of thought and a very superficial understanding of the nature of knowledge. This finding tends to support the research of Biggs (1987), Chin and Brown (2000), Pintrich, et al. (1993) who indicated that students tend to utilise shallow learning as their preferred learning mode.

Implications for religious education curriculum development and religious education learning

The theorists who develop religious education courses need to recognise the importance of student perception of the validity of the content they incorporate into their courses, and build that recognition into the courses they develop. The students must perceive course content as being valid before effective learning can occur.

The design of the religious education course used in Catholic schools in Perth is based on the recognition that student perception of the validity of content is an important factor in the teaching learning process. The results of this thesis indicate though, that some teachers may not be demonstrating to students the validity of the content of the religious education course as well as we would like.

The development of religious education curriculum may be enhanced if it is recognised that religious education items represent differing types of items where the importance of belief, trust in the teacher, evidence and acceptance to learning vary. Other items that do not represent the same 'type' of 'knowable content' require a different approach to teaching that recognizes the importance complex interaction of belief, trust in the teacher, evidence and acceptance to learning.

The recognition by the theorists that the effective teaching of religious education requires an academic approach is supported by the results of this thesis. Some students demonstrated that they do not merely accept content of the religious education course on the basis of trust in their teachers, but rather require the application of the same standards of teaching they perceive as occurring in their science course.

Religious education theorists need to recognise other educational models of learning that highlight the importance of experience for effective learning. Student experiences have been shown to play an important part in students accepting what is presented in the classroom as being valid evidence. In recognising the importance of experience in student perception of the validity of religious education content, theorists can develop courses that emphasise the importance of experience in learning and encourage teachers to build this aspect of learning theory into their teaching methodology.

The results of this thesis also highlight the importance of student perceptions in the teaching learning process. Models of learning recognize that 'selection of input' is a phase in the learning process. The results of this thesis emphasise the importance of this phase in the learning process in that students in religious education classrooms are not demonstrating learning as a result of rejecting some content on the basis of the validity of that content. Theorists, therefore, may need to further investigate the importance of student perception of the validity of content to the 'selection of input' phase of the teaching learning process.

A significant variable in determining how students decide to treat the content is their motivation to learn that content. Some students perceive the content of the religious education course as lacking relevance in their lives and, as a result, there is little motivation to learn that content. Theorists, therefore, must recognise the importance of motivation to learn to the learning process, especially in subjects where the relationship between careers and future advancement is not strong. Learning in subjects such as religious education will not automatically occur because the subject is part of a school curriculum, but requires a motivating factor to be present. Theorists in the field of religious education in recognising the importance of motivation to student learning will need to research methodologies to enhance student motivation in religious education.

Educational theorists recognise the importance of student perception of the nature of knowledge to learning. The results of this thesis indicate that students have strong epistemological beliefs about religious education and science, and that these epistemological beliefs differ from one subject to the other. Some students in this study demonstrate a perception that science knowledge is certain and simple, and they demonstrate that student metacognition is a factor in how they approach learning in these two subjects. Theorists in the field of religious education too, need to recognise the significance of this factor in affecting student learning in religious education, and incorporate this research into the development of educational models that will enhance learning in religious education.

The responses of some students to the items from the religious education and science courses indicate that students treat different subjects differently, when they perceive that the epistemology of the two subjects is different. Some student responses indicate that students use their epistemological beliefs inconsistently across domains (science and religious education in this study) and, as a result, may utilise different learning strategies in these different subjects. Again, theorists in the field of religious education too, need to recognise the significance of this factor in affecting student learning in religious education, and incorporate this research into the development of educational models that will enhance learning in religious education.

Implications for measurement

A Rasch measurement model requires agreement within a given range among the students with low, medium and high measures, as to the ordering of the item-perspective difficulties. Agreement about the conceptual order of item difficulties and the use of the Rasch measurement techniques can potentially provide teachers with valuable data regarding effective teaching in the religious education classroom.

The results of this study suggest that the ordering of religious education items by difficulty is not so easily achieved. Students responded to the religious education items on an individual basis and are influenced by personal commitment factors and, as a result, vary between individuals, giving the impression of an unordered response within the population. Personal values, beliefs and deeply ingrained behaviours may result in unordered responses to a set of items that are perceived as containing subjective content, as in religious education.

Despite the Rasch measurement results indicating that there is less than good agreement amongst students as to the order by difficulty of items, discussions with the students demonstrate, on an individual basis, that some kind of ordered response to the items is evident. The students perceive their reasoning for their responses to the items as being valid and logical. Discussion with students seemed to clarify the lack of real logic in their responses to items and resulted in a more considered response to the items. The

discussions with the students demonstrate that the students are responding to the items on a subjective basis. This personal response is probably the cause of the absence of a good fit statistic.

The results of this thesis indicate that the Rasch modeling technique does provide researchers and teachers with a useful tool for investigating the teaching and learning processes at work in the religious education classroom. The absence of a good fit statistic indicates that the analysis of responses to items that are largely influenced by personal values and belief may need a more considered approach. The influence of personal values and beliefs may be overcome with judicious wording of items, and significant and intensive discussions with the respondents, regarding the meaning of the items, prior to the testing phase. In addition, Rasch experts may be able to incorporate additional levels of statistical measures that may eliminate the 'noise' generated by personal values and faith that dominate some responses to some test items.

Implications for Catholic administration

The religious education course is common to all Catholic schools in the Perth Archdiocese. The opportunity to achieve more effective outcomes across all schools through developing better programmes is therefore possible. The results of this thesis raise a number of important implications for Catholic administrators.

The Catholic Education Office of Perth may wish to instigate inservice programmes that will provide teachers with the necessary skills to effectively achieve the educational objectives of the religious education course. Through effective inservice, teachers can be made aware of the factors that hinder effective teaching and learning in the religious education classroom, and be provided with the necessary professional skills to overcome the factors that negatively impact on effective teaching in the religious education classroom.

The importance of focusing on the life experiences of the students could be emphasized so that teachers become far more aware of the importance of providing

students with experiences that will enable their students to be aware of the evidence that indicates that the religious education items are indeed true.

The development of course outlines could incorporate genuine evidence that religious education teachers can utilize in the classroom to show students why the religious education items are true. Broad ranging strategies that will enhance the effective learning opportunities for students in the religious education classroom are also needed to assist teachers to achieve the goals of the religious education course.

Improving educational outcomes for science and religious education

The general acceptance of the 'knowable content' of science classrooms is not a concern if the goal of education is 'recall'. The results of this thesis indicate that some students accept science content largely on the basis of faith in their teachers and, where students cite 'evidence' for their belief in science content, in reality, the basis of their 'evidence' is faith. Students have little awareness of the differences between theory and fact, and regularly interchange the two concepts in their discussions and explanations for believing that science content is true.

From an educational perspective it would be important that students be introduced more systematically to scientific theory. Science texts, science teaching and the language used in science classrooms could reflect a truer representation of what the scientific method reveals, the reliance the scientific method has on faith and trust in arriving at conclusions, and the significance of theory in the science we find within classrooms. Students need to be encouraged to challenge and to ask the 'why' questions in each science classroom so that they will become more fully aware of the reality of the epistemology of science knowledge.

The students' response to the religious education content presents a different problem for educationalists. The results of this study indicate that when teachers can provide genuine evidence to support the validity of the religious education content, students will recall that content more easily, and accept that content as true on the basis of evidence. To achieve their goal, teachers of religious education therefore need to focus on providing

evidence to support each item, so that students can see the validity of evidence and the truth behind each item.

Of great concern for the religious education teacher is the lack of trust students have for their religious education teachers. To overcome this issue, religious education teachers could lessen their reliance on dogmatism, or church doctrine, as 'reasons' for accepting religious education content, and provide a genuine teaching and learning environment that will engender trust and communication. Teachers of religious education are trusted by their students when they teach their mathematics, science, art or english classes, and hence by utilising the same strategies they use in these secular subjects to develop trusting, learning environments, will be able to overcome the lack of trust evident in the data.

A common response evident in the students' comments regarding the religious education items indicates that some students fail to believe the religious education items because they have no experience of that item content in their lives. The literature points to the importance of experience to learning in all situations and in so doing highlights a significant strategy that teachers could employ to achieve their goals of teaching in the religious education classroom.

