Science and Mathematics Education Centre

The Use of Traditional Knowledge in Understanding
Natural Phenomena in the Gulf Province
of Papua New Guinea

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ABSTRACT

This study used qualitative methods (interviews) and quantitative methods (questionnaires) to investigate and describe (a) Papua New Guinea (PNG) village elders’ traditional ideas and beliefs on natural phenomena, (b) PNG secondary school student’s traditional science beliefs, (c) the sources of PNG secondary school students’ explanations of natural phenomena, (d) the types of explanations PNG secondary school students provide to describe natural phenomena, and the views of science teachers and curriculum officers on the inclusion of traditional knowledge in the science curriculum. Analysis of data included interviews with eight village elders and completed questionnaires from approximately 200 secondary school students in one rural provincial high school in the Gulf Province. Village elders’ beliefs were analysed and categorised into (a) spirits, magic spells and sorcery, (b) Christianity, (c) personal experience, and (d) modern science. Secondary school students’ sources of explanations were based on what they have heard at (a) home, (b) in the family and village, (c) in church and (d) from school. Approximately half of the secondary school students strongly hold on to traditional beliefs while learning formal school science and these were related to spirits, magic spells and sorcery that were similar to those of the village elders. Students also used scientific explanations of natural phenomena based on their learning in school and from their own personal experiences and interactions with the physical world. Interviews with science teachers and curriculum officers supported the need to include traditional knowledge in the science curricula. The study identified students holding both traditional and scientific explanations of natural phenomena. There is both a need and value for traditional knowledge being incorporated in science education programs that harmonise with school science. The thesis concludes with six recommendations to bring these ideas to fruition.
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ACRONYMS

CDD Curriculum Development Division
ESL English as a Second Language
HSC Higher School Certificate
LMS London Missionary Society
NCD National Capital District
NDOE National Department of Education
NEC National Executive Council
NRI National Research Institute-
PMV Passenger Motor Vehicle
PNG Papua New Guinea
SC School Certificate
SISS Second International Science Study
TOUS Test Of Understanding Science
TPPS Tok Ples Pre Skul
UPNG University of Papua New Guinea
CHAPTER 1

INTRODUCTION

1.0 Overview of Chapter

This chapter provides a brief description of the context and framework in which this study is placed by explaining the concepts of culture, worldview and traditional knowledge. The chapter describes the research questions that guided the study and states the limitations which help to place the study in its context. Finally, an overview of each of the chapters is given.

1.1 Background and Rationale

During the early 1970s, the researcher experienced his first science lesson in a science laboratory in a secondary school in Port Moresby. The smell of the laboratory was strange and the displays of animals like snakes, lizards and a human foetus made him realise that science was a study that dealt with nature and its surroundings. It also occurred to him that in science, important things were discovered and explained by famous scientists. The researcher remembers that he was taught by a foreigner and the learning context was based on the Western formal system of learning. However, it was during a practical session on the dissection of a frog that made the researcher became sick, as he felt sorry for the poor animal. The anatomy of the frog was studied in order to see and learn its internal organs, tissues and systems that were similar to humans. The smell of the chloroform to put the frog to sleep was unbearable and the feeling of having to touch the animal was not welcomed by the researcher. The result and consequences after this practical lesson was that the researcher lost his appetite. He found it hard to swallow food during meals because the memory of dissecting the frog with its internal organs exposed kept recurring in his mind.
In 1978, as a newly graduated secondary school science teacher, the researcher began his teaching career at a secondary school near Rabaul in the East New Britain Province. He found the teaching exciting and challenging as the training he received at Goroka Teacher’s Training College (now University of Goroka) in the Eastern Highlands Province moulded him to teach formal Western science with strange looking equipment. The students came from various cultural groups and brought to the science classroom different ideas about their natural world, traditionally handed down by the elders to the young from generation to generation.

Secondary school students can be engaged in scientific experiments in the school laboratory but the learning derived from such an experiment may be limited if they see no relevant links between the activity and their personal concerns. For example, according to the researcher, in an experiment on the ‘expansion of air’, students in a Grade 7 science class were asked to predict and explain what would happen after they rubbed their hands together and held a test tube with air inside. The test tube was enclosed by a cork with a glass tubing attached to it. The glass tubing had a drop of coloured water added to it. In this experiment, students rubbed their hands together to make them warm and then touched the test tube. The students observed that the coloured water in the glass tubing moved. Surprisingly, this demonstration can illustrate that students can observe a phenomena such as this and simply relate it to magic. In fact, if an experimenter was demonstrating this and used the command, ‘move coloured water move’, this would have really amused some students into believing that it was magic. Indeed, many students do not see that it is the warmth (heat energy) produced from the rubbing of both hands that makes the air expand inside the glass tubing thus allowing the coloured water to move. It is assumptions like this belief in magic that interested the researcher to conduct a study to investigate whether students’ understanding of science concepts was influenced by their cultural background and any traditional knowledge that they may possess which they bring to formal science classes.
1.2 Teaching and Learning Science in PNG

It has always been a dilemma teaching and learning science in PNG because students come from different tribes where cultural ideas and beliefs are a reality in their minds. Students bring to science classes their ideas and beliefs about the natural world that often are not in conformity with the accepted scientific notion (Driver, Squires, Rushworth, & Wood-Robinson, 1994). The aim of teaching science in PNG appears to persuade students to accept science as ready-made packages of knowledge (Blumer, 1971) imported from off-shore (Avalos, 1993; George, 1991; Matane, 1976; Thaman, 1993; Thomas, 1993; Weeks, 1993). This research study was designed to investigate traditional knowledge (stories) or beliefs that students bring to science classrooms about the natural world and ultimately see if this knowledge could help enhance, harmonise and improve their understanding of school science.

Both Boeha (1987) and Kelontii (1996) claimed that National High School students in PNG aged 16 to 17 years bring to science classes various scientific beliefs about the ‘force’ concept. These beliefs include the understanding and interpretation of natural phenomena, which students possess before the systematic study of science with its highly developed descriptive and explanatory systems. These beliefs differ, in many respects, from those that students are required to study in their science classes. Similarly, research in PNG (Clarkson, 1994; George, 1991; Hill, 1994; Maddock, 1981; Vlaardingerbroek, 1990) identified some prevalent traditional beliefs or ideas being used to explain natural phenomena in dealing with traditional knowledge. Interestingly, these studies have shown that scientific explanations of the physical world are learned in school science chiefly for passing examinations. However these studies, except that of Kelontii’s (1996), have not examined the concurrent existence of traditional knowledge and students’ understanding of the natural world that they hold while attending science classes. These ideas, beliefs and knowledge, which students have continuously brought to science classes, form the basis and foundation of this study. The fact is that students have always brought to science classes knowledge and beliefs about their natural world. However, teachers tend to continuously ignore, and have not dealt seriously, with this knowledge and instead have taught solely Western scientific knowledge. Therefore, to address this
dilemma this study aimed to investigate some of the traditional ideas, knowledge and beliefs which students hold while attending formal science classes.

Various researchers have argued that the culture of a learner plays a central role in learning science, using prior knowledge and stated perceptions in arguing how learning occurs and its reliance on the environment as a source of information (Jegede, 1995). In the case of Papua New Guinean students who attend science classes with their Melanesian worldview, the interaction between the Western mechanistic worldview and their Melanesian traditional knowledge somehow complicates their cognitive processes. Indeed, there are strongly held traditional beliefs by some tribes and less strongly held traditional beliefs by other tribes in PNG. The various adapted teaching strategies in which the science curriculum and instruction are implemented in PNG classrooms appears to give the impression that the Western view of nature is the only correct way of learning about the natural world, thereby underestimating and undervaluing the learner's traditional knowledge. Moreover, viewing traditional knowledge as unimportant and non-scientific may create difficulties for Papua New Guinean learners. This conflict of one worldview with another in learning science is perhaps similar to the intrusion of a first language with the learning of a second one (Jegede, 1995). Therefore, there is a need to interpret meaningfully how information is mastered and what elements interact to make learning of scientific concepts in PNG classrooms possible. The conceptions about science held by students in PNG cultures needs to be taken seriously. In fact, Malinowski (1948), after studying several cultures, concluded that 'there are no people, however primitive, without religion and magic. Nor are there, it must be added at once, any savage races lacking in either scientific attitude or in science' (p.7). In the same way, Cobern (1993b) states that 'if science is taken to mean the causal study of nature by simple observation, then, of course, all cultures in all times have had their own science' (p. 2).
1.3 What is Culture?

Culture is a concept that is easy to understand yet difficult to define meaningfully. In spite of this, Kroeber and Kluckhohn (1963) had identified over 160 definitions by the mid twentieth century and there have been probably as many since. The meaning of 'culture' as described by early researchers till today are all similar, as shown in the following summary, and are determined from anthropology and ethnography of which this study has its basis. To begin, Taylor (1913) identified culture as that complex whole which includes knowledge, belief, art, morals, law, custom and any other capabilities and habits acquired by people as members of a society. Similarly, Piddington (1963) represented culture as the total sum of material and intellectual equipment whereby [people] satisfy biological and social needs and adapt themselves to their environment. A deeper explanation by Goodenough (1963) stated culture as standards of deciding what is, standards for deciding what can be, standards for deciding how one feels about it, and standards for deciding how to go about it. Again, White (1972) determined culture as a class of things and events, dependent upon symbolising, considered in an extra somatic context, while Geertz (1973) translated culture as an ordered system of meaning and symbols, in terms of which social interactions take place.

Furthermore, Phelan, Davidson and Cao (1991) conceptualise culture as the norms, values, beliefs, expectations and conventional actions of a group while Banks (1988), Ingle and Turner (1981), Jordon (1985), Samovar, Porter and Jain (1981) established and listed the attributes of culture as communication (psycho- and sociolinguistic), social structures (authority, participant interactions, etc.), customs, attitudes, values, beliefs, worldview, skills (psycho-motor and cognitive), behaviour, and technologies (artefacts and know-how). Similarly, Maddock (1981) lists culture as 'beliefs, attitudes, technologies, languages, leadership and authority structures' (p.20) while Ogawa (1986) illustrates a culture’s view of humans as its view of nature and way of thinking. Interestingly, Power (1992) asserts that culture provides the shared knowledge and values that enables the members of a group to communicate effectively with one another. Again, Jegede (1994) claims that culture consists of a
group of activities with a common purpose, views, vision and practice which Taylor (1994) views as the myth that reproduces the appearance of a single social reality.

Research on culture (Jegede, 1998; Jegede & Okebukola, 1989; Okebukola & Jegede, 1990) explains that it is a determining factor for differences in achievement in school work. In fact, Ogbru (1992) agrees and states that school learning and performance are influenced by complex social, economic, historical and cultural factors. Similarly, Glaser (1991) determined that cognitive activity (in school and outside) is inseparable from its cultural milieu. Because each society expects the younger educated generation to pass on the socio-cultural attributes of its people, the socio-cultural factors within non-Western societies become a composite part of the environment. These factors control, to a greater extent, what children in such an environment learn and what they become and know about in later life (Jegede, 1997). Finally, culture as the totality of all humans, embodies every challenges we undertake, including science education. As a result, Gallagher and Dawson (1984) and Maddock (1981) concluded that science education is a cultural and human enterprise involving the transmission of cultural heritage of a people. Contrarily, Jegede (1997) questioned why African students, like Papua New Guinean students learning Western science, show certain traits that do not seem to agree with the expectations of learners in 'typical' Western science classes. These students hardly show courage to ask questions in class and when forced to give their opinions, some believe science has little relationship within their own real world. Other assume that science is a weird, special activity, which requires explanations to be either magical or superhuman which is often real and frustrating for the teacher who perhaps shares the same socio-cultural background. For the teacher with a Western science background, the situation is even worse (and may be depressing) when having to teach students with non-Western science backgrounds in a foreign language. However, a person's culture implies a certain difference between themselves and people of other cultures (Baker, 1998).
1.4 What is Worldview?

Cobern (1996) defines worldview as 'metaphysical levels antecedent to specific views that a person holds about natural phenomena, whether one calls those views common-sense, theories, alternative frameworks, misconceptions, or valid science' (p. 585). Specifically, a worldview is said to be the set of key non-rational beliefs on which these conceptions of reality are grounded. Cobern (1996) states that a person's worldview provides a non-rational foundation for thought, emotion, and behaviour. Furthermore, it provides a person with beliefs about what the world is really like and what constitutes valid and important knowledge about the world.

Similarly, Kearney (1984) accords worldview as a 'culturally organised macrothought: those dynamically inter-related basic assumptions [i.e., presuppositions] of a people that determine much of their behaviour and decision making, as well as organising much of their body of symbolic creations ... and ethnophilosophy' (p.1). Again Cobern (1991, 1993a, 1994) draws upon anthropology to examine Kearney's model of student's worldview that comprises seven 'logico-structural categories' (self, other, causality, classification, relationship, time and space)' (pp. 38-39). Ideally, a person's worldview presents a special plausibility structure of ideas, activities and values that allow one to gauge the possibility of any assertion which are culturally validated (Cobern, 1996). Interestingly, Baker (1998) describes worldview as the dynamic belief system of the individual formed and shared through life-long interaction with one's culture, society, and environment, which disposes individuals and communities to accept or reject actions and ideas.

Ogawa (1995) views the scientific worldview as an abstraction, in which nobody lives, separated from the real world. Among the Japanese, traditional culture does not seem to be in conflict, in its strict sense, with science. Similarly, Jegede (1997) views traditional worldview as traditional beliefs and superstitions being used as a framework through which daily occurrences are interpreted. African society holds the notion that supernatural forces do have significant roles to play in daily life and the younger members are expected to learn and believe these notions without questioning them. Traditional societies in PNG also expect knowledge to be handed
down by the elders to the younger generation without being questioned. However, this can create conflict when learners gain scientific knowledge at school that is not in agreement with the traditional worldview. Finally, Cobern (1996) discusses and suggests that culture, worldview and conceptual change in science are important for science educators in understanding the key, culturally based beliefs about the world that students bring to science classes. Teachers also need to understand how these beliefs are supported by a student's culture because science education is successful only to the extent that science can find a niche in the cognitive and socio-cultural milieu of students. Again Cobern (1996) suggests that through teaching and the curriculum, teachers and curriculum developers should examine and understand the key, culturally based-beliefs about the world that students bring to science classes.

1.5 Traditional Knowledge

Traditional knowledge in many traditional societies in PNG appears to be finite and is passed down from generation to generation by word of mouth by older members of a tribe to the younger generation as a survival tactic. Such knowledge includes the skills of hunting, trading expeditions, gardening (planting and harvesting), building shelters, healing diseases, forecasting weather, initiation ceremonies, funeral rites, protection against crocodiles, fishing expeditions, and various activities associated with cultural heroes. The teaching and learning, which occurred through practical absorption (observation) and participatory activity embedded in the villagers' daily lives, are usually conducted by the most respected elders in a community. Specialists teach the tasks to a selected few who had gone through the primary and secondary streaming processes by way of pre-initiation (Kelontii, 1996). Pre-initiation is mainly done through observing the child's interests at an early age. For example, suppose a child is found to possess aggressive behaviour, he is singled out and given a warrior's initiation. In traditional societies in PNG, the learners were confined to a tribal group of a particular village. Whatever skill was a speciality to that village was confined to that village and used as a means of bargaining with other villages. For example, clay pots for cooking, the making of which was a trade known only in a particular village, were exchanged for sago and betelnut, grown in another village. For such trading purposes, each other's languages had to be mastered and so inter-
marriages were encouraged to establish lasting commercial relationship for generations.

The characteristics of traditional learning are through observation, imitation and verbal instruction, by personal trial and error through demonstrations, mostly with real life activities, and in context-specific and person-oriented activities (Harris, 1992). In many villages, learning of indigenous languages, folklore, personal-social relationships, traditional vocations and dances and the nature of family structures, still depend heavily on these procedures and experiences from the past. The traditional teaching methods to which the children are exposed and become familiar can be utilised, adapted and integrated into the formal learning environments at school in order to suit their immediate interests and needs. However, given these early life experiences, the majority of students find formal learning strategies totally different from those to which they previously have been exposed. McLaughlin (1996) states that educators should carefully consider and plan learning experiences that recognise these cultural difficulties, a situation that sadly is not always the case.

PNG must protect and promote its indigenous traditional knowledge because of its cultural diversity. The Vice Minister for Education, Professor John Waiko, addressed participants at the Second Waigani Seminar on ‘Information and the Nation’ at the University of PNG while speaking on the topic ‘The Value of Traditional Knowledge in the 21st Century’. Professor Waiko stated that indigenous knowledge is a living treasure both in the immediate past from recent oral and written history and in antiquity from the ancient past (Levi, 1997). Therefore, Papua New Guineans must learn to accept, preserve and promote the traditional knowledge that has been inherited from their ancestors. PNG has more than 6,000 autonomous ethnic groups spread across the country with more than 800 languages. This diversity is a great potential source of scientific research that would benefit from high information technology awareness, and at the same time save traditional knowledge from extinction (Levi, 1997). The Ministry of Education is intent at keeping traditional knowledge alive through the current national education reform process that is directed at integrating the traditional knowledge into the national curriculum.
1.6 Science Education in PNG

The development of science education in PNG has led to serious attempts to overcome difficulties encountered by students of different cultural backgrounds. Students bring to class prior knowledge constructed in their early childhood during socialisation and enculturation by others such as their parents, peers and other family members. The students’ cultural background may often have a greater effect on their education than the science subject content because they may interpret new information from a traditional perspective. For example, the unit on human reproductive and contraceptives taught in upper secondary schools appears to make the learners betray themselves culturally and so culture in the view of both learners and the indigenous population is devalued (Fensham, 1988). Moreover, students in PNG are also at a cultural disadvantage because they are studying Western science curricula where some units taught may be defiant to cultural taboos, thus making them reluctant or hesitant in their learning. It is in the light of the views mentioned above that the formal education programs in PNG are derived from the stated aims of the secondary school science syllabus (Department of Education, 1975). These aims consist mainly of attitudinal objectives and help the students to develop:

- an awareness of, interest in and curiosity about the natural surroundings of their environment by seeking scientific explanations.
- an understanding and appreciation of their environment and confidence in their ability to effect changes and improvements in the environment.
- an understanding of significant scientific facts and theories and the ability to apply them in relevant situations.
- their ability to think critically and reduce tendency to adopt opinions based on unsupported or unreliable evidence.
- an understanding and appreciation of the methods of science and the past, present and possible future contributions of science to humankind.
Furthermore, a proposal with recommendations was forwarded by secondary school science teachers during the South Pacific Conference on Pre-Tertiary Physics Education in 1993 to the National Department of Education (NDOE) in an attempt to reconsider and re-address the curriculum component policy. The proposal recommended that:

- the curriculum should encourage students to learn science using as much as possible their cultural and environmental background and experience.
- the history of science and technology (including traditional knowledge and skills) should be incorporated into teaching programs (Recommendations of the South Pacific Conference on Pre-Tertiary Physics Education, 1993, p. 3)

Earlier research (Boeha, 1987; Maddock, 1981) indicated that children in PNG have difficulty accepting particular scientific models that consist of systems of concepts that are associated with the rules of inquiry and analysis of phenomena. Alternatively, the patterns of thinking in traditional PNG societies are simple and empirical and some also are associated with beliefs in the efficacy of magic. The present system of education in PNG is concerned with changing the behaviour of students in ways that are considered to be desirable for society in terms of knowledge, skills, attitudes and values, which reflect the goals, aims, and objectives of the society itself.

With little research conducted on traditional knowledge of natural phenomena and the various ideas and knowledge about natural phenomena that students bring to science classrooms, it is important to investigate views held by students in a typical science class in a typical PNG secondary school. This study therefore attempted to identify the types of traditional knowledge (stories) and beliefs held by respected village elders and secondary school students on natural phenomena. There is still more research needed on the ways in which children learn in different cultural settings. This research is crucial for a developing country like PNG to enable students to develop their potential so that they can grow and mature as individuals and at the same time fulfil the needs of their own societies.
1.7 Objectives of the Study

The objectives of the study were to (a) identify and describe the various traditional knowledge (stories) held by respected village elders and secondary school students on natural phenomena in Papua New Guinea (PNG), (b) identify the types of traditional science beliefs that secondary school students hold, (c) investigate the sources and explanations that secondary PNG school students use to understand natural phenomena, (d) investigate the types of explanations that secondary PNG school students give for natural phenomena, and (e) identify the views of science teachers and curriculum officers on the inclusion of traditional knowledge in the science curriculum.

1.8 The Research Questions

In order to provide a focus for these objectives, the following research questions were formulated to direct this study.

1. What traditional beliefs or stories do village elders hold in explaining natural phenomena?

2. What traditional science beliefs do secondary school students hold?

3. What are the sources of explanations that secondary school students give for natural phenomena?

4. What types of explanations do secondary students give for natural phenomena?

5. What views do science teachers and curriculum officers have on the use of traditional knowledge in the science curriculum?

In answering these specific research questions, the various ideas and beliefs that students hold while attending formal science classes are identified. The study also
determined whether students’ learning of scientific concepts is influenced by their cultural and social environment and whether or not it is integrated as part of their traditional knowledge and beliefs. Furthermore, the study determined whether the views highlighted by the science teachers and curriculum officers on traditional knowledge will help in developing a suitable PNG science curriculum.

1.9 Limitations

This study was restricted by some limitations and its dependence on some basic assumptions. The first limitation was that the study was done in one location and setting which was in the Gulf Province of PNG. Therefore, this does not represent and is not reflective of the whole population of PNG as there are marked differences between provinces.

The second limitation was that the study did not attempt to interview all village elders in all the Toaripi speaking villages, either inland or on the coast from Cape Possession to the Avei mouth of the Purari river. In this study, the sample was small and included only elderly men. Although the interviews with the village elders were conducted in the Toaripi language with the researcher who also speaks Toaripi, the transcribing and translations into English may have distorted some meanings that were previously expressed by all the elders.