Student perception that religious education has little value in some students' lives is a difficult issue to overcome. Students seem to perceive the value of other subjects because of increased access to better careers and higher pay. Many school subjects struggle to generate relevance in our community, and need to generate a perception of value to engender student interest and commitment. These subjects achieve this perception of value by generating interest in learning itself, and achieving excellence as a value within itself. To overcome the ingrained reticence to value the content of religious education teachers need to find a reason for religious education existing beyond the often quoted 'just because'. In achieving this outcome teachers of religious education will then be more affectively able to achieve their goal.

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APPENDIX 1

TEACHING POINTS FOR THE THREE SECTIONS OF THE RELIGIOUS EDUCATION COURSE, PERTH, WESTERN AUSTRALIA

Section 1 Loving Justly	
A: Discovering Human Potential	
1	God created in people a concern for justice.
2	God created within people the potential to love justly.
3	Maturity means respecting the rights of the Creator.
4	To develop just love, people need to love the human family.
5	Just love brings happiness and contentment.
6	Just love leads to peace.
B: Accepting Human Weakness	
7	Mature people feel discontented with injustices.
C: Potential Offered By Christian Salvation	
8	God helps us to love justly.
9	People like to love justly.
10	God loves justly.
11	God seeks to protect people against behaving unjustly.
12	Jesus modelled the virtue of justice.
D: How Catholics Accept Their Gifts	
13	God's rights must be respected.
14	God gave the right to life in the Fifth Commandment.
15	Life is a right from conception.
16	Children have responsibilities towards their parents.
17	Parents have responsibilities towards their children.
18	Members of a family have responsibilities to each other.
19	The Seventh Commandment means respecting the property of others.
20	The right to necessities precedes right to ownership.
21	The Eighth Commandment upholds justice.
22	False witness and perjury are injustices.
23	Calumny and detraction are injustices.
24	Rash judgements are an injustice.
25	Telling secrets and breaking confidentiality are injustices.

TEACHING POINTS FOR THE THREE SECTIONS OF THE RELIGIOUS
EDUCATION COURSE, PERTH, WESTERN AUSTRALIA (continued)

Section 2 Vocation	
A: Discovering Human Potential	
26	People show concern for their vocations as intended by God.
27	Developing a vocation means working for family, society and creation.
28	The lay vocation includes discovering other appropriate life-styles.
29	Developing a vocation may include finding employment.
B: Accepting Human Weakness	
30	People fail to follow their vocations.
31	People become discontented at their failure to follow their vocations.
C: Potential Offered By Christian Salvation	
32	People have a sense of vocation.
33	People fail to follow their vocations.
34	Jesus, sent by God, modelled how to follow a vocation.
35	God seeks to protect people against behaviours that prevent them from following their vocations.
36	Jesus instituted the Christian vocation.
D: How Catholics Accept Their Gifts	
37	Christian vocations call also to particular Christian life-styles.
38	God offers Salvation through the Sacraments of Service.
39	Jesus serves his people as Priest through Holy Orders.
40	The Sacrament of Marriage is a Sacrament of Service.
Section 3 Conscience	
A: Discovering Human Potential	
41	People show concern for developing their conscience as intended by God.
42	People are capable of developing their potential for goodness.
43	The search for goodness leads people to discover moral conscience.
44	Developing moral conscience means forming conscience to recognise what is right.
45	Everyone is obliged to do what their conscience tells them to be right.
46	Formed moral conscience leads to long-term happiness.
47	Moral conscience does not determine what is right and what is wrong.
B: Accepting Human Weakness	
48	People can fail to form their moral conscience.
49	People can become discontented at their failure to develop conscience.
C: Potential Offered By Christian Salvation	
50	People desire to form moral conscience.
51	People fail to develop their inner goodness.
52	Jesus, sent by God, modelled how to form and follow moral conscience.
53	God seeks to protect people against unformed conscience.
54	God offers Salvation by revealing that human life is sacred.
D: How Catholics Accept Their Gifts	
55	God demands respect for human life through the Fifth Commandment.
56	The Fifth Commandment requires treating people with respect.
57	The Fifth Commandment forbids the deliberate killing of human life.
58	The Sixth Commandment requires respect for human conception.
59	The Seventh Commandment gives people the right to the necessities of life.

APPENDIX 2

THE QUESTIONNAIRE USED IN THIS STUDY

PLEASE READ THE FOLLOWING INSTRUCTIONS **PRIOR** TO COMPLETING THIS QUESTIONNAIRE

Please answer each question honestly. Your answers are completely confidential. None of your teachers or the school administration will have access to your responses.

The questionnaire has two sections. One section contains items taken directly from your religious education course the other contains items taken directly from your science course. To this extent each item is accurate.

None of the items have been altered or falsified to try and trick you.

You are asked to read each item. Please then consider the five alternatives adjacent to each item.

BOX 1: The first alternative asks whether you 'recall' (remember) being taught that item in class. If you do recall the item being taught in class please put a tick ☒ in the first space. If you cannot recall the item being taught in class leave the first space empty.

There are four additional questions you are also asked to consider. Each question asks you to consider whether you believe the item in the first box. You are asked to put a tick ☒ in only one of the next four boxes.

BOX 2: "I believe this because I have evidence it is true". Believing that it is true is different from knowing or remembering (you have memorised it for a test but do not believe it to be true). In box 2 you are asked whether you **actually believe** that the item is true. The reason you believe that it is true **must be** because you have some **evidence** that convinced you to believe it. This evidence could have been physical evidence that you have witnessed (seen, heard, felt, experienced, or data or statistical evidence from an experiment or text book). The evidence may not have proved that the item is true, but the evidence is sufficiently convincing for you to believe that it is true.

BOX 3: "I believe that this is true because I trust my teacher". By ticking this box you are indicating that while you have **no evidence** to convince you that it is true, you **actually believe** that it is true because you trust your teacher to teach you what is true.

BOX 4: "I believe this even though I do not have any evidence to suggest that it is true". By ticking this box you are indicating that you **actually believe** that it is true even though you have **no evidence** to convince you that it is true. You believe that it is true for some reason (you just believe it, you feel that it is true and so on) despite the lack of evidence.

BOX 5: "I do not believe that this is true". This alternative means that you do not believe that the item is true. You may have **memorised** this item for a test and you may be able to **recall** it, but you still do **not believe** that it is true. You may trust your teacher to teach you what is true, but you do not believe that this particular item is true. You may have seen some evidence that the teacher thought would convince you that it was true, but you still do **not believe** that it is true.

THE QUESTIONNAIRE USED IN THIS STUDY (continued)

A Discovering Human Potential		BOX 1	BOX 2	BOX 3	BOX 4	BOX 5
43	People are capable of developing their potential for goodness.					

The item
to be considered

Tick this box only if
you recall being taught
this item.

Tick only one of these four boxes



Example 1		I can recall being taught this in class	I believe this because I have evidence it is true	I believe this because I trust my teacher to teach me what is true	I believe this even though I do not have any evidence to suggest that it is true	I do not believe that this is true
A Discovering Human Potential		BOX 1	BOX 2	BOX 3	BOX 4	BOX 5
43	People are capable of developing their potential for goodness.	<input checked="" type="checkbox"/>				<input checked="" type="checkbox"/>

In this example the person indicates that they **can** recall being taught the item (they ticked box 1). They also indicated that they **do not** believe that the item is true (they ticked box 5).

Example 2		I can recall being taught this in class	I believe this because I have evidence it is true	I believe this because I trust my teacher to teach me what is true	I believe this even though I do not have any evidence to suggest that it is true	I do not believe that this is true
A Discovering Human Potential		BOX 1	BOX 2	BOX 3	BOX 4	BOX 5
43	People are capable of developing their potential for goodness.	<input checked="" type="checkbox"/>			<input checked="" type="checkbox"/>	

In this example the person indicates that they **can** recall being taught the item (they ticked box 1). They also indicated that they **do** believe that the item is **true even though** they **do not** have any evidence to suggest that it is true (they ticked box 4).

THE QUESTIONNAIRE USED IN THIS STUDY (continued)

Example 3		I can recall being taught this in class	I believe this because I have evidence it is true	I believe this because I trust my teacher to teach me what is true	I believe this even though I do not have any evidence to suggest that it is true	I do not believe that this is true
A Discovering Human Potential		BOX 1	BOX2	BOX 3	BOX4	BOX 5
43	People are capable of developing their potential for goodness.					

In this example the person indicates that they **can not** recall being taught the item (they did not tick box 1).

Even though they could not recall being taught the item in class they also indicated that they **do** believe that the item is true because **they feel that they have evidence to suggest that it was true** (they ticked box 2).

THE QUESTIONNAIRE USED IN THIS STUDY (continued)

Now that you have read the instructions please complete the following questionnaire.