The third limitation was that the study was restricted to only one school with two classes each of Grades 9 and 10 and three classes each of Grades 7 and 8 in PNG. For the findings of the study to be generalised to the whole country, it must be assumed that the students involved in the study were representative of PNG, and this is not necessarily true. Although the total sample was 216 students, only 159 students attempted the first instrument, Traditional Science Beliefs, 179 students attempted the second instrument, Student Questionnaire 1: Sources of Explanations and 153 students attempted the third instrument, Student Questionnaire 2: Types of Explanations. The fact that not all students responded to all the instruments may have created inconsistencies in results. As only nine students from the senior grades
were randomly selected for interviews, this may not have been reflective of the school population.

The fourth limitation involved the modification of the items used in the *Traditional Science Beliefs* instrument and the construction of items in *Student Questionnaire 1: Sources of Explanations* and *Student Questionnaire 2: Types of Explanations* into a form suitable for *English* as Second Language (ESL) speakers. This modification and construction of items in the instruments may have affected data processing and any comparison between the results of this study.

Further discussion of the limitations essential to this study is given in Chapter 10.

1.10 Overview of Thesis

Chapter 2 reviews the literature that relates to science education in developing countries in terms of students’ cultural beliefs, traditional knowledge, ideas and explanations about natural phenomena. Chapter 3 gives a background to PNG culture and the past and present education system. Chapter 4 describes the methodology of the study and examines the various qualitative and quantitative research methods and their relevance to this study. It also contains a description of the population studied, the interviews with village elders, the design of the questionnaires, the approaches used in the study and the methods used for statistical analysis. Chapter 5 examines and outlines the results analysed from the interviews with village elders on their beliefs, ideas and explanations about natural phenomena. Chapter 6 presents the data that discusses secondary schools students’ traditional science beliefs in PNG. Chapter 7 examines and discusses the data obtained from the sources used by secondary schools students in explaining natural phenomena in PNG. Chapter 8 examines and discusses the types of explanations secondary schools students hold in explaining natural phenomena. Chapter 9 discusses science teachers and curriculum officers’ views on traditional knowledge in the PNG science curriculum.
In Chapter 10, conclusions are made from the findings relating to the types of beliefs and traditional knowledge (stories) held by respected village elders and secondary school students on natural phenomena and whether these have had an influence on students’ learning of formal science concepts. It also includes the science teachers’ and curriculum officers’ views on traditional knowledge in the PNG science curriculum and provides recommendations for the use of traditional knowledge in assisting teachers and curriculum officers in developing strategies and materials that will enhance and improve the relevance of secondary school students’ science learning. The limitations identified in this study also are presented in the final chapter.
CHAPTER 2

SCIENCE EDUCATION IN DEVELOPING COUNTRIES

2.0 Overview of Chapter

This chapter commences with a review of literature in developing countries related to this study. The issues of culture and worldview are also discussed in this chapter as they both help to determine the ideas, beliefs and explanations possessed by village elders and secondary school students in a particular cultural group (Toaripi) of the Gulf Province. Children's ideas about natural phenomena and the use of explanations in science teaching are discussed.

2.1 Results of Studies of Traditional Knowledge in Developing Countries

This section presents research studies describing the effect of traditional explanations in the way a learner interprets new knowledge similar to the current study in developing countries.

2.1.1 Traditional knowledge and explanations

Anamuah-Mensah's (1998) study, which attempted to explore the extent of 'native' science beliefs among Ghanaian students in secondary and tertiary institutions, was based on the assumption that the way in which individuals respond to traditional causal statements is indicative of their native science beliefs. The sample consisted of 182 students [47 secondary school students (Form 1 to 3), 56 Form 4, 42 Form 6 and 37 university students] who responded to 28 statements on a five-point Likert-like Scale on 'Native Science Beliefs'. All 28 items were examined using a principal component analysis that yielded 10 factors, namely:

- belief that certain actions invoke the presence of supernatural beings such as evil spirits and witches;
- belief in supernatural events or beings;
• belief that actions of individuals can result in consequences for them;
• belief that certain actions had positive consequences;
• belief that certain events (both natural and man-made) can result in unfavourable consequences,
• belief that disease can be caused by certain (food-related) acts such as eating bananas or snails;
• belief that certain anti-social behaviour such as spitting or urinating into fire can precipitate severe consequences, including death; and
• belief that certain foods can improve the intelligence of the individual.

Strong beliefs were shown in only 6 of the 28 belief statements. At least 10% of the respondents exhibited native science beliefs for 20 out of the 28 statements. The study revealed that native science beliefs are held firmly by a substantial proportion (at least 10%) of students. The need to consider the personal cultural beliefs held by the science students during science lessons was emphasised.

Ingle and Turner (1981) maintained their belief that for any progress to be made in improving science education in developing third world countries, there has to be an understanding of traditional modes of beliefs about the natural world. Okebukola (1986) claim that the cultural background of the learner may have a greater effect on education than does the subject content is consistent with another study (Okebukola & Jegede, 1990) which shows that reasoning based on a worldview which accepts the power of magic impairs students in adopting an empirical methodology and accepting empirical evidence.

Jegede and Okebukola (1991) suggested that a traditional worldview causes the student to become involuntary selective when making observations. They believed that this effect might be attributable to the epistemology inherent in a student’s traditional worldview, and to feelings of fear, rather than to a body of conflicting knowledge. These findings are consistent with Ogguniyi (1988) who suggested that members of rural communities explain natural phenomena through non-rational means. Barlex and Carre (1985) argued that we do not see things as they are, but as we are. Jegede and Okebukola (1991) claimed that a subject in their study who is
afraid of an object to be observed, owing to certain taboos or philosophical or religious beliefs, may end up making totally variant observations as a result of attendant feeling of dread or foreboding. Ogguniyi (1988) stated that traditional and scientific modes of thought have become widely used to denote polar opposites in a linear theory of social change. Similarly, Uvrevbu (1984) asserted that most science curricula in African countries are modelled on western curricula and, hence, do not reflect the cultural background of the African learner.

Jegede and Okebukola (1991) used Ogguniyi’s (1987) “Traditional Cosmology Test” to collect data from 319 students with a mean age of 16.9 years enrolled in pre-degree science programs. They were asked questions designed to measure their commitment to a traditional cosmology and also were given a ‘Test of Observational Skills’. The two sets of data were correlated and students with a high level of traditional belief scored less well in the observation tests than those with a low level of traditional belief. The authors claimed, as a result, that the causative factor affecting students’ scores is the extent of their belief in traditional cosmology, superstitions and taboos. They also suggested that certain preconceived notions about the objects upon which the observational tasks were built constrained the subjects with a high level of belief in African traditional cosmology from making careful, systematic and critical observation. If a high level of African traditional cosmology prevents students from making careful, systematic and critical observations, it certainly will have an effect on the results of school science education, which emphasises observing, hypothesising and reporting. These skills are generally considered important for the development of ‘scientific thinking’, a concept Horton (1967a) distinguished from ‘traditional thinking’. Horton identified six attitudes that distinguish traditional from scientific thinking namely, attitudes toward: the prediction of events; cause and effect; experimentation; the confession of ignorance; coincidence, chance and probability; and time. Horton’s underlying premise is that traditional thinkers resist change, whereas scientific thinkers embrace change in order to test or modify existing theory.

Horton (1971) described beliefs about the natural world as a representation of reality based upon prototype experiences that are shared by most members of a cultural
group (Prince, 1969) whether ethnic, organisational or academic. Due to this, it is the researcher's intention to use the term 'traditional explanations', to mean those explanations agreed upon by members of an identifiable group sharing a common culture. Traditional explanations, however, seem to be far more widely shared, appear to be highly tenacious, and conflict with science education in at least three approaches. They are identified as traditional beliefs, epistemology and taboo (see section 2.1.2).

However, Baker and Taylor (1995) maintain that if the above research findings are correct, it is educationally unsound to present science education to developing countries without careful consideration of traditional perceptions through which they are likely to interpret phenomena. The research implies that traditional views, cultural explanations and language are simply expressions that a society considers as normal to its _eco-culture_. These _norms_ are communicated through the epistemology inherent in the culture and the meanings embedded in particular metaphors, which are passed on through time-honoured interpretations of reality. These factors mean that students' cultural backgrounds are likely to affect their ability to fully comprehend and manipulate scientific concepts. The implication of this observation is that many of us do not seem to appreciate the size of cultural gap that exists between _Western_ and non-_Western_ interpretations of reality as they affect science education (Baker & Taylor, 1995).

2.1.2 Traditional beliefs

Snively (1990) claims that different individuals understand and experience the world through an interpretive framework that embodies a coherent set of beliefs and values, mostly derived from their natal culture. These interpretative frameworks are referred to as _orientations_ namely, scientific, utilitarian, spiritual, aesthetic, recreational, health and safety. Each orientation is typified by beliefs that are sometimes contrary to accepted scientific beliefs. These observations suggest that the cultural beliefs of students in developing countries often causes them to reject classroom ideas unless teachers attempt to reduce the conflict between the two.
According to Maddock (1977), traditional explanations were strongest among students and parents who were least involved with the formal education system. Those who spent more time at school were most likely to reject traditional explanations or hold dualistic perspectives of natural phenomena. These students were most likely to adopt scientific explanations and viewed village people as backward and ignorant (Waldrip & Taylor, 1999). Maddock's (1977) findings can be interpreted to mean that traditional explanations are significant to students unless and until they are subsumed by school science explanations. As this subsumption progresses, students are less likely to accept traditional explanations, but if subsumption does not occur, scientific explanations will be either accommodated within traditional explanations or rejected. Maddock (1983) found that a direct relationship exists between the strength of traditional beliefs and attitudes to learning, and George and Glasgow (1989) found evidence that traditional beliefs or 'street science' conflict with conventional science education in the West Indies. They found that it was difficult convincing students that some beliefs had harmful effects.

However, a conflict of belief need not always result in the rejection of scientific ideas. In some circumstance, indigenous students resolve the issue of conflicting belief not through rejection but through accommodation or dualism. Maddock (1983) and Marshall and Gilmour (1989) claimed that students were willing to present both the school view and their traditional view, each in its own context and believed that each was valid. Jegede (1994) calls this ability of students to accept conflicting explanations as collateral learning, the process whereby a learner in a non-Western classroom constructs, side by side, and with minimal interference and interaction, Western and traditional meanings of a simple concept. Baker (1998) confirmed that Jegede (1994) described a real, cognitive phenomenon that is experienced by many non-Western students seeking to make sense of two interacting worlds - traditional culture and the classroom. Jegede's (1994) theory of collateral learning explores the cognitive explanations of how the act of cultural border crossing takes place, especially in environments where cognitive conflicts arise from different cultural settings (school culture and home culture). Baker (1998) states that a conflict of belief occurs when a student is confronted by two or more explanations of the one phenomenon, one of which is a traditional belief that pre-dates the classroom.
explanation. This traditional belief is a true alternative explanation where it is in conflict with Western scientific thought, and is likely to be resolved by rejecting the novel in favour of the known, by accommodating traditional and scientific views in a compartmentalised fashion, or by assimilating traditional and scientific views to construct a new and different perspective (p. 65).

The second potential conflict occurs when the students' traditional epistemology, or ways of knowing, considered normal within a culture, is in conflict with the scientific epistemology. Greer (1992) stated the problem that arises when indigenous students are told, for example, that they can learn more about frogs by dissecting them. If the students' cultural perspective identifies a frog as a sacred animal, or as a relative, and their epistemology states that the normal way to understand a relative is to observe and communicate, not dissect, the result is epistemological conflict.

From the researcher's experiences of teaching in a secondary school near Kokopo in the East New Britain Province, a classroom group which was considered to be simple became uncontrolled due to the rules of tambu (Pidgin for taboo). Simple in this case meant that the male and female students were treated the same and there was no cultural differences amongst them. In fact, the power of taboo affects the way one views any activity, including formal learning, through observations of social and classroom activities. The classroom performance of female students, for example, was significantly affected by their refusal to participate until male students finished, and their refusal to compete with male students. Baker (1998) stated this perception by the girls which interprets that male students must 'legitimise' females' participation by indicating that they were finished, is related to the understanding of village taboos pertaining to the roles of men and women. The tendency to defer to male students was most obvious among girls from rural areas and least evident among urban students. Similarly, Waldrip and Taylor (1999a) claimed that students who were breaking taboo were most often made against urban students. Therefore, taboos are significant to the process of formal education as suggested by Jegede and Okebukola (1991) who both stated that taboos are also significant to the content of formal education.
Taboos, or socio-cultural constraints, exist within all social groups, so they are not reliant upon any specific cultural context or epistemology for their power. Baker (1998) stated that within Australasia, a spiritual orientation is more likely to enhance a person's response to taboo due to the fear of the intangible. By contrast, adult Western society, with an individualistic and materialistic orientation, implicitly encourages its members to ignore taboos or find ways around them. Although the effect of taboos seems not to have been exhaustively researched in the context of science education, Baker (1998) concluded that it is an important issue that helps to shape students participation in, and interpretation of, science education. Baker (1998) claimed that explanations and beliefs that typify members of a cultural group appear to influence the acceptance and interpretation of new ideas, particularly when they relate to prediction, cause and effect, probability, and time.

2.2 Science Education Research within Papua New Guinea

According to Yager (1993), the PNG government-operated secondary school system only started in the late 1950s and expanded very quickly. The first high school to take on Grades 11 and 12 was opened in 1969 (Bacchus, 1984) and the university sector was established during the mid-1960s, which resulted in an upsurge of research being conducted within PNG. Attendance at school, the mastery of English, and obtaining paid employment became, and still are, viewed as the hallmarks of successful positive attitudes towards science throughout the academic year irrespective of the performance in science subjects (Wilson, 1987a). Wilson (1985, 1987b, 1988a, 1988b) studied data from the Second International Science Study (SISS) and stated that most teaching time was allocated by lower secondary science teachers to practical work and that there were frequent question and answer and note-taking sessions. However, Waldrip's study (1994) stated a decrease in the time allocated to practical work while Wilson (1989, 1990) reported that the PNG science curriculum was wider and broader than elsewhere although it was of less depth than those in many countries. Since the PNG education system is in the reforming stage, the whole science curriculum is being revised.
Were (1967) attempted to measure the intellectual development of New Guinea secondary students aged 14 - 16 years based on Piaget's concept of formal thought using a test divided into verbal-logical and empirical sections. Subsidiary and comparative evaluations were made by using tests of divergent thinking, intelligence and attainment. There were three groups of subjects: the first sample came from first form (Grade 7) of a New Guinean secondary school; the second - a group of New Guinea scholarship students - came from Forms I (Grade 7), II (Grade 8), and III (Grade 9) of a multi-racial high school; and finally there were European subjects, who also came from a range of forms and all their ages ranged from 14 to 16 years. The analysis of the data showed comparative successes of the two New Guinean samples on the Piagetian test estimated by non-parametric tests of significance. The results suggested that New Guineans do not ordinarily reach the level of formal thought by the time they begin their secondary education.

Wilson's (1977) study produced and administered two attitude scales to student teachers in Papua New Guinea, in order to determine whether attitudes to primary science teaching and to science per se were significantly changed during the two-year college courses or after teaching in the field. Large and significant changes in attitudes to primary science teaching were found and small and significant positive changes in attitudes to science did take place. Results for teachers in the field were more like those for students completing college and males scored higher than females. Griffiths (1970) outlined problems encountered in teaching science to preliminary year students at the University of PNG and stated that individual students entering the course have a wide range of background experience which constitute problems for the teacher. Furthermore, for most students English is a second language and lack of fluency and confidence in using English may have serious impact in the use of scientific terminology and systems of classification, which requires a high degree of accuracy. Other difficulties included the understanding of diagrams of three-dimensional objects, the reading of scales, and the solution of numerical problems. The researcher experienced these difficulties when he discussed examples with Grade 10 students who had completed their 1998 Grade 10 School Certificate Science Examination paper at Malalaua Provincial High School in November 1998. Griffith's (1970) study also found that students have
difficulty in dealing with formal logic and abstract models required by a Western education system.

2.2.1 Ethnoscience (traditional science)

George (1991) defined ethnoscience or traditional science as explanations or interpretations of the physical world held by students in the form of notions, beliefs or stories. Andrews (1970) defined ethnoscience as 'the "science", in the sense of modes of classification of the material and social universe, possessed by societies unaffected or little affected by modern international scientific thinking and discoveries' (p. 1). Examples of research on ethnoscience presented here are concerned with the ways in which several New Guinea societies order particular aspects of their universe, namely plants and animals, colour, space and number. Current research still shows that traditional science is strongly held by the various tribal groups in PNG.

A general reference to New Guinea folk taxonomies of plants and animals shows that in most systems terms for the larger category include, for example, scorpions and snakes in a single primary taxon. This can only be understood in terms of the significance that particular species have for humans and of their place in the local cosmology (Blumer, 1971). The kind of categorisation developed and documented for the Western Enya people of the Laiagam area state a classification of the 'animates' comprising several kinds of semantic features. Morphological features are the most numerous with eight being eyed, bony, furred, winged, tailed, eared, biped, legged. The second most numerous groups are the six features of habitat: forest dwelling, aquatic, pond dwelling, heavenly, subterranean, stone dwelling. The third group comprises general characteristics such as carnivores, intelligent, hunts game mammals. The final feature type is that of similarity which is human like. In addition to the covert features 'animate', there are two overt features, 'parenthood' and 'brotherhood'. 'Fatherhood' is perhaps best interpreted as authority, power, size and importance. For all the primary taxa given, at least one or two of the terminal taxa are given as the 'fathers' of the entire subset. In the cases where two 'fathers' are given, each occupies a particular habitat: the 'fathers' of the game mammals are the
terrestrial spiny anteater and the tree kangaroo. Of all the primary taxa, only humans and sky people share parents: the sun as father and the moon as mother. This kind of classification reflects Engan cosmology, and especially the relations of man and animals as characterised by dietary rules.

There may however, be a close agreement between lower order folk and scientific taxa. Blumer (1971) studied the Karam animal classification and found that approximately 60% of lower order taxa applying to vertebrates corresponded to scientifically recognised species, and some other terminal or intermediate taxa corresponded reasonably well to genera (Blumer, 1971). Similar findings of an ecological study of the mammalian fauna of the Mt Wilhelm area on Chimbu faunal classification state that the Chimbu people recognised and named forms, which in most cases correspond to species, recognised by the zoological taxonomist. Not surprisingly, exceptions do arise as where different but biologically similar species are grouped in the same taxa. As with the Engan, the extent to which there is agreement between zoological and Chimbu taxonomy becomes markedly less in considering larger categories.

The Toaripi of the Gulf Province have basically five terms for colour where the term maea (meaning body) is used in a large number of compound expressions, which often have abstract meanings. When used with koavi (yellow), sea (white), mohari (red), uru (blue or black), popori (green, yellowish green, bluish green), maea means all the colours. Therefore, the colour categories of the Toaripi are maea koavi, maea sea, maea mohari, maea uru, and maea popori.

On pregnancy, Shea (1978) reports that according to one clan, pregnancy occurs when a spirit child enters a woman and is not directly related to sexual intercourse which may sometimes play an indirect part in bringing a woman to general readiness for pregnancy. Frequent sex acts would, by sustained ‘hammering’ on the womb, assist in producing the overflow of blood which was required before any woman could be possessed by the spirit child (Shea, 1978).
George (1991) investigated some ‘traditional science’ ideas on natural phenomena of PNG university undergraduates and Radio Science Project staff of the National Department of Education who were asked to report ideas, stories or beliefs they learnt from their family members, friends or the community on the origin of the universe, grouping of things, the origin of plants and animals, illness, health and deformities, reproduction and sterility, growth and infertility in garden and animals. On universe, origin and existence, a powerful supernatural spirit called Patip/Yanigela created the universe and everything in it. Each component of the universe is associated with its own spirit, like the spirit of the garden, spirit of the animal, spirit of weather, etc. The spirit of lightning is considered to be an angry spirit that the people are fearful of.

On illness, health and deformities, the respondents believed that these are caused by magic performed on one by another due to disobedience for displeasing of ancestral spirits; the spell of a village magician or a sorcerer, an elder’s anger; or breaking of traditional rules. One clan believed that illness could be cured by one of the following means: burning the hair or clothing of a dead relative and rubbing the ashes on the skin of the sick person; public declaration of no ill-feeling or hatred against the sick person by a public gathering of his/her family or clan members; rubbing a particular specimen of the bark of a tree on the sick person’s body and the chanting of a few verses by a village doctor. On fertility and yields in the garden, the pleasing of ancestral spirits, especially that of the deceased landowner to whom the garden belongs will enhance garden fertility and ensure maximum yield of harvest. Sacrificial killing of a pig and offering its blood to the spirit was one way of pleasing the spirit. Farmers devise their own magic and chants during the planting and harvesting seasons to stimulate increased growth and yields in their gardens.

It is evident from these studies by Blumer (1971) and by George (1991) 20 years later, that traditional science exists and is used to explain natural phenomena among cultural groups. This knowledge is crucial as it may create learning problems for students when they learn formal science. Learning problems may occur when explaining various scientific concepts in English. For example, elders in a village near Aitape told the younger people not to go near a large oval-shaped rock near the
shore. To them this rock was significant because it was a place where they heard their ancestors speaking to them. Later in life, the young people learnt that indeed they were actually cries of dugongs, which the elders told them never to harm and kill. The common belief was that these animals were once human beings that turned into dugongs because of men’s ill treatment. Beliefs like this are important as they make people become aware of their surroundings and help them sustain it for future generations. Therefore, teaching strategies should be devised and used that integrate traditional knowledge and explanation in order to harmonise traditional science learning with those of formal science. To assist this, different cultural processes should be involved in the acquisition of science culture. Therefore, when the culture of science harmonises with a student’s life-world culture, science instruction will tend to support the student’s view of the world, and the process of enculturation tends to occur (Wolcott, 1991).