		I can recall being taught this in class	I believe this because I have evidence it is true	I believe this because I trust my teacher to teach me what is true	I believe this even though I do not have any evidence to suggest that it is true	I do not believe that this is true
	A Discovering Human Potential	BOX 1	BOX 2	BOX 3	BOX 4	BOX 5
1	People are capable of developing their potential for goodness.					
2	Developing a vocation may include finding employment.					
3	To develop just love, people need to love the human family.					
4	Just love brings happiness and contentment.					
5	The search for goodness leads people to discover moral conscience.					
6	Developing moral conscience means forming conscience to recognise what is right.					
7	People show concern for developing their conscience as intended by God.					
8	Just love leads to peace.					
9	God created in people a concern for justice.					
10	God created within people the potential to love justly.					
11	Developing a vocation means working for family, society and creation.					
12	The lay (not a priest, brother, nun) vocation includes discovering other appropriate life-styles.					
13	Moral conscience does not determine what is right and what is wrong.					
14	Everyone is obliged to do what their conscience tells them to be right.					
15	Formed moral conscience leads to long-term happiness.					
16	Maturity means respecting the rights of the Creator.					
17	People show concern for their vocations as intended by God.					
	B Accepting Human Weakness					
18	People can fail to form their moral conscience.					
19	People become discontented at their failure to follow their vocations.					
20	People can become discontented at their failure to develop conscience.					

		I can recall being taught this in class	I believe this because I have evidence it is true	I believe this because I trust my teacher to teach me what is true	I believe this even though I do not have any evidence to suggest that it is true	I do not believe that this is true
		BOX 1	BOX 2	BOX 3	BOX 4	BOX 5
21	People fail to follow their vocations.					
22	Mature people feel discontented with injustices.					
23	People fail to follow their vocations.					
24	People fail to develop their inner goodness.					
25	People like to love justly.					
26	God loves justly.					
27	Jesus modelled the virtue of justice.					
28	Jesus instituted the Christian vocation.					
29	God seeks to protect people against unforned conscience.					
30	People have a sense of vocation.					
31	Jesus, sent by God, modelled how to follow a vocation.					
C Potential Offered By Christian Salvation						
32	Jesus, sent by God, modelled how to form and follow moral conscience.					
33	God offers Salvation by revealing that human life is sacred.					
34	God helps us to love justly.					
35	People desire to form moral conscience.					
36	God seeks to protect people against behaving unjustly.					
37	God seeks to protect people against behaviours that prevent them from following their vocations.					
38	The Seventh Commandment (don't steal) gives people the right to the necessities of life.					
39	Telling secrets and breaking confidentiality are injustices.					
40	God demands respect for human life through the Fifth Commandment (don't kill).					
41	The Sacrament of Marriage is a Sacrament of Service.					
42	Life is a right from conception.					
43	God's rights must be respected.					
44	The Sixth Commandment (don't commit adultery) requires respect for human conception.					
45	Rash judgements are an injustice.					

THE QUESTIONNAIRE USED IN THIS STUDY (continued)

		I can recall being taught this in class	I believe this because I have evidence it is true	I believe this because I trust my teacher to teach me what is true	I believe this even though I do not have any evidence to suggest that it is true	I do not believe that this is true
		BOX 1	BOX 2	BOX 3	BOX 4	BOX 5
46	Christian vocations call also to particular Christian life-styles.					
47	God offers Salvation through the Sacraments of Service.					
48	Jesus serves his people as Priest through Holy Orders.					
D How Catholics Accept Their Gifts						
49	Parents have responsibilities towards their children.					
50	Members of a family have responsibilities to each other.					
51	The Seventh Commandment means respecting the property of others.					
52	The Fifth Commandment requires treating people with respect.					
53	The Fifth Commandment forbids the deliberate killing of human life.					
54	Children have responsibilities towards their parents.					
55	God gave the right to life in the Fifth Commandment (don't kill).					
56	False witness and perjury are injustices.					
57	The right to necessities precedes right to ownership.					
58	The Eighth Commandment (don't bear false witness against your neighbour) upholds justice.					
59	Calumny and detraction are injustices.					

THE QUESTIONNAIRE USED IN THIS STUDY (continued)

The following items are taken from the year 10 science course. Please complete the following table using the same method you have used for the Religious Education items.

Science Items		I can recall being taught this in class	I believe this because I have evidence it is true	I believe this because I trust my teacher to teach me what is true	I believe this even though I do not have any evidence to suggest that it is true	I do not believe that this is true
		BOX 1	BOX 2	BOX 3	BOX 4	BOX 5
1.	Human blood contains white blood cells that help to fight disease					
2.	White blood cells make antibodies to get rid of dead microbes					
3.	The earth pulls downwards on all objects by means of what is called its gravitational force.					
4.	Rocks are broken down in the process of weathering					
5.	An atom is made up of protons, neutrons and electrons.					
6.	A person's immune system can learn to recognise infections and so prevent the same diseases affecting us again.					
7.	Light, sound and heat are common forms of energy.					
8.	Viruses are exceedingly small and can only reproduce when they are inside living things.					
9.	The nucleus of the cell, controls cell activities.					
10.	The main weapons in a person's immune system are white blood cells called leucocytes.					
11.	Bacteria reproduce by splitting in two. Each half then grows, and splits in two again when it is big enough.					
12.	Electrons have a negative charge					
13.	Protons have a positive charge					
14.	Heating a substance makes the particles in that substance move more violently.					
15.	Chemical weathering results from the action of oxygen and water containing dissolved substances on rocks.					
16.	Plants produce oxygen as a result of photosynthesis.					
17.	Heat can be transferred from hotter areas to cooler areas by conduction, convection and radiation.					
18.	Mould is a fungus that spreads from place to place by spores.					

THE QUESTIONNAIRE USED IN THIS STUDY (continued)

Science Items		I can recall being taught this in class	I believe this because I have evidence it is true	I believe this because I trust my teacher to teach me what is true	I believe this even though I do not have any evidence to suggest that it is true	I do not believe that this is true
		BOX 1	BOX 2	BOX 3	BOX 4	BOX 5
19.	Osmosis is the movement of a solvent through a partially permeable membrane.					
20.	A particle acquires a negative charge when it gains extra electrons					
21.	Mankind has evolved over time on earth					
22.	All matter is made of atoms					
23.	A particle acquires a positive charge when it loses some of its electrons.					
24.	Matter is made up of extremely small particles in constant motion					
25.	Isaac Newton developed a Law of Motion that predicts that a passenger in a car who is not wearing a seat belt may go through the wind-screen when that car has a head on collision.					
26.	Isaac Newton developed a Law of Motion that predicts that a car which is fully laden will take longer to reach 100km per hour from rest than if that same car had no load.					
27.	Animals have evolved over time on earth					
28.	Gain or loss of energy can cause matter to change its state (solid, liquid, gas)					
29.	Chlorophyll enables plants to use energy from the sun to convert carbon dioxide and water into sugar. This sugar can then be converted into energy that the plant can use.					
30.	Resistance enables us to change the energy of an electric current into heat and light.					
31.	The Law of Conservation of Energy states that energy is never created or destroyed, but simply changes from one form to another.					
32.	Forces of attraction, known as cohesive forces, exist between the particles that make up a substance.					

	Science	I can recall being taught this in class	I believe this because I have evidence it is true	I believe this because I trust my teacher to teach me what is true	I believe this even though I do not have any evidence to suggest that it is true	I do not believe that this is true
		BOX 1	BOX 2	BOX 3	BOX 4	BOX 5
33.	The boiling point and melting point of substances varies with changes in air pressure.					
34.	An element is a substance which cannot be split up into anything simpler by any known chemical means					
35.	Lupins are a plant crop that has nitrogen fixing bacteria in their roots.					
36.	Stars are created from nuclear reactions of hydrogen and helium					
37.	The speed of light is about 300 million meters per second.					

OPEN-ENDED QUESTIONS FROM THE QUESTIONNAIRE

FOR THE STUDENT

What was the name of the teacher who taught you religious education last year.

.....

Please answer the following questions as fully as possible.

You may like to use the attached lined paper for additional comments

Describe any differences you noticed between how religious education was taught last year and how Science was taught last year. (you may like to comment on amount of homework you were expected to do, tests, how the teacher taught, what the teacher expected from you, how the teacher ran the lesson, and any other differences you would like to comment on)

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Describe any similarities you noticed between how religious education was taught last year and how Science was taught last year. (you may like to comment on amount of homework you were expected to do, tests, how the teacher taught, what the teacher expected from you, how the teacher ran the lesson, and any other similarities you would like to comment on)

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Describe any similarities you see between how you approached learning in religious education last year and how you approached learning in Science last year. (you may like to comment on such things as the amount of homework you did, preparation for tests, your attitude to lessons, what you thought about lessons, the importance of lessons, whether you tried, why you tried , why you did not try and any other similarities you would like to comment on)

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Describe any differences you see between how you approached learning in religious education last year and how you approached learning in Science last year. (you may like to comment on such things as the amount of homework you did, preparation for tests, your attitude to lessons, what you thought about lessons, the importance of lessons, whether you tried, why you tried , why you did not try and any other differences you would like to comment on)

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Thank you for answering these questions. I do appreciate your help with my research. Please hand the completed questionnaire to your teacher.

FOR THE RELIGIOUS EDUCATION TEACHER

Dear RE teacher,

My name is Philip Cox. I work atCollege and am part way through a Ph.D. My research deals with students' perceptions of the plausibility of the content that we present in religious education class and Science class. It is my view that students willingly accept the content in Science as factual, real and plausible because they believe that the scientific process guarantees that science content is factual. Students perceive RE content as lacking plausibility because they feel that it deals with the 'spirit world' that is outside scientific verification. As a result of these perceptions students tend to believe what is presented in science and actively learn the content. Part of the reason students fail to actively learn in RE is that they perceive that the RE content is not plausible and as a result they do not actively learn the content. I also believe that their perception of the plausibility of the RE content also impacts on their beliefs regarding what we teach.

I have surveyed students in Year 11 and would appreciate your input.

I would greatly appreciate your thoughts on the following questions.

What is your teaching area (besides RE).....

Describe any differences you noticed between how you teach religious education and how you teach your second area.(you may like to comment on amount of homework, assessment, how you teach, what you expected from your students, how you run your lessons, and any other differences you would like to comment on)

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Describe any similarities you noticed between how you teach religious education and how you teach your second area. (you may like to comment on amount of homework, assessment, how you teach, what you expected from your students, how you run your lessons, and any other similarities you would like to comment on)

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[illegible][illegible]

Thank you for answering these questions. I do appreciate your help with my research.

Appendix 4

LOGIT VALUES FOR THE RELIGIOUS EDUCATION AND SCIENCE ITEMS

Items have been re-ordered and grouped (A and B for the religious education items) to 'fit' the logit values. (NF indicates the item does not fit the conceptual order)

Religious Education A

Stem Item Religious Education	I can recall this Item	I believe this Item (evidence)	I believe this Item (other)	I believe this item (trust)	I Do Not Believe this Item
2	-1.347	-0.552	0.085	0.551	0.917
4	-0.662	-0.343	0.102	1.064 NF	0.141
10	-1.215	-0.211	-0.199	0.366	0.994
32	-0.981	0.279 NF	-0.117 NF	0.015	0.617
38	-0.66	0.195	0.247	0.575	-0.207 NF
39	-0.467	-0.333	-0.011	1.034 NF	0.271
40	-1.473	-0.705	0.086	0.547	1.265
41	-0.799	0.136	0.409	0.279 NF	-0.075 NF
42	-0.876	-0.22	0.037	0.496 NF	0.493
43	-1.107	-0.136	-0.035	0.244	0.751
44	-1.084	-0.203	0.067	0.419	0.511
45	-0.206	0.374	0.095	0.461	-0.162 NF
46	-0.587	0.292	0.074	0.127	0.227 NF
47	-0.69	0.45 NF	0.097	0.069 NF	0.114
48	-1.101	0.146 NF	0.078	0.268 NF	0.249
49	-1.282	-1.549	0.486	1.247	2.001
50	-1.019	-1.322	0.353	1.025	1.776
51	-1.288	-0.801	0.106	0.675	1.298
52	-1.228	-0.785	0.176	0.733	1.044
53	-1.424	-0.918	0.269	0.684	1.26
54	-0.944	-0.867	0.013	1.152 NF	1.052
55	-1.315	-0.622	0.046	0.59	1.099
56	-0.88	-0.489	-0.08	0.603	1.031
58	-0.853	-0.286	-0.072	0.378	0.893

LOGIT VALUES FOR THE RELIGIOUS EDUCATION AND SCIENCE ITEMS
(continued)

Religious Education Items B

Stern item Religious Education	I can recall this Item	I believe this Item (other)	I believe this Item (evidence)	I Do Not Believe this Item	I believe this Item (trust)
1	-1.373	-0.523 NF	-0.438	1.578 NF	0.91
3	-0.694	-0.293 NF	0.113 NF	0.278	0.734
5	-1.277	-0.212 NF	0.157	0.774	0.114 NF
6	-1.491	-0.175 NF	-0.29	1.373 NF	0.255
7	-0.599	-0.141 NF	0.568 NF	0	0.349
8	-0.548	-0.005	0.022	-0.012 NF	0.841
9	-0.736	-0.237	0.247	0.275	0.498
11	-0.808	0.089	0.288	0.031 NF	0.319
12	-0.325	-0.062	0.477 NF	0.033	0.312
13	-0.651	0.278	0.463	0.549	0.739
14	-0.584	0.185	0.275	-0.347 NF	0.728
15	-0.435	0.09	0.612	-0.425 NF	0.62
16	-0.264	0.215	0.501	-0.472 NF	0.631
17	-0.587	0.035	0.484	-0.206 NF	0.475 NF
18	-0.948	-0.044	-0.395	0.832	0.525 NF
19	-0.616	-0.04 NF	-0.078	0.361	0.526
20	-0.367	-0.156	0.308	0.032 NF	0.596
21	-0.562	0.192 NF	-0.299	0.223	0.716
22	-0.297	0.054 NF	-0.031	0.082	0.673
23	-0.561	0.144 NF	-0.195	0.122	0.75
24	-0.525	-0.013	0.079	0.058 NF	0.658
25	-0.926	-0.034 NF	-0.221	0.515	0.581
26	-1.533	0.029 NF	-0.322	0.956 NF	0.27
27	-1.003	-0.111	0.129	0.73	0.059 NF
28	-0.879	-0.035	0.267	0.356	0.138 NF
29	-0.506	-0.078	0.654	-0.004 NF	0.21 NF

LOGIT VALUES FOR THE RELIGIOUS EDUCATION AND SCIENCE ITEMS
(continued)

Religious Education Items B (continued)

Stem item Religious Education	I can recall this item	I believe this item (other)	I believe this item (evidence)	I Do Not Believe this item	I believe this item (trust)
30	-1.101	-0.182	-0.107	0.809	0.359 NF
31	-0.914	0.061	0.255	0.307	0.109 NF
33	-1.034	-0.095	0.042	0.802	0.089 NF
34	-1.108	-0.157	-0.132	0.628	0.491 NF
35	-0.627	-0.106	0.209	0.254	0.384
36	-0.79	-0.053	0.447 NF	0.146	0.191
37	-0.531	-0.008	0.665 NF	-0.065 NF	0.179
57	-0.383	-0.064	-0.026	0.422	0.433

Science Items

Science Stem Item	I can recall this item	I believe this item (evidence)	I believe this item (trust)	I believe this item (other)	I do not believe this item
1	-2.247	-1.281	0.093	1.377	2.089
2	-1.303	-0.667	-0.063	0.61	1.469
3	-2.274	-1.707	0.582	1.392	2.14
4	-1.781	-1.349	0.538	0.989	1.531
5	-2.532	-1.105	-0.135	1.274	2.409
6	-1.833	-1.029	0.216	0.723	1.737
7	-2.433	-1.437	0.197	1.505	2.231
8	-1.407	-0.521	0.075	0.703	0.736
9	-1.79	-0.721	-0.081	0.63	1.692
10	-1.197	-0.401	-0.061	0.431	1.074
11	-1.611	-0.648	0.003	0.643	1.2
12	-2.293	-0.933	-0.057	0.922	1.841
13	-2.631	-1.019	-0.198	1.288	2.185
14	-2.037	-1.17	0.066	1.085	2.125
15	-1.002	-0.356	-0.016	0.427	0.89
16	-2.253	-1.114	0.046	1.187	1.752
17	-1.594	-0.61	0.08	0.638	1.521