2.2.2 Language

Language undoubtedly exerts a channelling influence on thought processes and there is therefore a need to think in terms of the interrelationships between language and culture, language and social structure, language and cognition (Lawton, 1975). Waldrip (1994) maintains that in many developing countries, the language of instruction is not the mother tongue of either students or teachers. For example, in the PNG context, language problems are evident as there are over 700 different local vernaculars and the majority of teachers use English, the official language of instruction, although, for many, English is a second language. There is adequacy in the teacher’s command of the language but is often less than adequate for the students. Many science concepts do not have a corresponding meaning in the local traditional languages and so science teachers often have difficulty in expressing themselves (Boeha, 1988, 1990; Prince; 1970). Similarly, many PNG students have problems interpreting and retaining what has been learnt (Yeoman, 1988) and often fail to understand the meaning of words but rely on rote memorisation techniques (McLaughlin, 1991). While understanding in a particular language is a problem in PNG, there was no consideration given in this study except that the language used by
the researcher in the instruments and interviews was within the majority of the students’ abilities.

Gray (1999) also states that the language of instruction in the science curriculum is a problem where students learn through the medium of a second language, which is difficult, firstly, because of the complex and often abstract nature of the concepts or phenomena involved, and, secondly, because of the specialised terminology that has evolved. Research on language (Dlodlo, 1999) in Zimbabwe used instruction in the mother tongue or code switching of appropriate scientific terms where necessary which resulted in meaningful and authentic scientific terminology for Nguni speakers. There is a need for textual material to be more accessible and user friendly (for example, incorporating simpler grammatical structure, simpler language, or greater use of graphics).

2.2.3 Publications of PNG science education research

Palmer (1991) identified and presented a science/science education bibliography from 1978 to 1990, where 392 articles by PNG authors were reviewed. The bibliography was categorised in a number of ways to indicate patterns of research productivity in various areas of science education, and at different levels of education. A questionnaire was devised to obtain information from former and current researchers in the field about their own contributions. Palmer (1991) reported on a key conference in 1982 where the acting Secretary for Education (Roakeina, 1983) stated that research had to be practical and comprehensible to administrators to help educate children more efficiently. The main thrust of science education has been towards producing materials for the Curriculum unit of the National Department of Education, which has produced one third of the total science education effort (Palmer, 1991). The government thus sees science educationalists as being needed for basic curriculum tasks; indeed one conclusion of the 1982 Research Director's Conference was that educational research should be policy and action-oriented (Guthrie & Currin, 1983).
A second influence on science education can be traced from pure science research. In 1984, the Science Faculty of the University of PNG held the Waigani Seminar where a stimulus for research, and communicating of scientific research to the general population (Palmer, 1991) was addressed. The seminar also pointed out that the government had no science policy for PNG, and there is, according to Palmer (1991), to date still no national science policy for PNG.

Palmer (1991) claims that PNG academics have been very much a minority in tertiary education, but the number has increased steadily in recent years. In the early years, PNG nationals held junior positions within tertiary education with higher teaching loads and relative lack of research opportunities. However, the situation has changed as more PNG nationals are in senior positions but the amount of research done does not appear to have increased. Science education does have difficulties in salary and career structures available to nationals who are both good scientists and administrators who can earn more outside the tertiary education system (Palmer, 1991).

Table 2.1 classifies all papers from Palmer (1991) as being pure science or science education and also classifies them by broad content area. Generally, 235 papers that contain some educational component have been classified as science education, whilst 157 with no educational component have been classified as pure science. Papers were also divided into 17 subcategories relevant to the speciality within science being considered. Areas where there has been a lack of educational research do become clear from the data in Table 2.1. Biological education is underresearched, which is surprising in that biology has been considered a more popular science amongst PNG nationals than the physical sciences. Geology education, mining education, astronomy education, history of science and basic educational psychology as applied to science education, all appear to be neglected areas. According to Palmer (1991), one problem with this analysis is that it looks at the number of publications in each area forgetting that it is not just the quantity of research that is important but the quality as well.
Table 2.1: Number of papers written in each content area between 1978 and 1999

<table>
<thead>
<tr>
<th>Field</th>
<th>Number of papers</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pure science</td>
<td>Science</td>
<td>Total</td>
</tr>
<tr>
<td>Science</td>
<td>6</td>
<td>88</td>
<td>94</td>
</tr>
<tr>
<td>Agriculture</td>
<td>11</td>
<td>28</td>
<td>39</td>
</tr>
<tr>
<td>Biology</td>
<td>38</td>
<td>6</td>
<td>44</td>
</tr>
<tr>
<td>Environment</td>
<td>6</td>
<td>4</td>
<td>10</td>
</tr>
<tr>
<td>Chemistry</td>
<td>16</td>
<td>27</td>
<td>43</td>
</tr>
<tr>
<td>Physics</td>
<td>1</td>
<td>18</td>
<td>19</td>
</tr>
<tr>
<td>Technology</td>
<td>24</td>
<td>26</td>
<td>50</td>
</tr>
<tr>
<td>Food technology/nutrition</td>
<td>8</td>
<td>3</td>
<td>11</td>
</tr>
<tr>
<td>Health/medicine</td>
<td>13</td>
<td>4</td>
<td>17</td>
</tr>
<tr>
<td>Geology/geography</td>
<td>12</td>
<td>1</td>
<td>13</td>
</tr>
<tr>
<td>Mining</td>
<td>17</td>
<td>4</td>
<td>21</td>
</tr>
<tr>
<td>Astronomy</td>
<td>1</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Psychology</td>
<td>2</td>
<td>6</td>
<td>8</td>
</tr>
<tr>
<td>History of science</td>
<td>0</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>General</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Anthropology/pre-history</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Overall total</td>
<td>157</td>
<td>235</td>
<td>392</td>
</tr>
</tbody>
</table>

(Adapted from Palmer, 1991, p. 244)

Quality may be considered in the form of publication of each of the papers. For research purposes, an academic PhD theses is likely to be the most useful form of publication for future researchers, then a Master's theses, followed by articles in refereed journals, followed by conference papers, with articles in non-refereed journals generally considered the least useful type of publication. Under this criterion, there are only eight theses relevant to science education over the past 13 years, two at doctoral level and the remainder at Master's level. Two of the Master's theses were obtained by PNG nationals and the remainder by overseas nationals. Science education is thus under-researched at this level. Of the remaining references, probably about one third are from books or refereed academic journals, whilst the majority of all publications quoted are from non-refereed journals or are conference papers. Analysis of science education research at a particular level of education indicates that not enough research is being done in science education at the primary level. Indeed, the amount of publications in science education reached a maximum in
1984/85. National academics may not be keeping up the levels of publication achieved in 1984/85. Science education research is attracting few people in the masters or doctoral programs involving PNG science education research. Primary science education also is under-researched. It would be interesting to see if there has been any increase in the number of publications from 1991 to 2000 compared to those published from 1978 to 1990.

2.3 Culture and Worldview

As discussed briefly in Chapter 1 (Section 1.5), the term ‘culture’ has over 160 definitions (Kroeber & Kluckhohn, 1963), and there have been many since then, but a lot of confusion still exists even within the multi-cultural literature. For example, Weiner (1995) defines culture as a label for subjectively perceived differences. Aikenhead’s (1995, p.9) summary of culture informs science education research and includes the following attributes: communication, social structures, customs, attitudes, values, beliefs, worldview, skills, behaviour, and technologies. The researcher has chosen what other researchers have included in their definitions of culture as ‘the distinctive way of life of a social group, including its shared values, morals, beliefs, conventions and artefacts’ (Arca, Guidoni, & Mazzoli, 1983; Eckermann, 1988; Geertz, 1973; Phelan et al., 1991).

The researcher’s emphasises the shared nature of culture, since the culture of a group distinguishes its members and is expressed through relationships and behaviours that have significance to the group and provide them with an ongoing sense of identity and purpose. Thus, a cultural group can be identified and embodied in common language, shared history, shared mythical legends, kinship, customs, traditions, rituals, and shared land and sea boundaries (Simet & Iamo, 1992). Therefore, a culture implies that a relationship exists between the shared beliefs and customs of a social group, and the form and content of their daily lives. As mentioned earlier, belief is central to culture and a nexus exists between belief and social customs. In the context of culture and education, Aikenhead (1995) suggests that science is actually a distinct Western sub-culture, and that successful science education consists of ‘border crossings’ from the students’ natal culture to the sub-culture of science.
2.3.1 Culture and science learning

Many researchers (Baker & Taylor, 1995; Boehe, 1987; Cobern, 1993; 1996; Cobern and Aikenhead, 1998; Geertz, 1973; Jegede; 1995; 1997; 1998; Maddock, 1981; Ogbu, 1992; Ogawa, 1986; Okebukola & Jegede, 1990; Waldrip & Taylor, 1999) have stated that the culture of a learner plays a central role in science learning. The learner’s use of prior knowledge and situated cognition is a basis for arguing how learning occurs and is dependent on the environment as a source of information. For example, PNG students who attend science classes with their Melanesian worldviews may have experienced that the interaction between the Western mechanistic worldview and their Melanesian traditional knowledge complicates their cognitive processes in learning science concepts meaningfully. For example, students may have difficulty in explaining the uneven heating and warming of the earth that causes the wind to blow strongly. Students may refer to their traditional stories and say that it is the angry spirits that cause the wind to blow strongly. The noises that the wind produces are in fact made by the angry spirits.

Traditional beliefs, ideas or stories used to explain natural phenomena exist in every community (George, 1991) but due to the ineffective curriculum adapted by these non-Western countries (Thaman, 1993), confusion may be created between students’ worldviews and school science worldviews. As a result, students have not been able to fully utilise their traditional knowledge and learning in a more meaningful way. Waldrip and Taylor (1999a) maintain that the process of enculturation into a Western school view involves an explicit devaluation of students’ traditional worldviews that governs their village lifestyles. They also stated that a Western school view had limited viability in relation to traditional values and practices. In fact, traditional views, cultural explanations and language are simple expressions, which is normal to a society as well as its eco-culture. These norms are communicated through an established built-in theory of knowledge, meanings and symbols within the culture through time-honoured explanations of reality (Baker & Taylor, 1995).

Similarly, research in PNG (Clarkson, 1994; George, 1991; Hill, 1994; Kelontti, 1996) within cultural groups has shown that prevalent traditional beliefs or ideas
continue to exist in explaining natural phenomena. Waldrip (1994) highlights culture as a major area of research in PNG that affects science education and students' understanding and learning of science. Initial studies have looked at cognitive aspects of PNG culture from a Western view and only examined how this affects science learning. Boehe's (1985) interviews with National High School (Year 11 and 12) students aged between 16 and 17 years about instances/events on force, found that students pre-beliefs of force were very similar, and to some extent common, to those beliefs held by students elsewhere globally. These beliefs could be easily interpreted as the understanding and interpretation of natural phenomena, which students possess prior to the systematic study of science. This has importance in developing suitable science curricula in order to harmonize conflicts between students' beliefs and formal science concepts. Boehe (1985) felt that the existence of students' beliefs has not been adequately considered in the past where teachers may have caused confrontation with traditional beliefs and have not provided students with a learning program that builds on their past experiences and beliefs.

Finally, Vlaardingerbroek (1990) suggested that in the area of ethnoscience, conflict between 'science' and traditional beliefs does not occur but rather a dualistic conceptualisation of reality exists. His study, which examined trainee PNG secondary science teachers' opinions about ethnoscience, found that most teachers seem to have maintained their traditional beliefs.

2.3.2 Worldview and science learning

As discussed briefly in Chapter 1 (see section 1.4), worldview, like culture, has many definitions of which some are vague and tend to reflect each researcher's ideological perspective. It is commonly agreed that everyone has a worldview, whether they know it or not. Proper, Wideen and Ivany (1988) state that all people possess worldviews which are germane to what they think and do. Such views are acquired through a variety of influences including the family, media, and interpersonal relationships and through ways our institutions are structured and the way they function (p. 547). Sire (1988) suggests that a worldview is composed of a number of basic presuppositions, more or less consistent with each other, more or less consciously held, and more or
less true. They are generally unquestioned by each of us, rarely, if ever, mentioned by our friends, and only brought to mind when we are challenged by a foreigner from another ideological universe (p. 17). Baker (1998) states that most definitions of worldview used by researchers follow the socio-cultural trend, defining worldview in terms of basic presuppositions about the world, self, and others, that are corporately held and culturally formed. For example, Christie (1984) defines worldview as 'the ideas and beliefs, which a group of people hold about its world and the people and things in it' (p. 3). Kearney (1984) states worldview as 'the basic assumptions of a people that determine much of their behaviour and decision-making' (p. 1) while Aikenhead (1995) claims worldviews as 'culturally validated presuppositions about the natural world' (p. 5).

On the whole, worldviews tend to develop central, unifying themes (Witherspoon, 1974, p.46) about everything observed or experienced by individuals and communities. The result is that researchers write as if worldview is exclusively collective and cultural. However, beliefs, ideas and knowledge exist within the mind of the knower and cannot be separated except through their expressions. Since belief is personal, as in the heart of worldview, then worldview must also have a personal element. This should be consistent with personal construct theory (Kelly, 1955) which is supported by the theories concerning "children's science" (Osborne & Freyberg, 1985) built upon the constructivist view that all perceptions are theory-laden.

To better understand the nature of worldview, it is best to seek how it is formed. Seagram and Lendon (1980) speak of worldview formation as a 'furnishing of the mind' and emphasise the important role of others in the process. They conclude that 'this furnishing of the mind occurs at the mother's knee and that its integrity and energy depend upon the integrity and the depth of the affective bond that can be formed there' (p. 214). Therefore, early learning shapes further learning for each child, thereby highlighting the roles that parents play in their socio-cultural environment in the construction of future knowledge and values. Baker (1998) states that an individual's worldview can, and often does, differ from the worldview of others who share the same culture. According to Baker (1998), worldview is a belief system and is dynamic, affecting daily life. Its dynamism resides in the fact that, as
members of communities, the beliefs of individuals are both challenged and affirmed regularly, as rational, thinking creatures, individuals re-form their beliefs according to a complex web of interacting perceptions and allegiances.

Many science educators have studied the role of worldview presuppositions in the learning of science (Baker et al., 1995; Ogawa, 1986, 1989; Ogunniyi, 1987, 1988; Jegede & Okebukola, 1989, 1991; Cobern, 1991, 1993, Ogunniyi et al., 1995). However, researchers have used several terms to identify a non-Western culture’s worldview. The most frequently used are ‘traditional thinking’ (Horton, 1967a, 1967b; Ingle & Turner, 1981), ‘traditional worldview’ (Ogunniyi, 1988), and ‘traditional culture’ (Ogawa, 1989). Researchers in many non-Western cultures have shown that reasoning based on a worldview that differs from the scientific worldview may impede the learning of science (Ingle and Turner, 1981; Ogawa, 1986, 1989; Ogunniyi, 1988; Jegede & Okebukola, 1989). They attributed this to the fact that a culture’s reasoning is highly governed by the presuppositions that are dominant in that culture. Those presuppositions have been formed through people’s interaction with their natural world over hundreds of years. They have been transferred from generation to generation and are deeply rooted in a culture’s subconscious (Cobern, 1991).

Non-Western science educators have explored aspects of the effect of students’ worldview on science education. For example, in following Kearney’s logic-structural worldview theory to investigate South African prospective science teachers’ worldview, Lawrenz and Gray (1995) found that students hold presuppositions of time and space that were non-mechanistic and psychologically bound. Lowe (1995) studied the impact of school science on Solomon Islands students’ worldviews and found that although students’ belief systems operated within the framework of religion, they rely on magic to explain events. It was also found that science is rarely used for practical purposes.

Many researchers have studied students’ worldviews concerning causality. For example, Odhiambu (1972) argued that while the Western worldview is dualistic, the African worldview is monistic and that reason and faith are dependent and
intertwined into one single thought system. Odhiambu (1972) also argued that the concept of cause and effect is foreign in the African culture; however, the animistic concept is indigenous. As a result, there is no need for an African to make hypotheses to explain events. Ogguniyi (1988) indicated that, while the world of the scientist is irrational and impersonal, the world of the African is rational and metaphysical. He agrees with Horton (1967a) in that both African and Western worldviews are based on different experiences. Ogguniyi et al., (1995) conducted a cross-cultural study of science teachers’ presuppositions from Botswana, Indonesia, Japan, Nigeria and Philippines. It was found that science teachers have a poor understanding of the nature of science or a form of collateral thinking. They argued that science teachers hold both the scientific and traditional thought without a sign of dissonance.

The socio-cultural aspect of African students’ worldviews has been studied by Jegede and Okebukola (1991), who identified five worldviews that affect the learning of science in Nigeria – authoritarianism, goal structure, African worldview, sacredness of science, and societal expectation. They found that the first four factors impede the learning of science while the fifth one enhances it. Haidar (1997) investigated the nature of prospective science teachers’ worldview presuppositions towards nature. The study found that the teachers felt safe towards nature and considered it to be orderly, beautiful and special. More importantly, their presuppositions were mostly religious and many lacked the usual scientific presuppositions.

It can be seen from this discussion that there are major differences between Western culture and non-Western cultures that are crucial in science education. Consequently, there is a need to consider students’ worldviews in the science classrooms.

2.3.3 Traditional beliefs

Ogunniyi (1996) states that traditional beliefs are regarded as passively accepted ideas, thought systems or cultural practices that have been passed down from generation to generation. The word ‘tradition’ implies cultural elements passed down (usually orally or by example) from one generation to another. The word ‘belief’ is a mental state or act in which one places a complete trust or confidence in a being,
thing or an idea regardless of contrary opinions. It is a conviction about or an affirmation of what has been received to which one holds allegiance. For example, religious beliefs usually result in religious behaviours that are observable whether or not they make sense to the observer (Carlton, 1973). There are traditional beliefs about diverse natural phenomena, life, death, life after death, ancestors, spirits, marriage, witchcraft, taboos, divinities or the role an individual should play in a family or community (Ogunniyi, 1996).

George (1991) claims that traditional beliefs, ideas or stories to explain natural phenomena exist in every community. These beliefs are interpreted as the understanding and interpretation of natural phenomena, which students possess prior to the systematic study of science and developed as descriptive and explanatory systems. For example, Gomez (2000) reports that a group of women learnt local traditional medicine from village elders, which made them see the jungle differently. Thus, the jungle became their source of medical and food supplies where the plants, leaves, roots, fruits, bark of trees as well as marine life became useful as medicine. Other examples of research studies in PNG (Clarkson, 1994; George, 1991; Hill, 1994; Kelontii, 1996; Maddock, 1981) have shown prevalent that traditional beliefs or ideas exist to explain natural phenomena. However, these studies have not examined the concurrent existence of students’ traditionally held science beliefs.

The problem of diverse cultural practices and traditional beliefs found in many communities in developing countries also affects the curriculum through either pedagogy or conceptual understanding (Gray, 1999). Firstly, on pedagogy, Shumba (1999) examined traditional cultural practices that are generally authoritarian in nature, by which children are taught to respect the wisdom and authority of their elders and not to question them. As a result, this can relate to teaching that encourages students not to be curious and not to question things, and they become passive recipients of developed knowledge. Secondly, on conceptual understanding of phenomena, teachers face the problems of worldviews that students bring to science classes and which provide explanations that are in conflict with Western scientific thought. Indeed, Waldrip and Taylor (1999a) have commented on the destructive process of cultural alienation that has developed in situations where a
Western scientific worldview has been adopted with little attention to traditional cultures and beliefs. However, Gray (1999) assures that ways should be found in science teaching to accommodate the reality of cultural beliefs and norms may be the cause of cognitive conflict.

2.4 Children’s Ideas About Natural Phenomena

Typical secondary school students in PNG come from many different tribal groupings where cultural ideas and beliefs are a reality in their minds that has always made teaching and learning of science a dilemma in schools. These students already have a set of well-developed concepts of indigenous classification systems for numbers and plants and make use of such knowledge on local plants for medicinal, construction and fabric making purposes (Papua New Guinea Department of Education, 1979). Another concept that already exists in the country according to Maddock (1981) is that of fields of influences of fundamental forces, such as those surrounding a spirit entity in understanding the concepts of magnetism, gravity and electricity.

Baker and Taylor (1995) identified a relationship between language use and concept development and discusses that ‘personal construction of meaning in science is related to the linguistic background of the learner, and to the compatibility of the learner’s language with that of science education (p. 697)’. Furthermore, they also suggest that a learner's cultural background has an effect in knowing and learning science as this creates a gap between Western and non-Western interpretations of reality in science education. This is supported by an earlier study (Prince, 1969) where language itself was one of the main causes of difficulty in teaching science in a non-Western culture. To overcome this, for example, Maddock (1981) recommends the use of local culture in teaching friction and energy based on indigenous fire lighting techniques. Moreover, he also recommended the use of local landscape examples for geological topics in teaching about volcanoes and the use of local hydro-electric schemes in teaching electricity topics.
2.4.1 Research on children’s ideas about natural phenomena

As evidenced by the voluminous research globally, mainly from developed countries, students bring to science classes ideas and beliefs about the natural world (Driver et al., 1994; 1996) that are often not in conformity with the scientific notions. Osborne and Freyberg (1985) assert that children from a young age, and prior to any teaching and learning of formal science, develop meanings for words used in science teaching and their view of the world that relates to science. These ideas are sensible and consistent views from children’s beliefs and often remain either unchanged or changed through science teaching and learning. Interestingly, young children are curious about the world around them as they naturally attempt to make sense of it in terms of their own experiences, current knowledge and use of language. Moreover, Schollum and Osborne (1985) state that children are interested in ‘customised’ explanations for everyday observations where they tend to accept more than one explanation of a specific event. They are not concerned if some of these explanations are self-contradictory and therefore, are unable to judge between scientific explanations (whether they can be tested and rejected) and non-scientific explanations. Because of their interest in acquiring sensible explanations about their world, children also are not concerned if two theories explaining two different situations are in conflict. In fact, children’s interests, thinking processes and constructions of meanings are limited by their level of cognitive maturity, experiences, language use and their knowledge as well as the appreciation of these experiences, ideas and theories (Schollum & Osborne, 1985; p. 55-56).

Furthermore, Driver et al. (1994) detailed accounts of children’s ideas about natural phenomena, such as life and living processes (living things, nutrition, growth, responding to the environment, reproduction and inheritance, microbes, and ecosystems), materials and their properties (materials; solids, liquids and gases; chemical change; particles; air and rocks), physical processes (electricity, magnetism, light, sound, heating, energy, forces, horizontal motion, gravity and the earth in space) which are well developed before they are taught formal school science. In some instances, these ideas conform to the science they are taught while in many cases; however, there are significant differences between children’s notion
and schools science. Many of the conceptions, which children develop about natural phenomena, are derived from their sensory experiences. Some conceptions or knowledge schemes which children develop are influenced by their interaction with their natural environment and may not be represented clearly through language. For example, children playing ball develop a range of knowledge schemes about the various way of throwing or catching a ball, which enables them to throw and catch the ball successfully. It is only much later that students have a formal opportunity to represent and analyse such motions and yet a knowledge scheme that enables the child to interact effectively when throwing and catching the balls has been in existence at a younger age (Driver et al., 1994).

Indeed, studies of children’s conceptions about natural phenomena indicate that there are commonly occurring features in children’s notions, which can be mapped out and described. Moreover, these children’s notions appear to evolve as they become adapted to wider experiences. For example, the concepts light and sight have been studied among children where typical 5 and 6 year olds identify light as the source or the effect, as this light bulb or the brighter patch on the wall. Later, children identify something in between the source and effect. For example, one turns the light switch on and the room is filled with a batch of light, which enables one to see things. It is later during the primary phase that children begin to use the notion that light travels. Infact, children’s science conceptions are not specific nor heavily culturally dependent but shaped through personal experiences with phenomena (Driver et al., 1994).

In schools with students from a range of social and ethnic backgrounds, teachers are able to find that students’ ideas provide common ground for building good working relationships. For example, Nussbaum and Novak’s (1976) study of Israeli children’s conception of earth in space revealed five conceptions termed ‘notions’. They progressed from earth as a flat surface with an absolute frame of reference for up and down, through intermediate notions, to scientific notion of the earth as a sphere and up and down being defined in terms of the earth as a reference. This study was replicated in Nepal (Mali & Howe, 1979) which identified the same
sequence of conceptions but found that although Nepali children were lower in gaining the concepts, the development of these ideas were similar in both cultures.

Similarly, Maddock (1981) claims that children in PNG have difficulty in accepting scientific models (consisting of systems of concepts) associated with the rules of inquiry and analysis of phenomena. This is because the patterns of thought for most children are also associated with beliefs in the efficacy of magic. In many traditional societies, knowledge systems are finite and passed down orally from the older generation to younger generation. Secondary school students still hold on to such a magical view of this knowledge that according to Maddock’s (1974) study with Grades 9 and 10 students where they have positive attitudes towards natural scientific control and manipulation of the natural environment. This attitude of having power over the environment is an important basis in introducing science education in the student’s context. It is important to be aware of the similarities and differences in the ways that children conceive natural phenomena as it reflects a part of the intellectual environment in which they live. As a result, various teaching approaches have been suggested in studies that have involved patterns of children’s thinking on natural phenomena (Maddock, 1974) but little has been published on the outcomes of this teaching.

2.4.2 The use of explanations in science teaching and learning

To understand the differences between explanations and descriptions of phenomena, Horwood (1988) draws a sharp distinction between them and suggests facts to be independent from theories. He also concludes that textbooks and tests introduce and exchange terms that often confuse students. He defines descriptions as ‘pure information isolated and without a network of relatedness’ while ‘explanations have information with connections, a relationship built on a system of causality’ (p. 41). Similarly, Pallrand (1993) claims that students get confused between describe and explain with what-questions (observe/describe) and why-questions (explain) thus establishing the basis of certain facts in school science. However, Tamir and Zohar (1991) found that secondary school students in biology applied teleological and anthropomorphic reasoning to explain plants and animals phenomena. In other
words, explanations for plant and animal phenomena were argued to be governed by natural design or attributed to human-like behaviours. Driver et al. (1996) state that an explanation is simply what is accepted by the person who has given it, and by the person who has received it.

Furthermore, explanations are derived from happenings or events about a phenomenon and if the explanations represent more than one phenomenon, they become a phenomena (Christie et al., 1992b). Explanations may be on how or why things happen and can help improve our understanding of how the world works. For example, a weather forecaster can explain why it rains or why there are floods and droughts; veterinarians can explain why animals get sick and how to cure them; biologists can write explanations about how frogs lay eggs, and doctors can write explanations of why people get sick (Christie et al., 1992a). Again, Brown and Halton (1982) state that explanations are essential in that they provide reasons and causes. They claim that explanations are given in a manner that establishes causation, is not arbitrary, and follows rational procedure capable of being repeated (p. 59). The idea of explaining involves a transfer of understanding from one to another through procedures that are regularly repeated. They further claim that to successfully gain understanding, ‘the explanation must be comprehended, seen as relevant and must be believed to be true’ (p. 59).

Brown and Halton (1982) state that the comprehension of an explanation causes the readiness of learners to deal with the information that is presented. ‘What is being explained needs to be assimilable with what is already known, with existing cognitive structure within pupils’ minds’ (p. 59). The relevance of an explanation derives motivation in learners in order to understand the information that is presented. This motivation may be done cognitively, where the explanation serves to fill a gap in existing knowledge, or establish new links between previously connected ‘bits’. This motivation may be done effectively where the explanation is seen to satisfy a particular end, or to meet certain crucial needs learners have. “The belief of an explanation brings out the acceptance of the truth by the learners of the information that is presented. The acceptance or rejection of any explanation depends on whether it agrees with existing values and attitudes” (p. 60).
However, explanations used in science teaching differ in vigour, length and detail, involve various degrees of 'explain how' and 'explain why', are sometimes open-ended, include human agency, and can raise new questions as the previous questions are answered. Despite its many forms, explanation has a single purpose and that is to share knowledge and meaning (Treagust & Harrison, 1999). In fact, research in “children’s science” (Osborne & Freyberg, 1985) and “children's” ideas about life and living processes, materials and their properties, physical processes” (Driver et al., 1994) have investigated children’s views of the world and meanings for words that children use in science classrooms. Although this scientific knowledge is common knowledge, it is also very different in kind. Ogborn et al. (1996) assert that scientific explanations are often about unfamiliar things and the student becomes a stranger in an unknown world. However, much of the explanation in the science classroom is not explanation of phenomena, but of resources that the students needs in order to explain phenomena. For example, Ogborn et al. (1996) stated that teachers tend to explain to students how to think about waves instead of explaining to them how light travels.

A set of ideas maintained by one student may vary extensively from that particular student to another and ideas that are individually possessed may vary greatly from phenomena to phenomena (Inbody, 1963). Secondary school students’ ideas and thinking at any given time restricts and limits the types of instructions students can benefit from and utilise. Indeed, Inbody (1963) found that children’s ideas can be classified into six categories:

- Explanations, which were fairly complete, generally correct, causal in nature and with a minimum of verbalisation.
- Explanations, which were plausible, causal in nature, but with incorrect causation factors given.
- Explanations, which were generally, correct but appear to be largely verbalisitic because of the lack of additional explanation or justification.
- Explanations, which were generally incorrect, involving no causation, animistic, or referring to God or Jesus.
• Explanations, which were merely descriptions or restatements of observations.
• Responses, which provided no explanations.

(Inbody, 1963; p. 267)

Several of these same categories arose from the phenomenological analysis of the data in the present study.

2.5 Summary

The literature review on the findings of similar studies in developing countries found that explanations and beliefs that typify members of a particular cultural group appear to influence the acceptance and interpretation of new ideas that relate to prediction, cause and effect, probability and time. Three aspects of traditional explanations significant to science education are beliefs, epistemologies and taboos. Of these, epistemology appears to have great influence, which stems from the beliefs and practices derived from one's social milieu and has an effect on the epistemology, beliefs and practices of the science classroom.

Science education research carried out in PNG has shown that traditional science knowledge is used to explain natural phenomena among the various cultural groups. Traditional science knowledge or beliefs are passively accepted ideas, thought systems or cultural practices that have been passed down from generation to generation. Traditional science knowledge still exists and is important, and there is a need to devise teaching strategies that will harmonise this knowledge with formal science learning. To assist this, different cultural processes should be involved in the acquisition of science culture. Therefore, when the culture of science harmonises with a student's life-world culture, science instruction will tend to support the student's view of the world, and the process of enculturation tends to occur (Wolcott, 1991). The problem of language in schools also influences the thought processes and there is a need to think in terms of the interrelationships between language and culture, language and social structure, language and cognition. Most research in PNG has been towards producing materials for the Curriculum Unit of the National Department of Education. There is a need for more research in biology education,
geology education, mining education, history of science, astronomy education, basic education psychology and primary science education. The discussion on culture and worldview claims that there are major differences between Western and non-Western cultures and are crucial in science education. There is a need to reconsider students’ worldviews in the science classrooms. How village elders and secondary school students explain and understand natural phenomena, as part of their worldview will be discussed in Chapter 4. Background to PNG culture and the past and present education system are discussed and presented in Chapter 3.
CHAPTER 3

BACKGROUND TO PAPUA NEW GUINEA:
CULTURE AND EDUCATION

3.0  Overview of Chapter

This chapter outlines the research setting of this study and views Papua New Guinea (PNG) as a culturally diverse, developing country with its Melanesian people. It also presents an overview of the past and present education system stating the national objectives and aims, the current education reform and its results.

This chapter discusses how the early education system alienated traditional culture and impacted on the Toaripi people of the Gulf Province. The chapter briefly describes the science curriculum within its cultural context and the place of traditional knowledge in PNG society and the schools. Left with no, or at least few, choices, many villagers have managed to survive and live a life in harmony with their own traditional values and lifestyle. The values have been, in a way, either strongly interfered with or disturbed economically, socially and politically by the rapid influence of modern Western development. This is where the study originates from as it depicts the Toaripi, a group of coastal Elemas who speak this language and come from villages situated either on the coast or inland between Cape Possession to the Avei mouth of the Purari River in the Gulf of Papua. The physical features, history, district, economy and prominent leaders, the people and language, traditional and social change, and the sub-clans are discussed in Appendix 3.2.

A section on the importance of traditional knowledge is included because this study is related to it. The meanings and characteristics of traditional knowledge highlight the importance of PNG to protecting and promoting its indigenous traditional knowledge based on rich cultural diversity. For example, the country’s diverse genetic pool of native flora and fauna place it in the top 10 countries in the world for bio-diversity. This biological and agricultural diversity, combined with traditional
knowledge and customs provides valuable academic resources for international scholars. Many have obtained post-graduate qualifications through studying the country's wealth of traditional knowledge and cultures and its diverse flora and fauna (National Research Institute, 1999).

3.1 Background

3.1.1 PNG - a developing country

PNG is a developing country situated north of Australia and is the biggest in the South Pacific with a population of over 4.5 million people. The country gained independence from Australia on 16 September 1975 and is a democracy with 109 elected members in a parliament representing all 19 provinces plus the National Capital District (NCD). Each province has its own provincial government situated in a provincial capital. The main administrative centre is in the capital of Port Moresby in NCD. The country has a three-tiered system of democratic government [national, provincial and community (local)] based on the Australian and Westminster models. A ceremonial head of state, the governor general, is elected by parliament and there is an independent judiciary and public service.

3.1.2 Economy

The economy is based on copper, coffee (20% of the exports), cocoa, and copra, and has excelled with a booming and increasing diversified mineral sector and largely untapped forestry and fishing resources. Further reserves of gold, copper, silver, nickel, oil and gas are still being discovered at present. The most significant characteristic of the economy, however, is that the vast majority of the population (about 85%) is still dependent on semi-traditional agriculture. There is no manufacturing industry because of the shortage of skilled labour, low wages and the small size of the market. The country's imports include mainly manufactured goods and basic foodstuffs.
3.1.3 People

The people are grouped into Papuans and Melanesians. The Papuans are mainly descendants from the early arrivals and the Melanesians are closely related to the people of the Pacific. Additionally, some people in the outlying islands more closely resemble closer to pure Polynesians or Micronesians. There are politically four regional groupings with each representing the cultural and historical links that have developed. The Papuans from the Southern Region, Highlanders from the Highlands Region, New Guinea Mainlanders from the Momase Region-North and Islanders from the Islands Region. There are over 715 languages spoken (Central Intelligence Agency, 1999) of which English is the medium of instruction in educational institutions and in both the public service and private sectors throughout the country. Similarly, Motu and Pidgin are used for communication purposes as well. In fact according to Levi (1997b), the National Government declared that there are 817 different languages in the country. The people come from many different unique cultures and tribes and it can be a life-time’s work understanding one culture in-depth. This is evident from a number of anthropologists like Margaret Mead and Bronislaw Malinowski who have conducted research studies with the Manus and Trobriand Islands people in the country. However, nearly all Papua New Guineans are Melanesian who can be easily identified by their cultural or tribal groupings. Again Levi (1997a) reports that Professor John Waiko, the vice minister for Education, Science and Culture stated that the 6000 ethnic communities have expressions that are intricately bound up or interwoven with music, songs and dances, decorations or expressive arts in material forms through the ancient stone and wooden artefacts.

At present, while the country is changing quickly, the vast majority (85%) of the people are dependent on subsistence agriculture and live in villages. Many aspects of village life are still carried out traditionally where social structures and individuals’ responsibilities and privileges continue without much change. The social units are generally small, based on the family, clan and tribe, with the most important being the extended family where ownership is communal and everyone’s basic needs are met. Until recently, the world, for most Papua New Guineans related to their own
clan, because hostile or suspicious neighbours who spoke different languages surrounded them.

3.1.4 Traditional beliefs

Traditional religions or beliefs mainly dealing with making sense of the world were developed over tens of thousands of years. For example, people who lived in danger of crocodile attacks gave crocodiles an important place in their culture. These beliefs are still evident in parts of both the East Sepik and Sandaun Provinces. Another example is the weather, which is an important factor to farming communities, especially in the Highlands Region (Papua New Guineans were perhaps the world’s first farmers) where fertility and harvest were celebrated. Most people, especially in the Highlands, traditionally lived in very small, independent communities surrounded by communities speaking different languages, which could attack at any time. Many of these traditional beliefs revolved around fear of the unknown and suspicion of differences. A consequence was that peace was made among the spirits of ancestors and this is still a common theme in traditional beliefs. Interestingly, the fear of evil influences like those of sorcery (pointing the bone) and witchcraft is still prevalent. Even today, sorcery is practised. According to Kepson (1998), a jail term of 15 years was given to two boys between 12 and 14 years from Pomio in the East New Britain Province for killing an elderly woman whom they claimed was a sorceress. The boys accused the woman of using sorcery to kill their younger sister and claimed, that under their customary law, they were justified in killing her in retaliation. Similarly, another report (Post Courier, 2000) stated that villagers from Kup in the Chimbu Province set alight with kerosene three alleged sorcerers when they were accused of causing the death of an old man through traditional sorcery. The three sorceresses were tied up and set alight in a village house. Other ways of killing sorcerers have included tying both arms and legs and throwing them over cliffs and from mountaintops.

Interestingly, this collection of interests, beliefs and rules of conduct (such as the payback requirement of an eye for an eye) all constituted a religion. The early Christian missionaries were against this and have been responsible for the
destruction of much of PNG’s traditional culture. Whether this was seen as beneficial (stopping tribal wars and getting a better deal for women) or vandalism (the burning of carvings and spirit houses on the Sepik and Gulf Provinces) greatly depended on either the missionaries’ or the tribes’ value systems. Traditional Melanesian religious beliefs portray life that continues in the world of the dead so relatives of the temporal world and the world of the dead still continue to relate to each other through various modes like incarnations. Therefore, giving food to the dead relatives is no cult practice and worshiping and venerating Melanesian gods are practices that have religious significance to the Melanesians (Wari, 2000).

In PNG, formal Western schooling was spread with little thought to indigenous culture or context. Eyford (1993) states “many western educators are convinced their view of the world is reality while the view of others is more like superstition or fantasy” (p. 12). In contrast, Flannery (1998) states that the Melanesian worldview incorporates humans and animals, the seen and unseen, the living and dead, in a way that is vastly different from the European outlook. What Europeans call supernatural factors are for New Guineans simply the non-visible parts of a single continuum of life. Indeed they are eminently natural. In many PNG traditional societies, much of the cultures of the people, their traditional beliefs, and pattern of life evolve around the bush and the jungle near where they live. The people often associate their myths of origin to the natural environment where they live. When their environment, forest and rivers are destroyed, their cultures and ways of life are lost forever. Waiko and Jiregari (1982) assert that PNG societies view nature as a whole and continuity from the past to the present and into the future. The clan is linked with the surrounding land, water, forests, animals and heavens. The knowledge base contains the accumulated tools and wisdom for dealing with and living in the environment. The community pursues and propagates this base through repetitious learning reinforced either by rituals and sanctions of the ancestors or rewards from the spirits. This learning process occurred in small groups through demonstrations or in formalised teacher-student relationships and involved verbal instruction, the use of models, or metaphors of dance and drama with their totally interwoven pattern of verbal and non-verbal discourse (Waiko & Jiregari, 1892).
3.1.5 Traditional PNG society

In traditional PNG society, the majority of the people lived in subsistence (rural) sector in scattered small groups on their own land (Datec, 1996). Each society consisted of a number of families and relatives who owned land. The membership of the household was based on kinship through blood, marriage or adoption. In ethical terms, whatever helped the group maintained itself on the land was right and whatever went against the group was wrong in terms of welfare through food, family, work, safety, and housing; proper burial of every individual was guaranteed by custom. Leaders were chosen by consensus on ability and performance. Many aspects of group life reflected in cults were related to land, fertility, ancestors, food and defence. The economy was almost self-sufficient with some trading for specialised goods and all natural resources was owned by the group. Almost all communication was face-to-face and all knowledge was passed on to each succeeding generation by word of mouth (Datec, 1996).

3.2 An Historical Overview of the PNG Education System

3.2.1 Traditional education

Traditional education was centred on village life where young learners informally observed and imitated elders at work and then practised through personal trial and error. This type of learning assisted the beginner to acquire the technical aspects of hunting, fishing, canoeing, agriculture, butchery, house and canoe building. During puberty, secret or true knowledge about the tribe and life originating from the ancestors was passed on through sometimes, painful initiation ceremonies. Because of its divine origin, several conclusions can be made to describe Melanesian concepts of knowledge. Firstly, unlike Western knowledge, which is meant to be challenged, Melanesian knowledge was finite and not tested. It dictated a set of moral principles that guided and maintained the behaviour and spiritual strength of the community. The young learners were schooled in the accurate reproduction of received knowledge and customs (McLaughlin, 1996). At no point were they
encouraged to question or innovate, as these would alienate them from adult society (McLaughlin, 1995).

3.2.2 Early Education

Education during the colonial era in the country was only of one culture, that of the Western culture, which caused social, economic and spiritual problems and can be best understood as cultural confusion (Eyford, 1993). This confusion of structures and values results when one culture is imposed upon another. The nature of this confusion can be best understood by Hall’s (1983) interpretation of culture in terms of the hardware and software of a computer. Hall asserts that the primary level culture (PLC), core culture or basic level culture, is similar to the hardware of a computer. The conscious, explicit culture, the part that can be talked about and described, is similar to the software or the computer programs. The most intercultural relations are conducted with only slight differences in the software and not in the hardware. While the only difference is those which are representative of the explicit, manifest culture although all the underlying PLC are identical. The results of treating members of other cultures as though programmed in the same way can range from the humorous through the painful to the tragic and even destructive.

Sometimes education introduced can produce tragic results without much attention to cultural issues. For example, Hall (1983) describes some of the problems that arise in Navajo schools in the United States as a result of cultural differences. The parents on one area of the school took their children out when they heard teachers yelling at the children. The authorities could not understand why and discovered, only through research, that in Navajo culture, yelling was a sign of insanity, which confused the teachers about the behaviour of the Navajo parents. Furthermore, in Navajo culture, direct gaze was used to punish children and a person’s name was never used as a direct address. Similarly in PNG societies, one is never allowed to call his or her parents by name, as this would show disrespect. Another example is that of displaying a direct gaze, which may be interpreted as being very rude as it may create interest (becoming friends) or differences (arguments and fights).
3.2.3 Mission schools

The early missionaries first introduced formal education for their own interests in areas where they established their churches (Bray, 1993; Crossley, 1993; Thomas, 1993). Their main interest was in converting pagans by teaching them basic literacy to read the Bible and counteract the influence of early traders who took advantage of the local villagers. In the early 1940s, the Department of Education was made responsible for coordinating education with the missions and for determining a policy on standards and the language of instruction in education within the country. Schools were developed with a strong community involvement having both a broad social welfare role and an educational role. However, one outcome of this schooling was that it gave the indigenous people limited access to Western-style education. Therefore to increase access, the policy of universal primary education was introduced which emphasised the use of English as a common language as this would foster national unity in the country where almost over 700 languages were spoken (Smith, G. 1975; Smith, P. 1987b; Thomas, 1993).