Science Stem item	recall	Belief evidence	Belief trust	Belief Other	non-belief
18	-1.593	-0.813	-0.031	0.698 NF	1.892
19	-0.921	-0.215	-0.184	0.672 NF	0.663
20	-1.604	-0.616	-0.225	0.896	1.295
21	-1.682	-0.986	0.309	0.706	1.416
22	-1.925	-0.82	-0.149	0.918	1.706
23	-1.694	-0.569	-0.244	0.978	1.15
24	-1.639	-0.565	-0.197	0.639	1.538
25	-1.44	-0.908	0.19	0.777	1.32
26	-1.342	-0.741	0.108	0.618	1.286
27	-1.525	-0.9	0.193	0.726	1.363
28	-1.732	-0.935	0.062	0.78	1.737
29	-1.717	-0.717	-0.281	0.971	1.689
30	-1.258	-0.514	-0.11	0.528	1.293
31	-1.436	-0.599	-0.107	0.673	1.299
32	-1.166	-0.471	-0.09	0.58	1.061
33	-1.133	-0.48	0.146	0.526	0.778
34	-1.45	-0.524	-0.141	0.73	1.105
35	-0.635	-0.03	-0.01	0.186	0.682
38	-0.956	-0.226	-0.069	0.205	1.094
37	-1.238	-0.251	-0.118	0.429	0.901

Appendix 5

PERCENTAGE RESPONSES TO RELIGIOUS EDUCATION AND SCIENCE ITEMS

The religious education and science items grouped according to the student responses to the Recall and Belief Categories. The grouping is based on order of recall belief categories from hard (lowest percentage response) to easy (highest percentage response).

Group 1: Order of items from hard to easy: Evidence, trust, other, do not believe and recall

Religious Education Items	% who believe this because I have evidence it is true	% who believe this because I trust my teacher to teach me what is true	% who believe this for 'other' reasons	% who do not believe that this is true	% Who can recall being taught this in class
God seeks to protect people against behaviours that prevent them from following their vocations.	15.7	23	25	27	40.5
God seeks to protect people against unformed conscience.	16.1	22	25	27	40.5
People show concern for developing their conscience as intended by God.	17.1	20	25	28	42.4
The lay (not a priest, brother, nun) vocation includes discovering other appropriate life-styles.	17.9	20	24	26	36.3
God seeks to protect people against behaving unjustly.	19.2	22	23	27	47

Group 2: Order of items from hard to easy: Trust, evidence, other, do not believe and recall

Religious Education Items	% who believe this because I trust my teacher to teach me what is true	% who believe this because they have evidence it is true	% who believe this for 'other' reasons	% who do not believe that this is true	% Who can recall being taught this in class
Moral conscience does not determine what is right and what is wrong.	15	18.5	21	38	43.16
People show concern for their vocations as intended by God.	18	18.8	25	30	42.17
Rash judgements are an injustice.	18	19.7	23	28	34.06
Everyone is obliged to do what their conscience tells them to be right.	15	21.7	23	33	42.24
Developing a vocation means working for family, society and creation.	20	22.1	24	25	47.32
Formed moral conscience leads to long-term happiness.	16	17.1	25	35	39.07
Maturity means respecting the rights of the Creator.	16	18.3	22	35.05	36

PERCENTAGE RESPONSES TO RELIGIOUS EDUCATION AND SCIENCE ITEMS
(continued)

Group 3: Order of items from hard to easy: Trust, evidence, do not believe, other and recall

Religious Education Items	% who believe this because I trust my teacher to teach me what is true	% who believe this because I have evidence it is true	% who do not believe that this is true	% who believe this for 'other' reasons	% Who can recall being taught this in class
Calumny and detraction are injustices.	17	18.5	22	26	29.83
People can become discontented at their failure to develop conscience.	16	21.2	25	29	37.02

Group 4: Order of items from hard to easy: Trust, do not believe, other, evidence and recall

Religious Education Items	% who believe this because I trust my teacher to teach me what is true	% who do not believe that this is true	% who believe this for 'other' reasons	% who believe this because I have evidence it is true	% Who can recall being taught this in class
Just love leads to peace.	14	27	27	26.9	40.83
The right to necessities precedes right to ownership.	18	18	26	27.1	37.66
Mature people feel discontented with injustices.	15	24	25	27.4	35.83
People become discontented at their failure to follow their vocations.	18	20	27	28.5	42.81
People like to love justly.	16	17	26	30.5	50.07

PERCENTAGE RESPONSES TO RELIGIOUS EDUCATION AND SCIENCE ITEMS

(continued)

Group 5: Order of items from hard to easy: Trust, do not believe, evidence, other and recall

Religious Education Items	% who believe this because I trust my teacher to teach me what is true	% who do not believe that this is true	% who believe this because I have evidence it is true	% who believe this for 'other' reasons	% Who can recall being taught this in class
God offers Salvation through the Sacraments of Service.	20	20	22.1	23	44.71
Jesus serves his people as Priest through Holy Orders.	20	20	22.1	23	54.51
God created in people a concern for justice.	18	21	22.3	31	45.56
The Seventh Commandment (don't steal) gives people the right to the necessities of life.	17	21	22.5	30	43.65
People desire to form moral conscience.	20	21	23.1	28	43.3
To develop just love, people need to love the human family.	15	21	24.5	31	44.71
People fail to develop their inner goodness.	16	25	25.2	26	40.83
The Eighth Commandment (don't bear false witness against your neighbour) upholds justice.	19	26	12	32.1	48.8
People fail to follow their vocations.	15	23	24	31	41.47

Group 6: Order of items from hard to easy: Do not believe, evidence, trust, other, and recall

Religious Education Items	% who do not believe that this is true	% who believe this because they have evidence it is true	% who believe this because I trust my teacher to teach me what is true	% who believe this for 'other' reasons	% Who can recall being taught this in class
Christian vocations call also to particular Christian life-styles.	21	21.4	24	24	42.17
Jesus instituted the Christian vocation.	19	21.4	23	26	49.22
Jesus, sent by God, modelled how to follow a vocation.	20	21.5	24	24	50.07
Jesus, sent by God, modelled how to form and follow moral conscience.	16	21.7	26	28	51.62
The search for goodness leads people to discover moral conscience.	13	23.3	23	29	58.46
Jesus modelled the virtue of justice.	14	24	25	27	51.83
The Sacrament of Marriage is a Sacrament of Service.	19	20	23.5	26	47.18
God offers Salvation by revealing that human life is sacred.	13	24	25.8	27	52.82
People have a sense of vocation.	13	19	28.3	29	54.23

PERCENTAGE RESPONSES TO RELIGIOUS EDUCATION AND SCIENCE ITEMS

(continued)

Group 7: Order of items from hard to easy: Do not believe, trust, other, evidence and recall

Religious Education Items	% who do not believe that this is true	% who believe this because I trust my teacher to teach me what is true	% who believe this for 'other' reasons	% who believe this because I have evidence it is true	% Who can recall being taught this in class
God's rights must be respected.	14	21	26	28.8	54.3
God helps us to love justly.	16	18	29	29.5	54.6
Life is a right from conception.	17	17	24	30.5	49.2
The Sixth Commandment (don't commit a adultery) requires respect for human conception.	17	19	24	30.8	53.4
God created within people the potential to love justly.	11	19	30	30.8	56.8
Developing moral conscience means forming conscience to recognise what is right.	8	21	29	32.2	62.8
Telling secrets and breaking confidentiality are injustices.	21	11	26	33	39.4
God loves justly.	12	21	25	33.1	63.8
People fail to follow their vocations.	22	15	23	33.3	41.5
Just love brings happiness and contentment.	23	11	24	33.7	43.9
People are capable of developing their potential for goodness.	6	12	36	35.1	60.4
People can fail to form their moral conscience.	13	18	27	35.3	50.6
False witness and perjury are injustices.	11	16	27	37.2	49.4
Developing a vocation may include finding employment.	13	17	25	38.6	59.7
God gave the right to life in the Fifth Commandment (don't kill).	10	16	25	39.2	59.2
God demands respect for human life through the Fifth Commandment (don't kill).	9	17	24	41	62.3
The Fifth Commandment requires treating people with respect.	11	14	22	42.7	57.3
The Seventh Commandment means respecting the property of others.	8	15	24	44	58.3
Children have responsibilities towards their parents.	11	10	25	45.7	50.7
The Fifth Commandment forbids the deliberate killing of human life.	9	15	21	46.6	61.3
Members of a family have responsibilities to each other.	6	11	20	56.3	52.5
Parents have responsibilities towards their children.	5	9.3	18	60.9	58.3

PERCENTAGE RESPONSES TO RELIGIOUS EDUCATION AND SCIENCE ITEMS

(continued)

Science Items

Order of items from hard to easy: Do not believe, other, trust, evidence and recall

Science Items		% who do not believe that this is true	% who believe this for 'other' reasons	% who believe this because I trust my teacher to teach me what is true	% who believe this because I have evidence it is true	% Who can recall being taught this in class
1.	Human blood contains white blood cells that help to fight disease	3.7	7.5	22.4	51.4	77.0
2.	White blood cells make antibodies to get rid of dead microbes	6.8	14.7	25.4	38.9	59.4
3.	The earth pulls downwards on all objects by means of what is called its gravitational force.	3.7	7.8	16.1	62.5	76.9
4.	Rocks are broken down in the process of weathering	6.8	11.2	16.9	55.6	68.8
5.	An atom is made up of protons, neutrons and electrons.	2.9	8.4	27.5	49.9	80.8
6.	A person's immune system can learn to recognise infections and so prevent the same diseases affecting us again.	5.5	13.7	21.5	47.9	69.9
7.	Light, sound and heat are common forms of energy.	3.4	6.9	21.9	57.1	79.4
8.	Viruses are exceedingly small and can only reproduce when they are inside living things.	13.6	13.8	23.5	35.8	61.4
9.	The nucleus of the cell, controls cell activities.	5.6	14.7	26.2	40.7	69.2
10.	The main weapons in a person's immune system are white blood cells called leucocytes.	9.8	17.2	25.6	33.3	56.8
11.	Bacteria reproduce by splitting in two. Each half then grows, and splits in two again when it is big enough.	8.9	14.7	24.8	38.9	65.7
12.	Electrons have a negative charge	5.1	11.6	26.1	46.1	77.7
13.	Protons have a positive charge	3.4	8.2	28.1	46.9	82.1
14.	Heating a substance makes the particles in that substance move more violently.	3.7	10.1	23.9	51.4	73.3
15.	Chemical weathering results from the action of oxygen and water containing dissolved substances on rocks.	11.4	17.4	24.8	32.5	52.4
16.	Plants produce oxygen as a result of photosynthesis.	5.6	9.0	24.3	49.6	76.9
17.	Heat can be transferred from hotter areas to cooler areas by conduction, convection and radiation.	6.6	14.7	23.6	42.8	65.5
18.	Mould is a fungus that spreads from place to place by spores.	5.6	13.9	25.5	42.8	65.0

PERCENTAGE RESPONSES TO RELIGIOUS EDUCATION AND SCIENCE ITEMS
(continued)

	Science Items	% who do not believe that this is true	% who believe this even though I do not have any evidence to suggest that it is true	% who believe this because I trust my teacher to teach me what is true	% who believe this because I have evidence it is true	% Who can recall being taught this in class
19.	Osmosis is the movement of a solvent through a partially permeable membrane.	13.9	14.0	27.7	29.0	50.0
20.	A particle acquires a negative charge when it gains extra electrons	8.1	11.7	28.5	37.9	65.2
21.	Mankind has evolved over time on earth	7.3	14.3	20.2	47.5	66.7
22.	All matter is made of atoms	5.6	11.6	27.7	43.1	71.3
23.	A particle acquires a positive charge when it loses some of its electrons.	9.2	10.9	29.4	37.5	67.0
24.	Matter is made up of extremely small particles in constant motion	6.6	14.5	28.6	37.5	65.8
25.	Isaac Newton developed a Law of Motion that predicts that a passenger in a car who is not wearing a seat belt may go through the wind-screen when that car has a head on collision.	8.0	13.0	21.6	44.9	61.9
26.	Isaac Newton developed a Law of Motion that predicts that a car which is fully laden will take longer to reach 100km per hour from rest than if that same car had no load.	8.2	14.8	22.9	40.8	59.8
27.	Animals have evolved over time on earth	7.8	14.1	22.2	45.6	63.5
28.	Gain or loss of energy can cause matter to change its state (solid, liquid, gas)	5.6	13.1	23.7	45.8	67.8
29.	Chlorophyll enables plants to use energy from the sun to convert carbon dioxide and water into sugar. This sugar can then be converted into energy that the plant can use.	5.4	11.0	29.6	40.3	67.4
30.	Resistance enables us to change the energy of an electric current into heat and light.	7.9	15.9	26.0	35.6	57.8
31.	The Law of Conservation of Energy states that energy is never created or destroyed, but simply changes from one form to another.	7.8	14.1	26.5	37.7	61.6
32.	Forces of attraction, known as cohesive forces, exist between the particles that make up a substance.	9.5	14.8	25.7	34.2	55.9

	Science Items	% who do not believe that this is true	% who believe this even though I do not have any evidence to suggest that it is true	% who believe this because I trust my teacher to teach me what is true	% who believe this because I have evidence it is true	% Who can recall being taught this in class
33.	The boiling point and melting point of substances varies with changes in air pressure.	12.8	15.9	22.1	35.1	55.2
34.	The boiling point and melting point of substances varies with changes in air pressure.	12.8	15.9	22.1	35.1	55.2
35.	An element is a substance which cannot be split up into anything simpler by any known chemical means	9.4	13.3	26.9	35.6	62.1
36.	Lupins are a plant crop that has nitrogen fixing bacteria in their roots.	13.5	20.5	24.3	25.5	43.1
37.	Stars are created from nuclear reactions of hydrogen and helium	9.5	20.3	25.5	29.5	51.1
38.	The speed of light is about 300 million meters per second.	11.4	17.0	26.3	29.8	57.6

Appendix 6

COMPARISONS OF THE ORDER OF ITEMS AS A RESULT OF THE RASCH ANALYSIS AND PERCENTAGE RESPONSE RATES

The order of religious education and science items (from easy to hard) on the basis of the logit values and percentage response rates.

Religious Education Items

Rank of item	Order of Religious Education Recall Items Based on Percentages	Order of Religious Education Recall Items Based on Logits	Rank of item	Order of Religious Education Recall Items Based on Percentages	Order of Religious Education Recall Items Based on Logits
1	26	26	31	41	41
2	6	6	32	36	36
3	40	40	33	9	9
4	53	53	34	47	3
5	1	1	35	3	47
6	2	2	36	4	4
7	55	55	37	38	13
8	5	5	38	35	38
9	51	51	39	13	7
10	49	49	40	19	19
11	52	52	41	7	14
12	10	10	42	14	35
13	34	43	43	17	17
14	48	34	44	46	46
15	43	30	45	21	8
16	30	48	46	23	23
17	44	44	47	24	21
18	33	33	48	8	37
19	50	50	49	37	24
20	27	27	50	29	29
21	32	32	51	39	15
22	54	18	52	15	39
23	18	53	53	57	57
24	31	25	54	20	20
25	25	31	55	12	12
26	56	28	56	22	22
27	28	56	57	16	16
28	42	42	58	45	45
29	58	58	59	59	59
30	11	11			

COMPARISONS OF THE ORDER OF ITEMS AS A RESULT OF THE RASCH
ANALYSIS AND PERCENTAGE RESPONSE RATES (CONTINUED)

Science Items

Rank Order of Items	Order of Science Recall Items Based on Percentages	Order of Science Recall Items Based on Logits	Rank Order of Items	Order of Science Recall Items Based on Percentages	Order of Science Recall Items Based on Logits
1	13	13	20	20	11
2	5	5	21	18	17
3	7	7	22	27	27
4	12	12	23	34	34
5	1	16	24	25	25
6	16	3	25	31	31
7	3	1	26	8	8
8	14	14	27	26	26
9	22	22	28	2	2
10	6	6	29	30	30
11	9	9	30	37	37
12	4	4	31	10	10
13	28	28	32	32	32
14	29	29	33	33	33
15	23	23	34	15	15
16	21	21	35	36	36
17	24	24	36	19	19
18	11	20	37	35	35
19	17	18			