3.2.4 Learning in English

The official policy of conducting classes in English had a destructive effect on the culture of the people receiving this education. Over a longer period of time, by teaching students to learn English, their values, attitudes, beliefs and ways of doing things were conditioned in the Western way, creating a division between the school and village life. For example, Nelson Giraure (Giraure, 1974), described his passive learning as he remembered being completely inhibited during his first years at school. He could no longer make fun through speech. His quick wit was of no use to him. He was like a vegetable and controlled by the limits of his vocabulary. His days were spent listening to his teacher. Many questions he wanted to ask remained unasked because he did not have the ability to express them in English. Eventually he found it much easier just to sit and listen rather than attempt to speak so he sat and listened.
In some cases, the policy alienated many students from their cultures as expressed by another famous Papua New Guinean - Sir Paulius Matane (Matane, 1974). He stated that education made him a foreigner to his own tradition, culture and beliefs and wished that his proud fathers could come back to him now, take him and transform him into one of them - a colourful, articulate, skilful, proud, confident and brilliant man. But he had lost all these values because he went to school and as a result, he could not fit back into his own tribal group as he learnt so much about Western values and ideas.

3.2.5 Impact of formal education

The rapid establishment of Western formal education brought about broader social change but unfortunately the system had negative cultural outcomes. In providing formal Western education, the missionary society and the colonial government saw schools as powerful agents for change. There was never any intention that the schools should serve merely to reproduce values, beliefs and life styles of the societies in which they were built. In fact, their specific intention was the opposite and that was to produce and condition students with foreign ideas, beliefs and attitudes (Smith & Guthrie, 1980).

Educators (Delpit & Kemelfield, 1985) have recorded the cultural impact of the colonial education policy that promoted English as a language of instruction in the 1950s and 1960s. When the first pilot project of a vernacular school was established on Buka Island of the North Solomons Province in 1980, the chairman educated in English expressed a big gap in his education. He recalled that they were taught in English and were moulded to go outside and leave their villages to find jobs in the cities. No one taught them about their language and place. The expatriate and locally trained teachers trained them to leave their village and not to go back. He states that children of Australian and American immigrants were taught English for many years so that they did not learn the language of Papua New Guinea people nor their histories, values and cultures.
After independence in 1975 until the introduction of the education reforms in 1991 and 1992, the vernacular (elementary) schools were directed to instill village learning in order to educate Papua New Guinean children about the history, values and culture of their people (Delpit & Kemelfield, 1985). The teachers and children have used their own languages to teach themselves about their culture. Delpit and Kemelfield (1985) assert that if children are taught in their own languages, they will truly understand their cultures. Their languages tell them of their relationship to everything such as their elders, parents and even to the sand, rocks, sea and the stars. If Papua New Guinean children are not taught in their own languages, they will reject their cultures, elders and parents (Delpit & Kemelfield, 1985).

3.2.6 Past education system

Before 1991, PNG had a three-level education system (6-4-2 structure) with six years (Grades 1 to 6) of primary (community) school, four years (Grades 7 to 10) of provincial high school and two years (Grades 11 and 12) of national high school (senior high school). Students left school at the end of each level after they sat the entrance examinations set by the Department of Education (Measurement Service Unit, 1992). The science curriculum taught to all students was nationally prescribed from Grades 1 to 11. At Grade 12 level, it was an optional subject where students chose to take courses in biology, chemistry, physics and geology.

3.3 The Current PNG Education System

3.3.1 National Department of Education mission

A top priority of the National Government of PNG is that of human resource development. Hence the National Department of Education's (NDOE) mission as defined by the National Executive Council (NEC) is five fold:

- to facilitate and promote the integral development of every individual;
- to develop and encourage an education system which satisfies the requirements of PNG and its people;
• to establish, reserve and improve standards of education throughout PNG;
• to make the benefits of such education available and widely as possible to all of
the people; and
• to make education accessible to the poor and physically, mentally and socially
handicapped and to the educationally disadvantaged (Department of Education,

3.3.2 National objectives and aims

The NEC assigned four national objectives to the Ministry of Education as follows:

• to develop an education system to meet the needs of PNG and its people which
will provide appropriately for the return of children to the village community for
formal employment or continuation to further education and training;
• to provide basic schooling for all children as this becomes financially feasible;
• to help people understand the changes that are occurring in contemporary society
through the provision of non-formal education and literacy programs; and
• to identify the manpower development needs in the public and private sectors and
to provide appropriate higher education, development and training programs

In addition to these national objectives, education must prepare citizens who:

• will have a strong moral value system which places emphasis on personal
integrity, the equality of all members of society and the importance and relevance
of traditional values in modern life;
• are committed in their own personal development and view education as a
continuing life-long learning process;
• are invested with a productive work ethic and a realisation of the value of both
rural and urban community development activities in the context of national
development;
• are prepared for realities of life in most communities; and
are also capable of providing a basis for effective further training for manpower needs (Department of Education, 1996, p. 2).

As outlined in the National Constitution and the Philosophy of Education Report, through integral human development, the government has called for the education system to give value and status back to appropriate social attitudes, knowledge and skills which are relevant in community development. To this, a degree of competency in English, mathematics and science must be supplemented in order to ensure the development of PNG citizens who:

- are committed to their own personal development and view education as a continuing life-long learning process;
- possess a productive work ethic and value both rural and urban community development activities in the context of national development;
- are prepared for realities of life in most communities; and
- have the capability to participate in further training for manpower needs (Department of Education, 1996, p. 2).

The aims of the National Education Plan with full implementation by 2005 are to provide an education system that will adequately prepare:

- school leavers to return to their communities where there is and always has been traditional work and opportunities for community-based employment. This covers approximately 85% of the population. The major source of employment for these citizens will be their own subsistence and small-scale community based commercial enterprises. Their education will have prepared them and/or their parents for this reality.
- approximately 15% of the population who will find paid employment in the slowly increasing government, business and service industries. Their education will have provided them with the academic and technical skills to allow them to part take in tertiary education.
the small, but growing, number of marginalised urban youth for the realities of life in an urban situation (Department of Education, 1996, p. 3).

The former education system in effect from 1975 to 1992 did not reach all eligible young people and only a relative few have entered it through to the higher levels. The main aim of the four years of lower secondary schooling was to prepare students for post-secondary training courses, direct employment and responsible participation in community life. At Grade 11, there was a 'radical change in curriculum philosophy as students enter national high school, it became explicitly elitist, academic and highly selective' (Deutrom & Wilson, 1986, p. 397). This meant that at Grades 11 and 12 levels, programs were designed to prepare students academically for university studies. Therefore to overcome this problem, the education reforms were introduced in 1991 and 1992 to greatly increase access at all grades throughout the system.

In 1991 and 1992 the National Government instigated an Education Sector Review to identify, document and develop strategies to rectify problems in education, which had become endemic since 1975. The review confirmed excessively high rates of attrition at the primary level ensuring that universal primary education would likely to be ever achieved; low transition rates at the post grades 6 and 10 levels; a largely irrelevant curriculum; weak management and administration and declining resource allocations.

The reform of the education system began in 1992 and has two major components that include the structure and curriculum. The curriculum review represents a broad agreement on education for 21st century. It provides curriculum developers and policy makers with an overview of the entire reform curriculum from Elementary Prep to Grade 12 (Department of Education, 1997). It starts in a language the child speaks from the known vernacular and local culture to the new unknown language (English) with an understanding of national and international cultures.

A philosophy of education determines the guiding principles and the education system as a whole. The NDOE’s curriculum review (Department of Education,
1997) states that in line with the National Constitution’s and the Philosophy of Education Report’s aim of Integral Human Development, the Government of PNG calls for an education system which gives value and status back to appropriate community attitudes, knowledge and skills relevant to community development. It supplements this with degrees of competence in English, mathematics and science to ensure the development of citizens who are able to:

- participate in community decision-making at appropriate levels.
- live more useful community and productive lives and value both rural and urban community development activities in the context of national development.
- participate in further training for manpower needs and value education as a continuing life long process.
- relate responsibility to others and participate in the strengthening of social unity in the context of national development.
- develop a system of beliefs and values appropriate to their community and their individual rights.

The general aims of education describe the overall purposes of education in terms of the context, language, mathematics, resource development, social and spiritual development for elementary, primary and secondary levels (see Appendix 3.2, table 2).

3.3.3 The new structure

The former 6-4-2 structure before 1992 was characterised by high attrition rates at the primary level and a serious access problem at the secondary level with the two major blockages especially at Grades 7 and 11. Under the reformed system introduced after 1992, basic education includes elementary (EP, E1 and E2), primary (Grades 3 to 8) and secondary (Grades 9 to 12). Enrolments in elementary prep (EP) begin at six years of age. Elementary schools have been built on existing Tok Ples Pre Skul (TPSS) initiatives (Deipit & Kemelfield, 1985) and provide a preparatory year’s education (EP) followed by E1 and E2 to distinguish them from Grades 1 and 2 in the community schools. The language of instruction is in the vernacular, which
allows children to learn literacy in the language they speak. The National Government declared that all the 817 languages be the official medium of instruction at the elementary school level (Levi, 1997b). The preparatory curricular stresses initial literacy, numeracy, ethics, morality and cultural bonding. This new integrated curriculum based on the child’s own culture and community makes it relevant for EP, E1 and E2 and is designed to expand enrolment numbers and help improve retention in elementary schools. The transition to English begins in the third year (E2), which enables adopting a more relevant, integrated activity-based curriculum using locally developed materials (Department of Education, 1996).

The setting up of elementary schools in the villages has freed up classroom space and other facilities within the primary schools. This has allowed for the relocation of Grades 7 and 8 classes from high schools into the primary school system resulting in six years of primary education from Grades 3 through to 8. The primary curriculum has become more subject-specific and has improved the quality and relevance of education. The facilities freed up by the relocation of the Grades 7 and 8 classes increased the number of Grades 9 and 10 places, which in most cases doubled. At the same time, Grades 11 and 12 are being developed in selected schools as it is the government’s aim to have one such school in each of the province. Secondary education therefore consists of four years (Grades 9 to 12) with a curriculum that has been broadened to include more technical, agricultural, commercial and scientific content. Vocational centres have become part of the secondary system while open learning (distance education) provides another substitute for secondary education (Department of Education, 1996). The results of the education reforms and the new school system are further discussed in Appendix 3.

3.3.4 Education in the Gulf Province

The education division of the Gulf Provincial Government is responsible for the administration and operating expenses of 78 elementary schools, 106 community schools of which nine are topped-up, 4 vocational high schools and 5 provincial high schools. There is a possibility of upgrading one of the provincial high schools to a secondary school to enrol Grades 11 and 12 in the future (Rei, 1999b). About 40% of
3.4.2 Cultural analysis in the science curriculum

Thaman (1993) draws attention to all Pacific Islanders in maintaining their cultural identities in a world that is fast becoming culturally standardised. She asserts for a need to embark upon a systematic process of cultural analysis that examines the people's cultures, languages, environments, technologies, knowledge, skills, beliefs and values, in order to make better judgements about what needs to be transmitted to the next generation (p. 257). Thaman states that in Pacific countries, the missing link in the curriculum development process has been that of systematic cultural analysis which has not been achieved in Island countries in the 1970s and 1980s because of the great hurry to produce modern curriculum materials. According to Thaman (1993), cultural analysis can be done but the results take time to be fully informed in order to improve and make the curriculum decision better. She also states that there is a need of Pacific Islanders to examine their own cultures in order to identify aspects that will better inform future curriculum decisions. There is also an urgent need for research into the types of cultural knowledge and skills in the curriculum and also into culturally sensitive ways of teaching (Thaman, 1993). For example, Harris (1992) discusses different Aboriginal learning processes and identifies the need for Aboriginal people in Australia to take greater control over their school curriculum. Knowledge of traditional teaching and learning processes still exists with the older generations of Pacific Islanders and Thaman (1993) states s need to preserve this knowledge and divert it through the process of curriculum renewal and reform. She confirms the importance of this cultural heritage in educating young children in order to learn and understand their cultures and become part of it.

3.4.3 Culture in the PNG curriculum

Most students learn their traditional cultures informally and outside of school. The school was (and still is to a large extent) a place where things foreign were taught to allow students to pass examinations that enabled them to move to the next level of schooling and if they were fortunate, to secure paid job (Thaman, 1993). Moreover, a paid job helped the individual meet obligations to kinship, the church and general village community. Hence, a school for most students and the teachers themselves
was a place where a foreign culture was transmitted. Andrews (1970) asserted problems in science teaching are related to using inappropriate teaching practices and offering irrelevant courses in science. To overcome this, Blumer (1971) claimed that social anthropologists and linguists with research experience could assist teachers to identify students’ difficulties in understanding specific or groups of concepts. Moreover, Blumer (1971) suggested the use of existing concepts held by curious cultural groups be used in teaching science, such as indigenous fire lighting techniques in a section on friction and energy. Materials have made use of local landscape with examples for geological topics in teaching about volcanoes and the use of local hydroelectric schemes. However, science teaching still failed to attend to PNG’s cultural base.

Maddock (1981) asserted that the PNG science curricular went through further revision ten years alter, when for example, new drafts biology units recognised that students already had well developed concepts of indigenous classification systems and knowledge about local plants used in medicinal purposes, construction of houses and fabric weaving (Papua New Guinea Department of Education, 1979). A further number of concepts were identified that already existed in communities and were extended into many areas of the curriculum, for instance, the concepts of fields of fundamental forces, such as those surrounding a spirit entity was used in understanding magnetism, gravity and electricity (Maddock, 1981). While agreeing that there is merit in basing science curricula on local culture and sing the vernacular in instruction, particularly at elementary level in some places, Maddock (1981) claimed this imposed immense problems, due to the complex, multicultural, multilingual nature of the country. With over 700 different languages spoken, each by only a few thousand people with a diverse range of cultural patterns, this has limited the contribution of science education in terms of development.

In fact, Kelly’s (1977) eight-year study looked at cultural factors that affected the learning capacity of children in science and mathematics in the area of Piagetian conservation. Similarly, the Indigenous Mathematics Project classified and looked at various types of counting systems and food taxonomies among several cultural groups (Lancy, 1978). The accumulation of ethnographic research by anthropologists
contains observations relevant to scientific aspects of the culture studied. The sifting
of this information by suitable and sensitive researchers to a condensed and relevant
form on cultural scientific knowledge and models could be a sound basis for science
teaching.

Furthermore, Mackay (1970) used the ‘Test of Understanding Science’ (TOUS) to
investigate changes in understanding science among secondary level teacher trainees
at a PNG teacher’s college. However, the test was viewed from the professional
scientist’s view, used a foreign language, English, as the medium, and the cultural
background required to answer some of the items was specifically westernised and
technologically based. Although the results gave an insight into the difficulties of
achieving the objectives of school or college science courses (framed from a Western
scientist’s viewpoint), they revealed little about the specific culture of the students.

An instrument on culture administered in a number of indigenous languages, as well
as English, produced disturbing observations in science teaching from the view that
education prepare students for a place in their society (Maddock, 1974). The study
looked at he attitude towards investigation, control and manipulation of natural
phenomena and attempted to evaluate the aims in the science syllabus. In 1972, the
instrument was administered to Grades 9 and 10 students in high school and to
village people about the same age, from the same language groups who had only four
years of elementary schooling or less. In 1974, a large sample of students from Grade
7 through to tertiary level was tested, as well as a wider counterpart of village people
with no schooling to six years of primary schooling, and ranging from about 12 years
to mature and middle-aged people. The results showed a statistically and very
socially significant change in attitude from the lowest level of formal education
(those with zero to grade 2 elementary education) through to the highest level (those
with five years of high schooling and higher education). Follow-up interviews
revealed that students viewed village people as being ignorant and tradition-bound
and many attributed their own intellectual status to having being taught science at
school. Maddock (1981) stated that the use of a society’s cultural base, both
scientifically and linguistically, as the starting point and nucleus of a science

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education program is not well known and more research is needed to identify the background knowledge possessed by all 700 language groups.

However, science teaching can cut across authority structures and increase levels of attitudinal alienation (Maddock, 1974). Draper (1974) recognised this alienating effect and stated that after years in an urban educational environment, younger members regarded villagers as senselessly primitive and ignorant. This has made villager leaders feel incompetent to cope with this young elite and they have maintained their dignity by barring them from village debates and council meetings. Educational planners also identified this problem as stated in the 1975 Education Plan, 'a school which imparts inert ideas or turns a child against his culture is simply an unsatisfactory school' (Papua New Guinea Department of Education, 1975). Nevertheless, Maddock (1981) claimed that an embracing, community-based science curriculum suggests a thorough knowledge of the background culture, its beliefs, attitudes, technologies, languages, leadership an authority structures. This in turn requires an anthropological understanding of the curriculum by program planners and implementers to avoid sensitivity and the 'arrogance of ethnocentricity'. In essence, it is important to understand the traditional knowledge held by the community and by the students themselves.

3.5 Traditional Knowledge

3.5.1 What is traditional knowledge?

The Director General of UNESCO in 1994 defined traditional knowledge as:

The indigenous people of the world possess an immense knowledge of their environments, based on centuries of living close to nature. Living and from the richness and variety of complex ecosystems, they have an understanding of the properties of plants and animals, the functioning of ecosystems and the techniques for using and managing them that is particular and often detailed. In rural communities in developing countries, locally occurring species are relied on for many -- sometimes all -- foods, medicines, fuels, building materials and other products. Equally, people's knowledge and perceptions of the environment, and their relationships with it, are often important elements of cultural identity.

(Emery & Patton, 1997; p. 4)
Most indigenous people have traditional songs, stories, legends, dreams, methods and practices as a means of transmitting specific elements of traditional knowledge. It is sometimes preserved in the form of memories, rituals, initiation rites, ceremonies or dance. Occasionally, it is preserved in artefacts handed from father to son or mother to daughter. In indigenous traditional knowledge systems, there is usually no real separation between secular and sacred knowledge and practice – they are one and the same (Emery & Patton, 1997). In virtually all of these systems, knowledge is transmitted directly from individual to individual orally.

Emery and Patton (1997) reported a workshop in Inuvik, Canada on environment assessment on November 1995, which highlighted the characteristics of indigenous traditional knowledge. When asked about the meaning of traditional knowledge, Inuit people state: It is practical common sense based on teachings and experiences passed on from generation to generation; it is knowing the country; it covers knowledge of the environment (snow, ice, weather, resources), and the relationship between things; it is holistic – it cannot be compartmentalised and cannot be separated from the people who hold it; it is rooted in the spiritual health, culture, and language of the people; it is a way of life. Traditional knowledge is an authority system; it sets out the rules governing the use of resources – respect and obligation to share; it is dynamic, cumulative and stable; it is truth. Traditional knowledge is a way of life – wisdom is using knowledge in good ways; it is using the heart and the head together it comes from the spirit in order to survive; it gives credibility to people (Emery & Patton, 1997; p. 4-5).

3.5.2 Traditional knowledge in PNG

According to Waldrip and Taylor (1999), research shows that village elders from many tribal groupings are perceived to be the source of wisdom and are the recognised authority of tribal knowledge. In many PNG and other Pacific Islands traditional societies, traditional knowledge appears to be finite and is passed down from generation to generation by word of mouth by older members of the tribe to the younger generation as a survival tactic. The main functions of learning were those of explaining to the next generation the roles people played in society, and of teaching
the young how to perform both the roles they were obliged to adopt and ones they were free to choose for themselves. All the learning was acquired through observing and participating in family and community life and more formally, through rites for initiating the young adult into adult status (Latukefu, 1985; Thaman, 1993; Thomas, 1993). Such knowledge included the skills of hunting, trading expeditions, gardening (planting and harvesting), building shelter, healing diseases, forecasting weather, initiation ceremonies, funeral rites, protection against crocodiles, fishing expeditions and various activities associated with cultural heroes. The most respected elder in a community usually conducted the teaching and learning that occurred through practical absorption (observation) and participatory activity embedded in the villager's daily life. Particular skills were taught by experts who possessed these skills which meant every different skill had a different teacher. Specialists teach the tasks to a selected few who had gone through the primary and secondary streaming processes by way of pre-initiation (Kelontii, 1996; Latukefu, 1985; Thaman; 1993; Thomas; 1993). Pre-initiation was mainly done through observing the child’s interests at an early age. For example, suppose a child was found to possess aggressive behaviour, he was singled out and given a warrior’s initiation.

There have been publications of articles (Post Courier, 2000) that focussed on the growing importance of traditional medicine, traditional knowledge and the preservation of PNG ways and how they might be important for keeping our identity as a people. Papua New Guineans possess so much knowledge that could be of immense benefit to the world. For example, one hears stories of snakebite victims being jerked free from the jaws of death. The snakebite victim will be frothing in the mouth; his pupils dilated and his whole body is gripped by an unstoppable convulsion. The horrified relatives are hysterical and hey know that when the body stops twisting and turning, death has won. Then comes a quack doctor, who administers some herbs and the twisting and turning stops, but death is not the victor. As hysteria turn into jubilation, the victim lives. Such cases are occurring everywhere in PNG every day.
Such knowledge is handed down through many generations and how this knowledge was obtained in the first place is a mystery. But the knowledge, which can cover a wide range of activities from curing illness, gardening, fishing, hunting, warfare, sports and romance, are kept secret and only passed on with the greatest care. There have been cases where cures and remedies have been told in dreams while others are more direct. For example, a man called Saga of Kira Kira village in the National Capital District told how his family came to own an anti-snake venom. As a boy, Saga was returning home from school when his path was crossed by two big snakes engrossed in a savage battle. Saga watched the spectacle from a safe distance and after a while, one of the snakes fell limp across the track. The other snake dashed off into the bush reappeared again carrying some leaves in its mouth. As Saga watched, the snake caressed he limp snake several times until the limp snake came back to life. Both snakes then bolted into the bush. Saga went home and told his father the story and upon hearing the boy’s story, the father told Saga and hurried back to the site. They found the leaves that the snake had dropped. They tried it on a snakebite victim successfully and the knowledge became a family heirloom.