A comparison of religious education items according to rank order according to belief based on 'evidence', 'trust', 'other', no belief' and 'belief' (by item order)

item	rank	evidence	trust rank	other rank	no belief rank	belief rank	item	rank	evidence	trust rank	other rank	no belief rank	belief rank
1	12	6	59	3	57	31	45	56	21	32	28		
2	9	27	25	15	45	32	44	59	49	23	37		
3	33	11	58	34	26	33	31	57	46	19	41		
4	13	5	18	42	18	34	24	32	54	22	38		
5	36	53	55	18	42	35	37	39	48	37	23		
6	17	47	53	4	56	36	50	51	42	40	20		
7	56	43	50	49	11	37	59	52	30	52	8		
8	30	7	40	51	9	38	38	25	6	54	6		
9	39	33	57	35	25	39	16	4	33	33	27		
10	20	38	56	12	48	40	7	26	16	6	54		
11	42	46	19	46	14	41	35	45	2	50	10		
12	55	44	36	44	16	42	23	28	23	26	34		
13	52	10	4	59	1	43	25	48	32	20	40		
14	43	12	13	56	4	44	21	36	20	24	36		
15	57	23	26	57	3	45	49	31	14	53	7		
16	54	19	7	58	2	46	46	55	17	36	24		
17	51	35	27	55	5	47	40	41	10	29	31		
18	11	30	43	17	43	48	41	42	11	30	30		
19	26	29	41	31	29	49	1	1	1	1	59		
20	48	22	51	48	12	50	2	3	3	2	58		
21	14	15	9	39	21	51	5	14	15	5	55		
22	28	16	24	43	17	52	6	8	8	9	51		
23	19	9	12	41	19	53	3	13	5	7	53		
24	32	17	34	45	15	54	4	2	29	10	50		
25	22	20	35	25	35	55	8	18	22	8	52		
26	15	49	28	13	47	56	10	21	44	11	49		
27	34	58	47	21	39	57	29	34	38	27	33		
28	47	54	31	28	32	58	18	37	39	14	46		
29	58	50	45	47	13	59	53	24	37	38	22		
30	27	40	52	16	44								

Percentage response to science items for 'recall', 'belief' and 'non belief' (ordered from easy to hard by % belief)

Item	recall sc % ordered	Belief %	% Non Belief	Item	recall sc % ordered	Belief %	% Non Belief
5	82	97.1	2.9	21	67	92.7	7.3
7	80	96.6	3.4	31	62	92.2	7.8
13	83	96.6	3.4	27	64	92.2	7.8
14	74	96.3	3.7	30	58	92.1	7.9
3	78	96.3	3.7	25	62	92.0	8.0
1	78	96.3	3.7	20	66	91.9	8.1
12	78	94.9	5.1	26	60	91.8	8.2
29	68	94.6	5.4	11	68	91.1	8.9
6	71	94.5	5.5	23	68	90.8	9.2
18	66	94.4	5.6	34	63	90.6	9.4
28	68	94.4	5.6	36	68	90.6	9.4
9	70	94.4	5.6	32	56	90.5	9.5
16	78	94.4	5.6	10	57	90.2	9.8
22	72	94.4	5.6	15	53	88.7	11.3
24	66	93.4	6.6	37	58	88.7	11.3
17	66	93.4	6.6	33	56	87.2	12.8
4	69	93.2	6.8	35	43	86.5	13.5
2	60	93.2	6.8	8	62	86.4	13.6
				19	50	86.1	13.9

Percentage response to science items for 'recall', 'belief' and 'non belief' (ordered from easy to hard by % belief)

Item	% Recall	% Belief	% Non belief	Item	% Recall	% Belief	% Non belief
49	59	95.5	4.5	47	45	80.3	19.7
50	53	94.3	5.7	48	55	80.3	19.7
1	60	93.7	6.3	31	50	79.9	20.1
6	63	91.8	8.2	39	40	79.5	20.5
51	59	91.5	8.5	3	45	79.3	20.7
40	63	91.4	8.6	9	45	79.1	20.9
53	62	91.0	9.0	35	43	78.8	21.2
55	60	89.8	10.2	46	42	78.8	21.2
52	58	89.1	10.9	59	30	78.5	21.5
54	51	89.1	10.9	21	42	77.6	22.4
56	50	89.1	10.9	36	47	77.2	22.8
10	57	88.6	11.4	4	44	76.5	23.5
26	64	88.2	11.8	23	41	76.5	23.6
58	49	87.6	12.4	12	36	76.0	24.0
2	60	87.4	12.6	22	36	76.0	24.1
30	54	86.9	13.1	24	41	75.2	24.9
18	51	86.8	13.2	11	47	74.9	25.1
5	5	86.7	13.3	20	37	74.8	25.2
33	53	86.5	13.5	29	40	74.7	25.3
43	55	86.2	13.8	7	42	74.5	25.5
27	52	85.8	14.2	41	47	73.8	26.2
34	55	84.4	15.6	8	41	73.5	26.5
32	52	84.3	15.7	37	41	73.3	26.7
44	54	83.0	16.0	45	34	71.5	28.5
25	50	82.9	17.1	38	44	70.5	29.6
42	49	82.8	17.2	17	42	70.3	29.7
57	38	81.5	18.5	14	42	66.6	33.4
28	49	80.9	19.1	15	39	65.0	35.0
19	43	80.3	19.7	16	35	64.0	36.0
				13	43	62.2	37.8

Average Percentage Response to Religious Education Items (Items ordered from easy to hard on the basis of belief)

Item	Recall	Believe (evidence)	Believe (trust)	Believe (other)	Do Not Believe	Item	Recall	Believe (evidence)	Believe (trust)	Believe (other)	Do Not Believe
49	59	66	10	19	5	48	55	26	23	27	23
50	53	61	12	21	6	31	50	24	26	27	23
1	60	39	14	40	7	3	45	27	16	34	23
6	63	36	23	32	9	9	45	24	20	33	23
51	59	48	16	26	9	35	43	25	21	30	23
40	63	45	19	26	10	39	40	36	12	29	23
53	62	51	16	23	10	21	42	36	16	24	24
55	60	44	18	27	11	46	42	24	26	27	24
52	58	47	16	25	12	36	47	21	24	29	25
54	51	50	11	27	12	4	44	36	12	26	25
56	50	41	18	30	12	47	45	21	27	26	26
26	64	36	23	28	13	23	41	34	16	25	26
10	57	34	21	33	13	22	36	30	17	27	26
2	60	42	18	26	14	59	30	22	20	32	26
18	51	38	19	29	14	11	47	24	22	26	27
58	49	36	21	29	14	24	41	28	17	28	27
5	58	26	26	33	15	12	36	20	23	30	27
43	55	32	24	29	15	7	42	19	22	31	28
30	54	32	22	32	15	8	41	29	15	28	28
33	53	28	27	30	15	29	40	18	24	30	28
27	52	27	27	30	16	20	37	23	18	31	28
34	55	32	20	31	17	37	41	17	25	28	29
32	52	24	28	31	17	41	47	27	23	21	30
44	54	34	21	27	19	17	42	20	20	27	32
25	50	34	18	29	19	45	34	22	20	26	32
42	49	34	19	27	19	38	44	25	18	24	33
28	49	24	26	29	21	14	42	23	16	25	36
19	43	31	19	29	21	15	39	18	18	27	37
57	38	30	20	29	21	16	35	20	17	24	39
						13	43	20	16	23	41

Average Percentage Response to Science Items (Items ordered from easy to hard on the basis of belief)

Item	Recall	Believe (evidence)	Believe (trust)	Believe (other)	Do Not Believe	Item	Recall	Believe (evidence)	Believe (trust)	Believe (other)	Do Not Believe
5.	82	56	31	9	3	25	62	51	25	15	9
1.	78	60	26	9	4	27	64	51	25	16	9
3.	78	69	18	9	4	30	58	42	30	19	9
7.	80	64	24	8	4	31	62	44	31	16	9
13.	83	54	32	9	4	11.	66	45	28	17	10
14.	74	58	27	11	4	26	60	47	26	17	10
6.	71	54	24	15	6	10	57	39	30	20	11
9.	70	47	30	17	6	23	68	43	34	13	11
12.	78	52	29	13	6	32	56	41	30	18	11
16.	78	56	27	10	6	34	63	42	31	16	11
18.	66	49	29	16	6	36	51	35	30	24	11
22	72	49	31	13	6	15.	53	38	29	20	13
28	68	52	27	15	6	37	58	35	31	20	13
29	68	47	34	13	6	33	56	41	26	18	15
2.	60	45	30	17	8	8.	62	41	27	16	16
4.	69	61	19	12	8	35	43	30	29	24	16
17.	66	49	27	17	8	19.	50	34	33	17	17
21	67	53	23	16	8						
24	66	43	33	17	8						
20	66	44	33	13	9						

Appendix 7

The pattern of responses to the religious education and science items based on percentage responses