The customs governing the use of traditional knowledge differ from place to place, but generally speaking, are shrouded in secrecy. The ingredients, magic chants and the methods are kept secret by the practitioner. Many older persons value their knowledge and use it as a bargaining tool. Many die and take their knowledge with them without having to pass it on. Many Papua New Guineans do not take traditional knowledge seriously though. Their modern knowledge makes them believe that everything must be scientifically proven. So anything that has no scientific base is considered superstitious. But there is a growing interest by academics in traditional knowledge. Whether they will be able to break the secrecy is one thing, but the knowledge has to be protected. Yet there is fear that Papua New Guineans might be cheated of their knowledge. For example, there is no effective remedy for stonefish poisoning. A stonefish poisoned victim might yell in anguish while the leg swells to three or four times its size. When taken to the hospital, a minor surgery will be performed and the patient admitted for about a week.
In the village, many miles away from hospital, the quack doctor might bring relief within a few minutes and the patient will be able to walk again almost immediately. There will not be any need for surgery or hospitalisation, which means that such knowledge is very much sought after. There are traditional remedies such as the calling of fish such as trevelly and the krill, or ensuring a successful taro harvest. These traditional remedies are not commonly practised because in many places, jealousy can lead to sorcery. Sorcery was associated with poison but the real traditional sorcery was never administered directly. Because of ingrained beliefs and traditional practises, traditional medicine that has to be taken, is not encouraged. If it has to done, then the person administering it must drink the portion before the patient takes it. The sorcerer’s knowledge though is mysterious, and in many cases very hard to prove. For example, the calling of rain and sending away of rain is knowledge that has been passed down for generations. Sorcerers had a place in society. They maintained that balance that ensured order in society but at the same time became craft “politicians”.

Metta (2000) reports that the Tolais of East New Britain Province have their own Loch Ness monster, a huge snake the call ToBabe, the caretaker of the land, sea and volcanoes. The Tolais take his tale about the big snake seriously and believe that there is a creature that lays claim to the land and sea upon which the people have settled and are living off. Legends transcend the ages and tales abound about the huge snake that can transform itself into human being. The Tolais tend to tell people (when they talk about the big snake) that they are talking about the big boss of this place, the respected ages-old caretaker of his land, sea and volcanoes, and the one whose name translates into ‘Staring at the stars’, the one whom the Tolais call ToBabe-Ratagul.

Emery and Patton (1997) state that traditional knowledge comes from a wide diversity of experience in nature, from teaching and apprenticeship, working with the land, by absorbing the feel of the wild animals and plants, and by listening to legends and stories. For example, Gomez (2000) reports that women in the North Solomons Province of PNG learned local traditional medicine from the old people. These women saw the jungle with a different eye, as it became their source of medical and
food supplies. They found that plants, leaves, roots, fruits, bark of trees as well as marine life became useful as medicine. Therefore, it means that traditional knowledge is organised and based on integration, not on analysis into parts. In addition, basic assumptions about classification of plants and animals or cultural actions and rituals are often very different from those of technology-based societies. The characteristics of traditional learning through observation, imitation, verbal instruction, by personal trial and error and through demonstrations, are mostly with real life activities, and are context specific and person-oriented (Harris, 1992). In many villages, learning of indigenous languages, folklore, personal-social relationships, traditional vocations and dances and the nature of family structures, still depend heavily on these procedures and experiences from the past. During puberty, secret or true knowledge concerning the tribe, and life originating from the gods are passed on through sometimes, painful initiation ceremonies. For example, in parts of the East Sepik Province, young boys sometimes go through painful skin cutting ceremonies, which depict the sacred crocodiles that live in the mighty Sepik River. Once they have passed through this ritual ceremony and achieved it, they are recognised as adults in their society.

McLaughlin (1996) highlights several features to describe Melanesian concepts of knowledge, which have a divine origin. Firstly, unlike Western knowledge, which is meant to be challenged, Melanesian knowledge is finite and not tested. It dictates a set of moral principles that guides behaviour and maintains the spiritual strength of the community. The young learners are schooled in the accurate reproduction of received knowledge and customs. At no point are they encouraged to question or innovate as these behaviours would alienate them from adult society (McLaughlin, 1995). Only the most senior members of the tribe can challenge another elder’s view. Similarly, Emery and Patton (1997) assert that in many indigenous cultures, the elders speak the truth and hunters’ words are unquestioned. Indigenous people understand that there are different qualities of knowledge from people who have different levels of experience and wisdom, so they accept the knowledge the way it is presented. They do not attempt to challenge the wisdom of an elder.
Flannary (1998) claims that the *Melanesian* worldview incorporates humans and animals, the seen and the unseen, the living and the dead, in a way that is vastly different from the *European* outlook. What *Europeans* call 'supernatural' factors are for New Guineans simply the non-visible parts of a single continuum of life. Indeed they are eminently 'natural' (p. 200). Furthermore Waiko and Jiregari (1982) state that PNG societies view nature as a whole and as a continuity from the past to the present and into the future; the clan is linked with the surrounding land, water, forests, animals and heavens. The knowledge base contains the accumulated tools and wisdom for dealing with, and living in the environment. The community pursues and disseminates this knowledge base through repetitious learning, reinforced rituals, and sanctions of the ancestors or rewards from the spirits. For example, Kiki (1963) in his autobiography *Kiki Ten Thousand Years in a Lifetime* confirms that his mother's people referred to the dead as 'going to the west' because their dead were not buried in the ground but placed high up in tree branches facing the sunset. The people did not believe in the last judgement and had no concept of heaven or hell. But they believed that the dead were ever present and they can be called upon to help in any dangerous situation. Similarly, the 'Toaripi' of the Gulf Province referred to their dead ancestors to a dwelling place of the dead called 'alaua-ipi kivokipi' which connotes a place beyond the western horizon where spirits of the dead were supposed to dwell. Thus the exclamation 'alaua-ipi meaforoe a' is often said where there is a beautiful sunset, 'what lovely weather in the spirit land' (Brown, 1968). Thus Australia is referred to as the spirit land where the dead were supposed to dwell.

3.5.3 *Call to protect and promote PNG's traditional knowledge*

The Vice-Minister for Education, Professor John Waiko made a call for PNG to protect and promote its indigenous traditional knowledge because of its cultural diversity (Post Courier, 1997a). He spoke and addressed participants on the topic 'The Value of Traditional Knowledge in the 21st Century' at the Second Waigani Seminar on 'Information and the Nation' at the University of PNG. He stated that indigenous knowledge is a living treasure (Post Courier, 1997a). Papua New Guineans must learn to accept, preserve and promote the traditional knowledge which has been inherited from their ancestors. PNG has more than 6,000
autonomous ethnic groups spread across the country with over 700 languages. Its genetic diversity acknowledges a great potential source of scientific research, which would benefit from high information technology awareness, while at the same time would save traditional knowledge from extinction (Levi, 1997a). The Ministry of Education has started work on keeping traditional knowledge alive through the current national education reform process, which is directed at integrating traditional knowledge into the national curriculum.

3.5.4 Traditional knowledge in PNG’s school curriculum

Contrarily, Guy (1999) highlighted the ongoing debate on the inclusion or exclusion of traditional knowledge and skills in the school curriculum. He questioned the contemporary, relevance of these skills and knowledge and asked whether this traditional knowledge and skills base has been lost or abandoned. He questioned whether some recognition of this prior learning, where it existed, be included in the curriculum development process as relevant knowledge. In PNG at present, communities are ‘de-skilled’ where as in the past, they had an established system of comprehensive learning and teaching processes that valued the use of their own knowledge base and culture. Guy (1999) states that there is a need to revisit these processes where community people no longer live traditional lives by co-constructing the curriculum and reskilling community members to be responsible for their own development. For example, parents from a coastal Motuan village called Pari in the NCD stated that basic skills related to small business, motor maintenance, fishing and agriculture, respect, participation and acceptance were needed for living in the community. These parents felt that Pari school should offer to students leaving at the end of Grades 8 and 10 more practical activities related to fishing and agriculture, typing, poultry, piggery, handcraft, vegetable for restaurants and hotels, furniture construction, mechanics and sewing. Finally, Guy (1999) stated that a lot can be learned by talking to parents and engaging communities in issues concerning education, skilling and development. He highlights a need here for infrastructure that will allow school teachers, parents, community members and curriculum developers to ask their questions in the same forum and identify
mutually-acceptable alternatives for the development of relevant curricula and schools that are connected to social and economic activity.

Furthermore, the president of the Raluana Local Government in East New Britain Province has stated that some Tolai customs have outlived their usefulness and values and must be refined to fit in with today's changing lifestyle (Post Courier, 1997c). He stated that the Tolais must either do away with some of these customs completely or reform them to have real meaning in their lives instead of hindering progress. For example, land distribution is a major problem to family survival and being a matrilineal society, women have the final say in land distribution and use. If a young man persuades his wife to build their home and live on the father's land while he is still alive, the family is happy. However with his father's death, his aunts and cousin sisters can move in and claim the land, his father's belongings, thus denying him and his family all rights to land and properties, his father's food gardens and cocoa and coconut plantations.

3.5.5 Guidelines to preserve, develop and promote PNG's traditional culture

Boden (1997) describes the remarks made by Mr Gabriel Dusava, the Minister for Culture, Education and Science when he talks about cultural heritage. If cultural heritage is to be useful to PNG's people, then it has to be useable in the maintenance and enhancement of human life. If from an indigenous base a person finds inspiration to create music, dance, painting or sculpture, or to write books, then in this culture, it is a resource for inspiration. If from the knowledge of the ways of our forefathers we are able to cope with and solve problems, then culture is a knowledge resource.

Dr Jacob Simet, the executive director of the National Culture Council has called for proper guidelines to preserve, develop, encourage and promote PNGs traditional cultures as well as contemporary culture (The National, 1997). The concern for protection of PNGs culture should be related to PNGs way of life being a resource basis for considerations of identifying self-expression, artistic creativity for PNGs childrens' future. There is a need to develop a PNG contemporary sculpture for
PNGs traditional cultural past and to promote and locate markets for some products of PNGs various cultures. Kuble (1997) reports the remarks made by Mr Bebes Korowaro, the executive director for the Eastern Highlands Provincial Investment and Tourism Promotion Authority, when he stated that 'culture is a living resource and a source of strength to have pride and dignity and all Papua New Guineans have a responsibility to preserve, protect and promote PNGs diverse cultures. Similarly, a visiting African legal practitioner, Nene Ofoe Amegatcher of Ghana told the first PNG National Legal Convention on Alternative Dispute Resolution (ADR) that African indigenous society has its own legal system, characterised by native or lay participation and relies on unwritten, oral and flexible precedents or rules. This indigenous legal system developed as a result of on-going practices of people in a particular community, which over time has crystallised into local practice. He states that most people on the African continent remained attached to their traditional ways of life (Post Courier, 1999a).

Finally, Gumuno (1999) described a remark made by the Minister for Culture and Tourism, Herowa Agiwa, who stated that culture is not imported from other countries but was here before and PNG people must continue to uphold these unique cultures for future generations. This was supported by the president of Baiyer local level government, Mr Kiapa Minako, who stated that due to Western influences, many young people were forgetting their own cultures and following too much of the Western lifestyle. The only people who took pride in their cultures and traditions were the elderly men and women while young girls and boys were influenced by outside events and were no longer interested in their cultures. As a result, this was a bad signal for the future.

3.6 Summary

This chapter was written to highlight the problems that occurred when education was first introduced by the early missionaries and later by the colonial government. Most of the people (85%) in PNG mainly live a traditional subsistence lifestyle in the rural areas. Many still hold traditional beliefs such as fear of evil spirits, sorcery (pointing the bone) and witchcraft. Early education was traditionally centred on village life
where the young learner informally observed and imitated elders at work and them practised through trial and error. Unlike Western knowledge, which is meant to be challenged, Melanesian knowledge was finite and not tested. The early missionaries introduced schools for converting pagans by teaching them basic literacy to read the Bible. The official policy of teaching in English conditioned students to values and beliefs of the West over a long period of time, creating a cultural gap by alienating students from their own cultures. From 1975 to 1992, the curriculum was not seen as relevant for Grades 6 to 10 and the major result of the reform is the introduction of elementary schools where students enrol at 7 years of age and are taught all the subjects in the children’s local languages during the first three years of school.

Likewise, the science curriculum has not always met the needs of students because it has not been embedded in the culture. Traditional knowledge in PNG must be protected and promoted because of its cultural diversity and a living treasure of oral and written history. There is a need to revisit communities that had well-established processes of learning and teaching in the past, which valued their knowledge base, culture and skills so they can be included in the school curriculum. The inclusion of traditional knowledge and skills into the curriculum can be done if there is an infrastructure in place. Such an infrastructure will allow teachers, parents, communities and other members ad curriculum developers to ask their questions in the same forum and identify mutually acceptable alternative knowledge so that curricular relevant for schools are connected to social and economic activities. To gain knowledge of what some of this alternative knowledge might be, village elders in the Gulf Province were interviewed about their beliefs, ideas and explanations; these are described in Chapter 5.
CHAPTER 4

METHODOLOGY

4.0 Overview of Chapter

This chapter describes the methodology used in the collection and analysis of data in this study. It discusses the research background and introduces the research questions with the strategies used in collecting data. An outline of Denzin and Lincoln’s (2000) research process is discussed and used as a model for this study. This is followed by an explanation of why the research design was used and justifies the use of an interpretive methodology. Following on from this, a description of the sample used in this study and the research setting are discussed. This chapter also describes the development of the paper and pencil instruments used and their justification. Finally; a discussion of the methods of data collection and analysis is given at the end of the chapter.

4.1 The Research Background

In recent years and today, educational researchers are in a position to use a wide range of acceptable methods and styles for research. Researchers select a method and present their work in an appropriate style dependent upon the researcher’s preference and the purposes of the research conducted, which in turn is dependent on the phenomenon to be investigated. This phenomenon varies with time, place and the participants, so the results of the ‘research act’ (Denzin, 1970) are developed largely by the ‘research background’. The background for this study, as discussed in the Background and Rationale (see Chapter 1), is Papua New Guinea (PNG) village elders’ traditional beliefs and stories in explaining natural phenomena, and PNG secondary school students’ traditional science beliefs and their explanations of natural phenomena. The researcher investigated the sources of ideas, beliefs and explanations of natural phenomena held by village elders and secondary school students which related to his early years of teaching science (1979 to 1981) and writing science curriculum materials (1983 to 1986 and 1989 to 1994). It was during
this last period that he felt a need to investigate the beliefs; stories and explanations secondary school students bring to science classes.

The researcher also intended to investigate if the ideas and beliefs held by village elders were similar with those of the students in terms of their cultural and school science experiences. Of specific interest was how students use their cultural experiences to explain formal scientific concepts in a school setting. To do this, the researcher employed a multi-method, qualitative research approach (Denzin & Lincoln, 2000). According to Denzin and Lincoln (2000), the use of multiple methods or triangulation reflects an attempt to secure an in-depth understanding of the phenomena in question. However, objective reality can never be captured but can be known through its representations and that triangulation is an alternative to validation (Flick, 1998). The combining of multiple methodological practices, empirical materials, perspectives and observers in a single study is a strategy that adds rigor, breath, complexity, richness and depth to any inquiry (Flick, 1998). This study used a multi-method approach because qualitative research is able to harness the results of a range of techniques and strategies for observing and analysing phenomena. The researcher also used an interpretive approach because qualititave researchers acknowledge that interpretation is essential in discovering meaning and naturalistic because qualitative research is research in situ. These approaches were employed in this study to examine the sources of village elders' knowledge and beliefs on natural phenomena in the village setting and students traditional science beliefs, explanations and understanding of natural phenomena in a rural high school setting in a PNG classroom.

This study used a mixture of interpretive research methods which researchers have used previously in collecting and analysing data. For example, they include ethnography, qualitative, participant observation, case study and phenomenology (Erickson, 1986). Initially, this study included interviews conducted with eight village elders from a village in the Gulf Province of PNG. The interview process probed each elder’s understanding and explanations of natural phenomena in their village setting. The analysis of the interviews with the elders resulted in the design, development and administration of three instruments, Traditional Science Beliefs, Student Questionnaire 1: Sources of Explanation on natural phenomena and
Student Questionnaire 2: Types of Explanations on natural phenomena. The three instruments were administered to 216 students at a rural high school in the Gulf Province of PNG. This study combined both qualitative (observation and interview techniques) and quantitative (questionnaires) methods to provide data on the research questions.

4.2 The Research Questions

The basic research questions underlying this study relate to elders and secondary school students in the Gulf Province of PNG are as follows:

1. What traditional beliefs or stories do village elders hold in explaining natural phenomena?

2. What traditional science beliefs do secondary school students hold?

3. What are the sources of explanations that secondary school students give for natural phenomena?

4. What types of explanations do secondary students give for natural phenomena?

5. What views do science teachers and curriculum officers have on the use of traditional knowledge in the science curriculum?

4.2.1 Matching research questions with strategy

Table 4.1 shows the research questions used in this study and how they are matched against the type of strategy used.
Table 4.1: Matching research questions with strategy

<table>
<thead>
<tr>
<th>Purpose of Study</th>
<th>Research Question</th>
<th>Research Strategy</th>
<th>Examples of Data Collection Techniques</th>
</tr>
</thead>
<tbody>
<tr>
<td>EXPLORATORY</td>
<td>1. What traditional beliefs or stories do village elders hold in explaining natural phenomena?</td>
<td>- semi-structured interview questions</td>
<td>- in-depth interviewing</td>
</tr>
<tr>
<td>- to investigate natural phenomena such as sun, moon etc.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- to identify/discover important beliefs and ideas.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- to document the traditional science beliefs and natural phenomena of interest.</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>DESCRIPTIVE</td>
<td>3. What are the sources and explanations that secondary school students give for natural phenomena?</td>
<td>- descriptive statistics (frequencies, means).</td>
<td>- Student Questionnaire 1: Sources of Explanations</td>
</tr>
<tr>
<td>- to document the traditional science beliefs and natural phenomena of interest.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- to document the natural phenomena of interest.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EXPLORATORY</td>
<td>5. What views do science teachers and curriculum officers hold on traditional knowledge in the science curriculum?</td>
<td>semi-structured interview questions.</td>
<td>- in-depth interviewing.</td>
</tr>
<tr>
<td>- to identify important ideas and beliefs.</td>
<td></td>
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(Adapted from Marshall and Rossman (1989, p. 78))

4.3 Denzin and Lincoln’s Research Process

Table 4.2 shows the research process identified by the researcher from Denzin and Lincoln’s (2000) description of the process. The researcher used selected elements to guide research efforts and presents them in specific **bold italic** for clear identification. He then proceeds to discuss the ways in which they were used to construct the research text.
<table>
<thead>
<tr>
<th>Phase 1: The researcher as a multicultural subject</th>
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</thead>
<tbody>
<tr>
<td>* history and research traditions</td>
</tr>
<tr>
<td>* conceptions of self and others</td>
</tr>
<tr>
<td>* ethics and politics of research</td>
</tr>
</tbody>
</table>

<table>
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<tr>
<th>Phase 2: Theoretical Paradigms and Perspectives</th>
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</thead>
<tbody>
<tr>
<td>* positivism, post positivism</td>
</tr>
<tr>
<td>* interpretivism, constructivism, hermeneutics</td>
</tr>
<tr>
<td>* feminism(s)</td>
</tr>
<tr>
<td>* racialised discourses</td>
</tr>
<tr>
<td>* critical theory and Marxist models</td>
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<tr>
<td>* cultural studies models</td>
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<tr>
<td>* queer theory</td>
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</tbody>
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<tr>
<th>Phase 3: Research Strategies</th>
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</thead>
<tbody>
<tr>
<td>* study design</td>
</tr>
<tr>
<td>* case study</td>
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<tr>
<td>* ethnography, participant observation,</td>
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<tr>
<td>performance ethnography</td>
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<tr>
<td>* phenomenology, ethnomethodology</td>
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<tr>
<td>* grounded theory</td>
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<tr>
<td>* life history, testimonio</td>
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<tr>
<td>* historical method</td>
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<td>* action and applied research</td>
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<th>Phase 4: Method of Collection and Analysis</th>
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<tbody>
<tr>
<td>* interviewing</td>
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<tr>
<td>* observing</td>
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<tr>
<td>* artefacts, documents, and records</td>
</tr>
<tr>
<td>* visual methods</td>
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<tr>
<td>* autoethnography</td>
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<tr>
<td>* data management methods</td>
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<tr>
<td>* computer-assisted analysis</td>
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<tr>
<td>* textual analysis</td>
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<tr>
<td>* focus groups</td>
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<tr>
<td>* applied ethnography</td>
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</table>

<p>| Phase 5: The Art, Practices, and Politics of   |</p>
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<tr>
<th>Interpretation and Presentation</th>
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<tbody>
<tr>
<td>* criteria for judging adequacy</td>
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<tr>
<td>* practices and politics of interpretation</td>
</tr>
<tr>
<td>* writing as interpretation</td>
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<tr>
<td>* policy analysis</td>
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<tr>
<td>* evaluation traditions</td>
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<tr>
<td>* applied research</td>
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</tbody>
</table>

The researcher found Denzin and Lincoln’s (2000) research process to be powerful in explaining and justifying an interpretive methodology. Although they admit that ‘qualitative research deploy a wide range of interrelated interpretive methods, always
seeking better ways to make more meaningful the worlds of experience they have studied’ (2000, p. 19), researchers whether inexperienced or experienced also need some kind of design to place them in the research world. Behind this design ‘stands the biographically situated researcher’ (2000, p.19), so Denzin and Lincoln (2000) suggest five levels of activity and they vary between researchers depending on their biography.