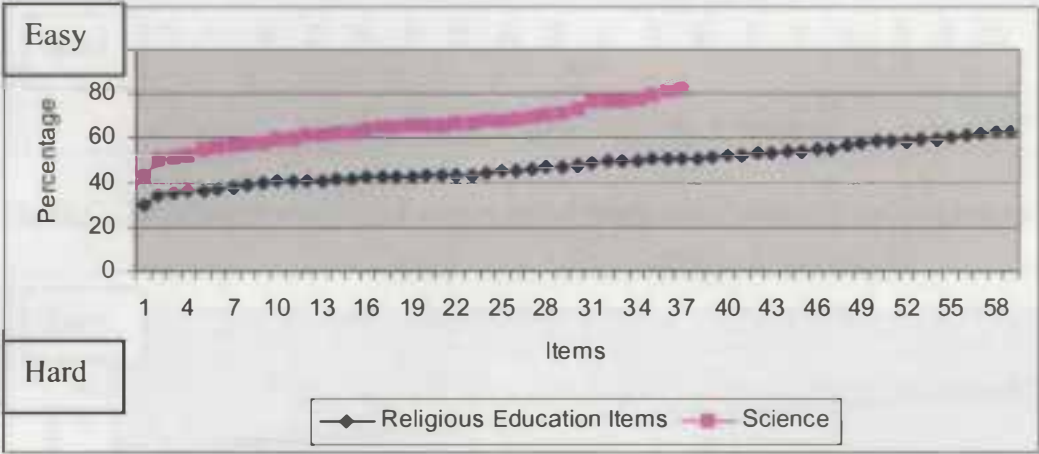


Figure A. Religious education and science recall items ordered from hard to easy.

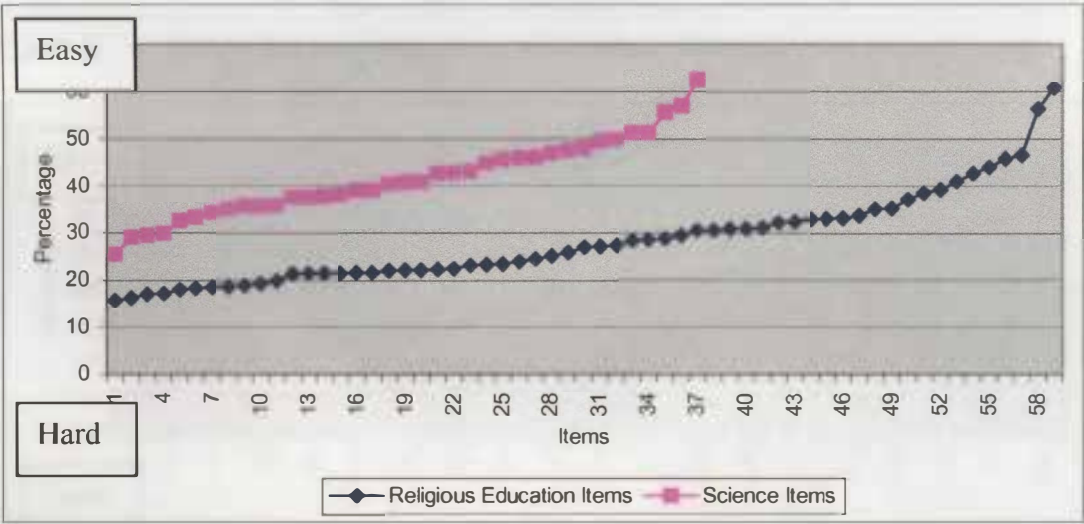


Figure B. Religious education and science belief (evidence) items ordered from hard to easy.

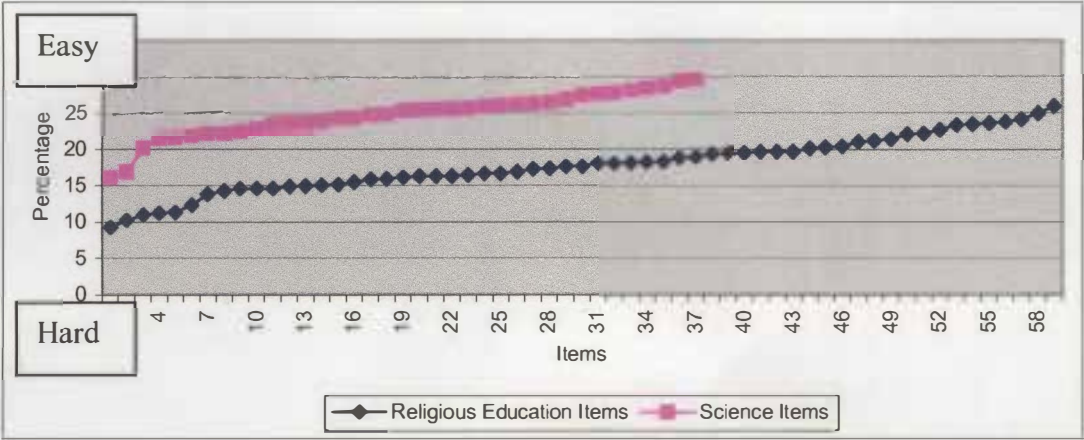


Figure C. Religious education and science belief (trust) items ordered from hard to easy.

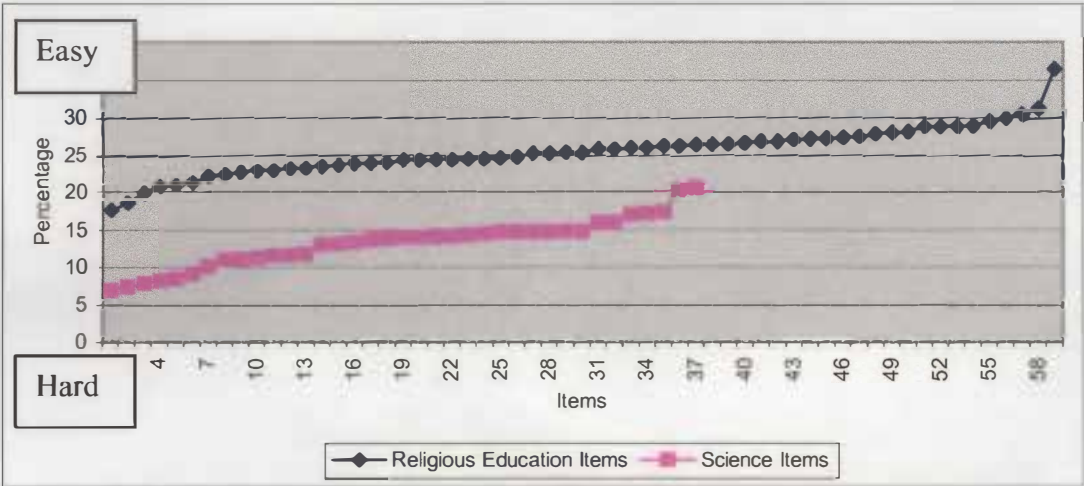


Figure D. Religious education and science belief (other) items ordered from hard to easy.

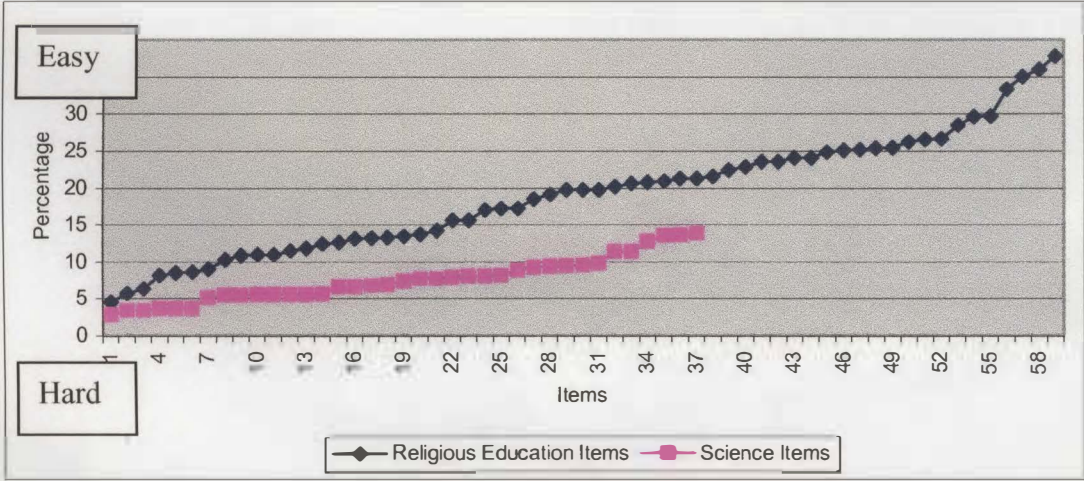


Figure E. Religious education and science belief (no belief) items ordered from hard to easy.