4.3.1 The researcher as a multicultural subject

Denzin and Lincoln (2000) claim the researcher as ‘socially situated’ (p. 19), where he or she enters and is guided locally by the traditions of historical research. This complex and contradictory history of research affects and confronts the researcher ethically and politically. The researcher has identified the elements of this step in the Research Process (see Table 4.2) in specific bold italic as all three elements contribute to frame his biography. His place in history and traditions of research, his conceptions of himself and others and his perceptions of ethics and politics of research have assisted to mould this study and are explicit throughout the text.

4.3.2 Theoretical paradigms and perspectives

In justifying the use of an interpretive methodology from that of an empirical and quantitative nature, it must be known that ‘all research is interpretive, guided by a set of beliefs and feelings about the world and how it should be understood and studied’ (Denzin & Lincoln, 2000; p.19). The paradigm, the researcher uses demands and asks questions based on the research and how the interpretations will be framed. Denzin and Lincoln (2000, p. 21) outline a useful analysis of the different paradigms, with their assumptions and criteria for evaluating research, and the form of narration. As in Table 4.1, the researcher located his research within the interpretivist tradition, also known as the constructivist paradigm or theory which Denzin and Lincoln (2000, p. 22) define as follows: criteria for evaluation - trustworthiness, credibility, transferability, confirmability; form of theory - substantive-formal; and type of narration - interpretive case studies, ethnographic fiction.
The 'criteria for evaluation' by Denzin and Lincoln (2000) are similar to those of Guba and Lincoln's (1989) 'credibility', 'dependability' and 'confirmability' and are stated as the subsets of "the trustworthiness criteria" (p. 233). Guba and Lincoln (1989) with their trustworthiness criteria have tried 'to parallel the rigour criteria that have been used within the conventional paradigm for many years' (p. 233). Guba and Lincoln (1989) explain that they prefer the 'authenticity criteria', such as 'fairness', 'ontological authenticity', 'educative authenticity' and 'catalytic authenticity' as criteria of goodness or quality for interpretive evaluation. The researcher chooses however to retain the use of Guba and Lincoln's (1989) 'trustworthiness criteria' as his measures of 'goodness' or 'quality' and assumes that the 'authenticity criteria' is more relevant to ethnographic evaluations where the various stakeholders are more willingly available for feedback and reflection. Research that is meaningful and dependent on interviews as data sources is, in the researcher's opinion, better served by the 'trustworthiness criteria'.

Within the more positivist criteria of internal and external validity, reliability and objectivity follow the trustworthiness criteria of credibility, dependability and confirmability as criteria for judging the value of the research process and its resulting text. Therefore, the researcher has sought to maintain a high standard of 'goodness' or 'quality' while realising that interpretive research is based on description of daily life and search for meaning given to actions by the individuals who live it.

4.3.3 Interpretivism

The interpretive paradigm is limited with its own characteristics and combines beliefs about ontology (What kind of being is the human being? What is the nature of reality?); epistemology (What is the relationship between the inquirer and the known?); and methodology (How do we know the world, or gain knowledge of it (Denzin & Lincoln, 2000). Interpretive research is a situated activity that locates the observer in the world and consists of materials and practices that make the world visible. This world is turned into a series of representations that include filed notes, interviews, conversations and recording to the self. It involves a naturalistic approach to the world where researchers study things in their natural settings to
make sense of, or to interpret, phenomena in terms of the meanings people bring to them (Denzin & Lincoln, 2000).

All research is interpretive and guided by a set of beliefs and feelings about the world and how it should be understood and studied (Denzin & Lincoln, 2000, p. 19) and these beliefs shape how the researcher sees the world and acts in it. The net that contains the researcher’s epistemological, ontological and methodological premises is termed a **paradigm** or in terms of an interpretive framework, a ‘basic set of beliefs that guides action’ (Guba, 1990, p. 17). Each paradigm makes particular demand on the researcher, including the questions he or she asks and the interpretations the researcher brings to them. Interpretive research intends to understand (make sense of, and give meaning to) the dynamic and interactive processes in view of causality in its immediate and its larger contexts. The products of interpretive research are the description of daily life and the search for meaning by individuals, and recognises that prediction is impossible in systems of relations where cause is mediated by systems of symbols (Erickson, 1986). The processes involve observations and descriptions used to search for patterns to understand the meaning of reality as perceived by the person under study and involves theory building (Gallagher, 1984). It avoids pre-definitions, seeks interconnections, and observations are made in a naturalistic manner that avoids obstructive influence of the group under study. It is experiential and works within the context of daily life and seeks to understand values and the observer is the instrument and based on phenomenology. Simultaneous activities are used in the attainment and analysis of data (Gallagher, 1984).

The interpretive paradigms work within relativist ontologies (multiple constructed realities), interpretive epistemologies (the knower and the known interact and shape one another), and interpretive, naturalistic methods. They work from within a realist and critical realist ontology and objective epistemologies and rely upon experimental, quasi-experimental, survey and rigorously defined qualitative methodologies (Denzin & Lincoln, 2000).

Being a realist, the researcher holds the assumption that he can interpret and describe a world that he has experienced. The interpretations of the world by others can also be beneficial to him as long as they are grounded in their experience and based on
personal reflection. The researcher acknowledges that his interpretation will vary from that of an individual with a different ‘conceptual horizon’ as they occur within varying geographical, social, cultural, political and personal contexts, and therefore, must be described individually in terms of their subjective epistemologies (Coburn 1993).

4.3.4 Research strategies

The researcher has used several approaches such as case study (interviewing and observing), ethnography and phenomenology where “strategies of inquiry put paradigms of interpretation into motion” (Denzin & Lincoln, 2000, p. 22). This approach allowed the researcher to use his personal experience within an interpretive paradigm that allows a theory-driven mode of inquiry. The value of interpretive research is particularly evident in developing local, small-scale theories of specific context (Denzin & Lincoln, 2000). For ethnographic significance, this is derived socially, not statistically, from knowing how people in particular settings make sense of the experience of everyday lives (Wolcott, 1988). This in turn requires sufficient information as a basis for the ethnographer’s interpretation to give readers the base to make independent interpretations. The researcher used some aspects of phenomenology as it is referred to as a philosophy, a paradigm and a methodology equated with qualitative methods of research (Patton, 1990), and draws from it in its emphasis on experience and interpretation (Merriam, 1998). For example, a phenomenological analysis was used to describe the meaning of the experiences of a phenomenon (or topic or concept) for the village elders. The researcher wrote a description of ‘how’ the phenomenon was experienced by the participants in the study as ‘structural description’ and a description of ‘what’ was experienced as ‘textural description’ (Moustakas, 1994).

4.3.5 Methods of collection and analysis

The researcher used personal experiences and observations, interviews and survey questionnaires as the principal strategies for data collection. Personal experience, according to Clandinin and Connelly (1994) is founded on the study of experience in the social sciences. Thus, the study of life is the study of experience and is intensely
personal in nature. This research includes the personal experience of others and the researcher’s and therefore it is important to understand the autobiographical quality of our own experience (Clandinin & Connelly, 1994) because personal experience methods acknowledge the centrality of the researcher’s own experiences (Clandinin, 1993). The researcher believes that his personal experiences and living and teaching among his own people are valuable in this research. That experience includes diary notes, discussions with those who shared his experience and memories of working with educational institutions that have shaped his present understandings and practices in education.

4.3.6 The art of interpretation and presentation

There has been much debate about what constitutes good research and little has been done in evolving criteria for evaluating the rigour of interpretive research (Morgan, 1983). Therefore the minimum required to constitute good research is the sound logic of well-founded observations (Hammersley, 1992) which requires that one’s opinion of interpretive research is influenced ultimately by one’s philosophical ideas and interpretations. This is summarised as ‘positivist’, ‘postpositivist’, constructivist’, postmodern’ and ‘poststructural’ (Denzin & Lincoln, 2000). Interpretive research is creative in that interpretations are constructed and the researcher creates field notes and documents from the field called ‘indexing’ (Sanjek, 1990) or ‘fieldwork’ (Plath, 1990). From this text, the writer-as-interpreter moves to a research text that is, notes and interpretations based on the field text. This text is then re-created as a working document containing the writer’s initial attempts to make sense of what he or she has learned. The final publication is what comes to the reader.

Writing as interpretation occurs when the writing is done in different ways and new aspects of the topics and the relationships to it are discovered and knowledge is developed (Richardson, 1994). Form and content are inseparable. Writing is a dynamic, creative process and the researcher found that, as he wrote and re-wrote the form of his text, he found that his understanding of the content of his research sharpened and allowed access for further research.

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4.3.7 Validity and reliability

The use of validity in research findings depends on the use to which the findings are put, since readers (implementers) use research reports differently (Stake, 1988). In this case, internal validity amounts to a simultaneous demonstration of reliability (Guba & Lincoln, 1981) where traditionally, reliability referred to the extent to which one's finding can be replicated. Reliability in the qualitative sense refers to the dependability and consistency of the results obtained from the data (Guba & Lincoln, 1981; p. 288). The high degree of internal validity in ethnographic research provides the 'opportunity for continual data analysis and comparison to refine constructs and to ensure the match between scientific categories and participant reality' (Goetz & LeCompte, 1984; p. 221). It is also 'conducted in natural settings that reflect the reality of the life experiences of participants more accurately than do more contrived or laboratory settings' (p. 221) and that informant interviews are 'less abstract than many instruments used in other research designs' (p. 221).

The validity of research findings can be described as being a 'quality of the conclusions and the processes through which these were reached' (Taft, 1988; p. 61). However, the exact meaning of validity depends on 'the particular criterion of truth that is adopted' and 'in ethnographic research, the most appropriate criterion is credibility' (Taft, 1988; p. 61). Moreover, credibility is enhanced by and dependent on the accuracy of the data and the way the study is communicated to the audience. Thus, in ethnographic research, the onus of generalisation lies not with the researcher but with the reader of the research report (Kennedy, 1979).

For this study, the problems of validity and reliability will be addressed by "triangulation". This method relies on obtaining information in many ways from multiple sources of data, and employing multiple techniques for gathering the data. Furthermore, triangulation can be viewed as a process of using multiple perceptions to clarify meaning, and verifying the replication of an observation or interpretation (Stake, 1994). By acknowledging that very few observations or interpretations are perfectly repeatable, triangulation then serves also to clarify meaning by identifying different ways that the phenomena are being observed.
According to Stake (1988), the triangulation strategy allows for meaning to emerge from at least three independent approaches. In this study, the researcher, as the research instrument, interviewed the key informants—village elders, students, teachers, and curriculum officers. To make the interviews more meaningful, the researcher used Mathison’s (1988, p. 15) alternative conception of triangulation, which is ‘a technique that provides clear and better evidence from which researchers can construct meaningful propositions about the social world’, possessed by individuals. Furthermore, ‘the value of triangulation lies in providing evidence such that the researcher can construct explanations of the social phenomena from which they arise’ (Mathison, 1988; p. 15).

Here, the focused and conflicting outcomes of the triangulation strategy are accepted in providing a rich and complex picture of the social phenomenon. By reviewing the intermediate transcripts from interviews, questionnaires, observations and experiences, the researcher establishes a ‘research data base’ (Yin, 1994). By collecting and analysing the data continuously and reciprocally, as well as clarifying the researcher’s biases and theoretical orientation of the study, the researcher establishes a ‘chain of evidence’ (Yin, 1989). This is used in case study research to test and construct validity by using multiple sources of evidence and establishing ‘chain of evidence’ from the data collected. To test for internal validity in case studies, pattern matching and explanation-building is used.

In a traditional view, external validity is concerned with whether the study’s results can be generalised to other situations. The production of generalisable knowledge is an appropriate goal for interpretive research (Erickson, 1986) — a view that is accepted for this study. The rich, thick description — that is, detailed and precise description—provides a base of information appropriate to the judgement of anyone interested in the transferability or generalisability (Lincoln & Guba, 1985; pp. 124-125). Similarly, in the context of ‘fourth generation evaluation’, triangulation is only of value when ‘cross-checking items of a factual nature’ (Guba & Lincoln, 1989; p. 241) but from the researcher’s perspective it is possible to triangulate far more than ‘factual items’.
4.3.8 Criteria for judging accuracy

As already indicated, there has been a lot of debate on what constitutes good interpretive research. In ethnographic research, description is interpretive; ‘why it is interpretive is the flow of social discourse; and the interpreting involved consists in trying to rescue the “said” of such discourse from its perishing occasions and fix it in perusable terms’ (Geertz, 1973; p. 20). Furthermore, ‘interpretive research is a holistic method of evaluation that strives to generate research that is both believable and compelling’ (Schaller & Tobin (1998; p. 45). Although there may be no one best method of collecting and analysing field texts, there are still conventions for establishing the quality of interpretive research that, on the surface, can be understood as structures of organisation imposed by common sense. However, only the authenticity criteria offer promise that stakeholders’ constructions will be collected and faithfully represented and their rights honoured (Guba & Lincoln, 1989). Therefore, an interpretive research study like this one can be both authentic and credible and to satisfy the authenticity criteria in this instance, the researcher has employed four out of six of Guba and Lincoln’s (1989) methodological procedures to satisfy issues of credibility and trustworthiness.

4.3.9 Credibility

Guba and Lincoln (1989, p. 236) use credibility as a parallel to the positivist criterion of internal validity to establish congruence between the “constructed realities of respondents and those realities as represented by the evaluator and attributed to various stakeholders” (p.237). The six strategies for enhancing credibility by Guba and Lincoln (1989) are written in the context of evaluation; therefore are not all appropriate to this study, but the following have proven to be helpful strategies for the maintenance of credibility. There are six strategies and they address interpretive research concerns that are parallel to issues of validity in positivist studies (Schaller & Tobin, 1998); hence referred to as the parallel criteria.
**Prolonged engagement:** Guba and Lincoln (1989) describe this strategy as:

Substantial involvement at the site of the inquiry... to establish the rapport and build the trust ... and to facilitate immersing oneself in and understanding the context's culture. (p. 237)

The researcher believes his credibility in this field of study is verified by the amount of time he has spent living among and interacting with villagers like those village elders he interviewed. They were from his village of Lelefiuru and the interviews were conducted in the local language called Toaripi. He also interviewed students from the various Toaripi speaking villages around the Malalaua area of the Gulf Province in PNG. His prolonged engagement, and immersion enabled him, as a Toaripi within his own cultural group, to enhance and gain a better understanding of the events and culture of everyday life experienced by these village elders and students. Therefore, the use of personal experience methods in gathering and recounting the data is justified. In fact, he felt more relaxed and comfortable to do this study within his own cultural group as it was an opportunity in educating the younger Toaripi generation to be more knowledgeable about their natural world.

**Persistent observation:** Guba and Lincoln (1989) state that, ‘the object of persistent observation is to add depth to the scope with prolonged engagement efforts’ (p. 237). Similarly, ‘persistence observation allows a researcher to identify issues that have most salience and to study each in depth through the use of an emergent design’ (Schaller & Tobin, 1998; p. 46). During this time, issues are identified and then focussed upon in depth with those elements that are most relevant to the study. In other words, distraction by background events can be ensured to the extent that underlying factors of interest are not always observed. Throughout the fieldwork and the researcher's involvement with the Toaripi cultural group in this study, he constantly tried to seek meaning rather than simple facts, in order to add depth and a clearer understanding of the subject in his inquiry.

**Negative case analysis:** Guba and Lincoln (1989) describe this criteria as ‘the process of revising working hypotheses in the light of hindsight, with an eye toward developing and refining a given hypothesis (or set of them) until it accounts for all known cases’ (p. 237). Similarly, it 'is a process of thoroughly examining all
discrepant data that do not fit an assertion and making sure they can be explained' (Schaller & Tobin, 1998; p. 46). By its very nature, grounded theory provides for a 'review and synthesis'/review and object' operational method. The grounded theorist continually makes decisions about the comparability of new data to existing data, seeks themes and looks for congruence. For the research is to be credible, the researcher must ensure readers that data items, which do not fit emergent themes are adequately explained or, if of sufficient persuasion, have resulted in the modification of theory. However, as not all data achieve statistical significance at the 1.000 level, neither will all qualitative data perfectly fit the emergent themes. An example from this study is the problem created when one considers indigenous individuals like Boehe (1987) and Kelontii (1996) who have made significant contributions to their chosen field, especially in the sciences.

Peer debriefing: Guba and Lincoln (1989, p. 237) refer to this criteria as the 'process of engaging, with a disinterested peer, in extended and extensive discussions of one's findings.' Similarly, 'peer briefing allows a researcher to describe what is happening and postulate why to a disinterested peer, who can then raise questions and suggest alternative theoretical frames to be considered' (Schaller & Tobin; 1998; p. 46). The researcher is indebted to colleagues during the colloquiums in 1997, 1998 and 1999 at the Science and Mathematics Education Centre (SMEC) for their willingness to read, listen and critique sections of his research findings.

Members' checks: To ensure that the researcher's transcription and interpretation of words and events is close to the intentions of his sources he has, in the first instance, reflected to them his understanding of what is being said, inviting clarification and expansion. For example, before finalising the text produced from the interviews in Toaripi, he spoke with the various stakeholders, including several village elders, students, teachers and curriculum officers, about what he understood to have taken place.

Dependability: Guba and Lincoln (1989) describe this criterion as parallel to the criterion of reliability 'in that it is concerned with the stability of data over time' (p. 242). In other words, the methods used to collect and process data in this study were 'established, trackable and documentable ' (p. 242) such that a colleague pursuing
the same would encounter reorganisable data. Here, the researcher will emphasise 'context', because a naturalistic inquiry is context-dependent, and 'recognisable' because interpretation must always give rise to the possibility of multiple conclusions. Therefore dependability on the part of the researcher is a concern because, in naturalistic research, especially using grounded theory methods, one should expect that the research act would mature and shift in emphasis over time. Dependability in this study is provided by the use of clearly defined events through descriptions that have been assessed through a range of methods such as interviews, personal experiences, questionnaires and observations.

4.4 Subjects

4.4.1 Village elders

Village elders from various tribal groupings in PNG are perceived to be the source of all wisdom and the recognised authority on tribal knowledge (Waldrip & Taylor, 1999). This is the case when eight village elders with ages ranging between late 50s and 70s were interviewed between October and November in 1997, during the initial data collection of this study. The elders all came from a Toaripi speaking village called Lelefiur in the Malalaua District of the Gulf Province in PNG. They were selected on the basis that they had lived all their lives close to their village natural environment and had an in-depth understanding of it, and speak the Toaripi language fluently. Their learning of indigenous languages, folklore, personal-social relationships, traditional vocations, and the nature of family and community structures, are still dependent on the procedures of the past. Most of these village elders had attended and been educated in mission schools in the early 1930s run by missionaries of the London Missionary Society (LMS). Several of them had received at least six years of basic education and had been employed either in the public or private sectors and had retired and come back to live in the village. Several of them had also been actively involved in church activities in the village and in and around Port Moresby. It was also the researcher’s intention and interest to involve the elders in the study as he originates from this village with which he has maintained close contact over the years and also speaks the Toaripi language. It was in this language
that interviews were conducted with the village elders to probe their beliefs, knowledge and understanding of natural phenomena.

Initial contacts with all the eight village elders were made through the researcher’s brother-in-law, a respected retired Reverend of the Lelefu United Church. Through his involvement with the church, he possessed invaluable knowledge of the structures of the different clans in the village. Morauta (1984) affirms this stronghold of Christianity, which relates back to the early arrival in 1881 of Reverend James Chalmers, from the London Missionary Society (LMS), who was the first European to visit the two big villages of Uritai and Mirihae where a mission station was set up in 1884. Mission schools were started that focussed on literacy skills to enable local pastors to read and spread the word of the Bible to local clans.

Pou, the oldest, was in his late 70s and the only surviving member of his clan with knowledge of folklore and village clans. Mora was in his early 70s, a known fisherman and he had an in-depth knowledge of seasons and tides. When the researcher met him in October 1997, he was mending his fishing nets. Mesea was in his late 50s, a businessman - a passenger motor vehicle (PMV) driver and owned a truck which brought garden produce to the markets and transported people to and fro from the villages along the road between Malalaua and Kerema. Mai was in his early 70s, a retired government employee and has come back to live in the village and taken up fishing, making gardens and involved himself in church activities. He had been involved with the Native Corporative Society business in the village in the early 1960s. Ivan, Tati and Sari were in their early 60s and have all lived and worked in Port Moresby but have retired and moved back to live in the village. They also garden, fish and involved themselves in church activities. Sevese was in his late 60s and had been involved with the Native Corporative Society business in the village during the 1960s. He also gardens and fish and had been involved with other business activities at the Malalaua station.
4.4.2 Provincial high school students

The study also involved a total sample of 216 students with ages ranging from 13 to 20 years, from Grades 7 to 10 at Malalaua Provincial High School, a boarding school situated at Malalaua Station in the Gulf Province of PNG. There were 101 male and 115 females who came from the following villages: Apanaip, Baimuru, Birip, Darapae, Eopoe, Fergusson Island, Finschafen, Haruape, Hawakabia, Iokea, Isapeape, Iyapa, Kagua, Kayukovu, Kakoro, Kamina, Kanabea, Kapiri, Karama, Kavukavu, Keke, Kerepa-Huau, Kosipe, Kukipi, Lalafiru, Larihau, Lelefru, Lese Avihara, Lese Kavora, Lese Karova, Lese Oalai, Manam Island, Mapaio, Miaru, Minj, Mirivase, Moveave, Okavai, Popo Luluapo, Rove, Savaiviri, Sepoe, Tapala, Taure, Terapo, Uritai and Urulau.

Most of the students from the Malalaua area of the Gulf province speak the Toaripe language. However, the villages are divided into the Moripi and Toaripe census divisions. These villages are situated either on the coast or inland between Cape Possession to Freshwater Bay of the Malalaua sub-province. The villages are Iokea, Isapeape, Lalafiru, Lelefru, Lese Avihara, Lese Karova, Lese Kavora, Lese Oalai, Kukipi, Miaru, Mirivase, Moveave, Moveave Heatoare, Popo Luluapo, Savaiviri, Tapala, Taure, Terapo and Uritai. A few students come from Central, Madang, Southern Highlands, Milne Bay, Enga, East Sepik, Western Highlands and Morobe Provinces. Apart from speaking Toaripe, students tend to speak other languages such as English, Pidgin, Kaipi, Motu, Kamea, Kewabi, Kovo, Opao, Sepoe, Qute, Orokolo, Mekeo, Iare, Kakoro and Oiapu. This is a typical example of what one would find in a Provincial High School especially those in both the urban and rural areas of PNG. Most of the students learning science tend to speak several other languages while learning in English at school. Most of these students in the study come from backgrounds where the father is a subsistence farmer and the mother a housewife—both parents may have been educated to either Grades 6, 8 or 10 at school. Most of the students are boarders; only a few are day students who reside with their parents or guardians at the Malalaua Station. It is only during term (4 terms in a year) holidays that they go back to their villages and communities.
Typical secondary students in a rural boarding provincial high school come from various housing backgrounds ranging from buildings constructed of traditional materials to semi-permanent materials mainly found in developing countries. Toaripi is one of the main languages spoken by these students who attend Malalaua Provincial High School. These students learn to speak and write in English while attending and residing at the school but also speak Toaripi, Pidgin or Motu outside of school during the end of their term vacations in the above villages. Table 4.3 shows the breakdown in the number of Toaripi and non-Toaripi first language speakers in the sample of 153 students, based on responses to the Traditional Science Beliefs Questionnaire.

Table 4.3  Number of students who are Toaripi and non-Toaripi speakers (n=153)

<table>
<thead>
<tr>
<th>Grades</th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>10</td>
<td>9</td>
<td>8</td>
<td>7</td>
</tr>
<tr>
<td>Toaripi speakers</td>
<td>27</td>
<td>45</td>
<td>25</td>
<td>10</td>
</tr>
<tr>
<td>Non-Toaripi speakers</td>
<td>06</td>
<td>20</td>
<td>15</td>
<td>05</td>
</tr>
<tr>
<td>Total</td>
<td>33</td>
<td>65</td>
<td>40</td>
<td>15</td>
</tr>
</tbody>
</table>

Most of these students have spent their community schooling in their villages as most of these villages have their own community schools. After completing 6 years of community school, they sit an entrance examination at the end of Grade 6 to gain entry into one of the secondary schools in the province. In fact, Malalaua is the secondary school that takes in students from this area. In a typical science class, one would find a few students from the other 19 provinces, hence the diverse culture in the classroom. This school is situated near Malalaua Station, about 45 kilometres east of the provincial capital Kerema. The school is easily accessible both by road and air. Most students attending the school come from the abovementioned Toaripi speaking villages and speak about four other languages apart from learning in English, which is the medium of instruction in schools throughout the country. The subjects students study are English, mathematics, science, social science, commerce, agriculture, home economics, practical skills, and guidance.
In 1997, the school had three Grade 7 classes, two classes each of Grades 8, 9 and 10. Most of the students are boarders who reside in a two-by-one double story dormitory, two each for boys and girls. A typical school day begins at 7.40 in the morning and finishes at 1.50 in the afternoon, a duration of eight 40 minutes lesson periods per day. To keep the school clean, all students do work parades on Mondays, Wednesdays and Friday afternoons from 3.00 to 4.00 in the afternoon. They play sports on Tuesday and Thursday afternoons. There have been problems experienced at this school that resulted in closing early during a term due to not enough food (rice and tinned fish or meat) to feed students. There also have been high rates of absenteeism, which has resulted in fewer students in a class (normal class size = 40 students). Students who do not frequently attend classes are expelled from school.

4.4.3 Science teachers

Two male science teachers at the Malalaua Provincial High School were also interviewed during the study. These teachers do not have formal teaching qualifications. However, the head of science, Mr Ivalaoa, who teaches the senior classes (Grades 9 and 10) is very well qualified. He has a higher certificate in forestry, a diploma in science technology, part 1 and 2 of the London Institute in Biology, some other specialised courses from the London Institute in Microbiology, a short course in nuclear science (radiation) at the Australian Science and Nuclear Technology (ASNT), plus an administrative course in communication skills at the Administrative College (PNG Institute of Public Administration). He spent about 18 years with the University of PNG in the Biology Department from 1973 up to April 1991 and decided to leave to take up a teaching job. At the university, Mr Ivalaoa was technically qualified in science, working with the undergraduates at the university mainly forming practicals and attending to other administrative duties. He also acted in some senior positions after coming back from his overseas studies. He resigned in October 1991, because he decided to return home and plant his betelnut (fere) trees in the village. He actually returned home and spent the Christmas holidays. Then around April 1992, he visited the Kerema Education Office and enquired about teaching at the school. The Assistant Secretary at Kerema advised him to go and see the headmaster, as Malalaua needed a science teacher urgently
which he did. Back in Port Moresby, he was accepted and registered as a teacher. He started teaching at the school in 1992 and has been there for about six years.

The second teacher, Mr Paimuru, who teaches the junior grades (Grades 7 and 8) has been at this school for only a year after moving from another high school. He holds a degree in forestry from the PNG University of Technology in 1978. He has worked with various organisations in forestry first for 15 months with the Forestry Division at Goroka. He left and went to work with Bougainville Copper at Panguna in 1980. As a forester in Bougainville, he was basically a river vegetation research officer looking for plants that were suitable to grow on mine wastes. In Panguna, at the height of the Bougainville crisis in 1980, he left and came home to the village where he spent about 12 months. It was here in 1987 that someone told him about teaching as a career but he was not interested. Finally, in June 1990 he decided to enter into the Teaching Service. He started teaching science at Kerema High School until he was transferred to Malalaua in 1998.

Although both of these teachers do not have formal teaching qualifications, they both have in-depth knowledge and experience in the fields for which they were trained. Because of this invaluable experience they gained recognition to be employed by the Education Department. They both said that when they started teaching, they found it hard but they had very good deputy headmasters and fellow teachers who trained, assisted and gave them good advice on effective teaching methods. They are both from the Gulf Province and the head of science is a relative (uncle) of the researcher and speaks the Toaripi language. He had an advantage because he was well qualified in biology and had a better understanding in teaching the biology units. During the study, the researcher also observed some of his classes in which he was explaining, for example, an investigation on bones of the body. It was interesting to note here that he explained things to students in the Toaripi language in order for them to understand better. The researcher thought that this was a good approach in assisting students to learn and understand meaningfully abstract scientific concepts.

Both teachers also were interviewed on the units/topics they found interesting to teach, the types and various teaching strategies they used in motivating the students to learn. They were also asked about the ways in which they have tried to blend their
own traditional knowledge into teaching any of the units/topics they found interesting or difficult.

4.4.4 Curriculum educators

Two female science curriculum educators from the Curriculum Development Division (CDD) of the Department of Education also were interviewed during the second phase of the study. Mrs Aihii is about 46 years old and has a diploma in secondary teaching from Goroka Teacher’s College after doing a 3-year course from 1971 to 1973 and has taught for seven years. After teaching for seven years, she enrolled in a 4-year Bachelor of Science degree in biology and chemistry from 1982 to 1986. After working at the Curriculum Unit for another four years, she went to the University of Auckland in New Zealand to pursue a master of education degree. After graduating, she came back to the CDD as the principal curriculum officer for health, mathematics, science and physical education where her duties involved the supervision of these four subject areas.

During the interview, Mrs Aihii stated that she was trained to teach mathematics and home economics after graduating from Goroka. Her first teaching post after graduating from Goroka Teacher’s College was at Marianville High School. At that time, the school did not have science teachers but the sisters knew her because she did her high school there and was a good science student. So they asked her to teach science in the lower grades, like Form 1 and 2, which are now Grades 7 and 8 and she also taught Grade 9 science. Then she came down to Gordons Provincial High School (now a secondary school taking in Grades 11 and 12) where she was involved in generalist teaching for Grades 7 and 8 and taught all subjects in social science, mathematics, science and agriculture.

In January 1999, there was a shortage of curriculum officers in science so Mrs Aihii was doing duties for the curriculum officer as well as the senior curriculum officer (science) and the researcher witnessed this during her writing of the transitional science syllabus for the elementary to Grade 12 levels. As well as doing some editing to check the content, especially of the four subjects, Mrs Aihii was involved
in the actual starting of the writing and the workshops. It was evident from the
interview that the work was time consuming at a time they were short staffed.

The other curriculum officer, Mrs Hotsia, graduated around the same time as the
researcher at the end of 1977 and they both met again in September 1983, where she
wrote distance education materials for secondary school students in the Science
department at the College of Distance Education (CODE). She is about 40 years old
and holds a diploma in secondary teaching after graduating from UPNG Goroka
Teachers College. She also has a bachelor of education majoring in mathematics,
which took her about two and a half years (five semesters). At Goroka she was
trained to teach mathematics, science and commerce. After graduating she taught at
Asitavi High School for one year, Marianville High School for two years and at
Malala High School (now a secondary school) for another two years. Mrs Hotsia has
only taught Grades 7 and 8 science at these schools. At CODE, she spent about 10
years writing science materials for the science department as a writer and then as a
curriculum officer. She has been involved in the editing of the Grades 7, 8 and 9
science materials. At the curriculum unit, she is a curriculum officer in the
Mathematics department writing maths learning materials and syllabuses.

It is interesting to note here that these two female curriculum educators, like the two
science teachers, have an in-depth knowledge and understanding of science,
especially in writing science curriculum materials. The researcher knew them both
very well as he was involved in the writing and editing processes of the science
materials when he was with CODE and on science editing committees. They were
also interviewed on the subjects that they were trained to teach and the grade levels
they have taught. They also were asked about the units/topics they found interesting
to teach and why, as well as the various teaching strategies they used to motivate the
students learning. They were asked about the ways they have tried to blend
traditional knowledge into teaching any of the units/topics, and whether they found it
interesting or difficult to teach. They also were asked about how and why they chose
to become writers of curriculum materials and also asked about the workshops or
courses they had attended to help them become good writers. Lastly they were asked
about the materials that they have written and their roles as writers within the
institutions/schools they work.
4.5 Research Settings

4.5.1 Village setting

The interviews with the village elders took place in the village of Lelefru through a period of about ten days between October and November of 1997. During this time, the drought was the worst on record in PNG history. Lelefru village is the last Toaripi speaking village situated east of Kerema and has a population of about 300 people who live a mainly subsistence lifestyle on fishing, hunting, growing food gardens and planting, harvesting and making sago which is the staple diet of every villages along the coast of Papua. Most of the people belong to the United Church as evident by the new church building, which was completed and opened with many activities in the early 1990s. The village has a primary school where the children attend and upon completing their first six years, they are selected to either attend the Malalaua or Kerema provincial high schools to continue their secondary education (Grades 7 to 10). The village is situated near the beach, which has over the years been gradually eroded such that the village had to be relocated further inland over the years. There are several trade stores in the village, which sell basic foodstuff like rice, flour, sugar, tinned fish and meat, soap and other basic essentials to the villagers. There is also a health centre at Koaru station where villagers get treatment for malaria and other sicknesses. The village is easily assessable by dinghies from the coast and a dirt road that links the main roads and highways to Kerema, Bereina and Port Moresby.

4.5.2 Malalaua Provincial High School setting

Malalaua Provincial High School is one of the province’s five high schools. It is situated east of the provincial capital of Kerema, about 45 kilometres and easily accessible by road or air. In 1997, there were about 220 students attending the school who mainly came from the different Toaripi speaking villages situated either on the coast or inland from Freshway Bay to Cape Possession of the Malalaua sub-district.

In 1997, there were 14 teachers, two females and 12 male. The headmaster of the school teaches four periods of guidance to senior Grades (9 and 10). The deputy
headmaster teaches nine periods, three are guidance to Grades 7 and six of commerce to Grade 10s. Of the two female teachers, one was the senior subject mistress for English while the other taught home economics. The rest of staff teaches between 20 to 33 periods a week. The school had about 216 students who attended three Grade 7 classes and two classes each of Grades 8, 9 and 10. On Fridays, all grades do a project during periods 7 and 8. The subjects taught at the school include English, mathematics, science, social science, commerce, agriculture, and practical skills/home economics classrooms. The school buildings include about 10 classrooms, a double science classroom, a double practical skills classroom, a double home economics classroom, a library, a staff room (main common room, offices for headmaster, deputy headmaster, senior subject mistress - English, typist, storeroom, male and female toilets). School uniforms for girls are purple skirts with white shirts and for boys, purple shorts with white shirts which students purchase. The uniforms are worn on Mondays, Wednesdays and Fridays. A normal school day begins at 7.40 in the morning and ends at 1.50 in the afternoon, a duration of eight 40 minutes periods. There is a morning break of 20 minutes and a lunch break of 70 minutes. There is work parade in the afternoons on Mondays, Wednesdays and Fridays from 3 to 4 o'clock. On Tuesdays and Thursdays in the afternoon, the students compete in various sports like basketball, netball, soccer and rugby. They play in two divisions - junior and senior (males and females) and are divided into their dormitory names.

The school has only one electric and a manual typewriter for typing tasks with the demand for their use being high, especially for assignments and tests. As a result, this increases the backlog of work and most teachers end up typing most of their work with manual typewriters. The researcher experienced this especially with the head of science who used his own typewriter to type up his assignments and tests. The school also has a photocopying machine, an ink stencil machine for printing tests, assignments and other schoolwork.

The school provides housing for all staff, which include three high covenant (3 bedrooms) bungalows and five low-covenant duplexes (3 bedrooms). A small school canteen next to the headmaster’s house sells laundry detergent, sugar, tinned fish and meat, biscuits, toilet rolls, milk powder, bathing soap, rice and flour. The are also two water tanks on stilts, four on the ground with cement base for students to drink.
from and is the main source of water supply at the school. Bore water also is used
and is the main source of water supply. The school has a school truck - a Toyota
Hilux but has broken down and unable to run again at the time of the researcher’s
visit.

As the school is a boarding school, the boarders reside in a two-by-two double-
storey dormitory, two each for both boys and girls. Shower and toilet facilities are
provided next to the dormitories. Students in the dormitories are rostered to keep it
clean in a healthy and useable condition. On weekends, students do work parade on
Saturday mornings and in the afternoon; they are free to do their own personal
business such as laundry or shopping at the Malalaua Station or market. Students
who belong to the Seventh Day Adventist Mission attend services on Saturdays and
those who belong to United, Catholic and Four Square Gospel Missions attend on
Sundays.

In 1997, the school was closed early for Term 3 Holidays because there was not
enough food such as rice and tinned foodstuffs to feed the students. This meant the
students had a longer term 3 holiday and most of them came back during the second
week of term 4. Absenteeism is a major problem and a class of normally 40 students
would only have about 25 students after students are expelled. This is found mainly
in Grades 7, 8 and 9 classes. Students stay away because they are not motivated
enough to continue with other problems like being hungry and non-payment of
school fees. In 1997, the class size for the two Grade 10 classes were over 40
because students were getting ready to sit their school certificate examinations which
commenced on 31 October to 03 November 1997. Around this time, all Grade 10
students throughout PNG sit for compulsory examinations on the same days.

4.6 Pencil and Paper Instruments

4.6.1 Conducting interviews with village elders

The interviews with eight village elders from the village of Lelefiru in the Malalaua
area of the Gulf Province took place for about ten days towards the end of October
and early November in 1997. The interviews were designed to probe the village
elders' understanding of natural phenomena that included erosion and deposition; drought; sunrise and sunset; burning; moon; rain; thunder; lightning; rainbow and clouds. These interviews were conducted on the front veranda of the house of the researcher's brother-in-law, which had a view looking towards the beach. It was comfortable and relaxing and conditions were warm and humid at that time because it was done during the time in which the area experienced one of the worst droughts in PNG's history. Before the actual days of the interviews, the researcher had gone out with his brother-in-law and met with all the elders separately and introduced and reassured them of the importance of the study. The researcher had told them that he was doing some research that related to the importance of their traditional knowledge and that the knowledge they had acquired during their lifetime was an integral part of this research. The researcher also told them that he believed that the younger generation growing up needed to be cognisant of this knowledge.

The interviews were conducted in Toaripi and in this way the importance of the study was conveyed to the elders, which also won their respect. The researcher also emphasised the importance of the knowledge the elders held and that he was not seeking right or wrong answers to any of the questions asked on natural phenomena. In this way, the elders felt relaxed and comfortable and were able to talk and share their thoughts without any difficulty. In order to ensure that the elders perceived the interview process as meaningful, the researcher stated that whatever the elders said was not judged right or wrong and kept confidential as it was based on the elders own understanding. The initial questions focussed on the context of their involvement within their village, which is the ocean and the land environment. Each elder was asked about the sand on the beach, what happened to it and when it was eroded, where was it deposited? From where the interview was conducted on the veranda of the house, the beach was in full view with the sea and the wind blowing through the tall swaying coconut palm trees. Each of the elders interviewed fully understood the interviews questions and at some stages thought that some of the questions were interesting. Examples included: what is a rainbow?; what is lighting and thunder?; what causes the wind to blow?; what is the moon?; what is the sun?; does the sun stay in one place or visits many places?.

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Before the interviews took place, the elders were reminded that whatever they were going to say was to be recorded and their permission was sought for this. Fortunately, each agreed to the interview being recorded and that confidentiality was given under this agreement. The timing of the interviews took between 30 to 60 minutes and all eight interviews were recorded on six blank 90-minute tapes. At the end of an interview, it was played back with the interviewee present. This allowed the interviewees to hear and comment on any ideas with which they did not agree. It was also a chance for them to hear themselves talking on tape for the first time and to feel more comfortable with what they were saying for each of the items. All agreed that whatever they said during the interviews was acceptable to them. The interviews recorded with the elders were played on a transcriber and word-processed onto a computer file. It took almost three months to write up the first draft of the interviews mainly done in Toaripi. Fortunately the Toaripi Dictionary (Brown, 1968) assisted in translations of the interviews into English. For example, on erosion/deposition of sand along the beach of Leleferu village, the Toaripi meaning for ‘erodes’ is faveai or fareovai. Hence, Miri folo ma sa faveai (fareovai) translates as ‘The water erodes the sand on the beach. Unfortunately, there is no Toaripi meaning for ‘deposit’ so alternatively ‘to add to’ is used. Miri folo ma sa toa ti eta miri folo everave arori voa eta ou topiari loi translates to “The water hits the sand and adds it onto the top of the old (first) layer of sand.”

4.6.2 Constructing Instruments

For this study, three pencils and paper instruments were developed from the analysis of the village elders’ beliefs, ideas and explanations of natural phenomena.

- The first instrument Traditional Science Beliefs (see Appendix 4.1) was used to examine and identify students’ beliefs and ideas, which they possess while attending science classes.
- The second instrument Student Questionnaire 1: Sources of Explanations (see Appendix 4.2) was used to examine the various places or situations in which students have heard these explanations on natural phenomena being used. The places or situations were for
example, in the home/family/village, school, church or they may have never heard it being used.

- The third instrument *Student Questionnaire 2: Types of Explanations* (see Appendix 4.3) contained open-ended and structured questions. It was used to examine, determine and identify students written responses about explanations on natural phenomena that included erosion and deposition, plant growth, rain, thunder, lightning, rainbow, moon, sun, wind, clouds, and drought.

The first instrument, *Traditional Science Beliefs*, contained 40 items and was adapted from Anamuah-Mensah (1998) and modified by the researcher. Twenty items were selected from Anamuah-Mensah, 12 were added by the researcher based on the ideas and knowledge gained from the village elders, two were selected from Waldrip (1994) and six from Kolma (1998) with appropriateness for students in the PNG setting. Table 4.4 shows how the items were constructed.

**Table 4.4** Construction of items for the *Traditional Science Beliefs* instrument.

<table>
<thead>
<tr>
<th>Items</th>
<th>Original Idea</th>
<th>Adaptation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1, 3, 4, 5, 6, 7, 8, 9, 10, 12, 13, 14, 15, 16, 17, 18, 19, 30, 32, 37</td>
<td>J. Anamuah-Mensah</td>
<td>Own ideas and knowledge</td>
</tr>
<tr>
<td>2, 11, 20, 21, 22, 23, 31, 33, 34, 35, 36, 39</td>
<td>The researcher</td>
<td>Own ideas and knowledge/interviews with village elders</td>
</tr>
<tr>
<td>24, 25, 26, 27, 28, 29</td>
<td>F.S. Kolma (National, 17 April 1998)</td>
<td>Own ideas and knowledge</td>
</tr>
<tr>
<td>38, 40</td>
<td>B. Waldrip</td>
<td>Own ideas and knowledge</td>
</tr>
</tbody>
</table>

Modifications in terms of simplifying the sentences to avoid ambiguous meanings for students in the PNG setting were carried out by the researcher. The final version of the questionnaire consisted of 40 items concerning traditional science beliefs. Each item was rated using a Likert Type Scale: Strongly Agree (SA=5), Agree (A=4), Don’t Know (U=3), Disagree (D=2) and Strongly Disagree (SD=1). It was impossible to carry out a feasibility pilot study in the beginning to validate the first
questionnaire because of the geographical isolation encountered between the two different settings. Examples of items in this instrument were: 'Do not eat ripe bananas at night or in the morning or the food you will eat will not digest well (Item 11), 'If you point at a rainbow, you will get a mokora poi or a lump will grow under your arm pit' (Item 20), 'The evening star Oa Miri-Mirou represents a planet called Venus' (Item 21) and 'If you see a ghost or karisu in the night, someone will die' (Item 35).

The second instrument, Student Questionnaire 1: Sources of Explanations included items that were derived from the ideas, beliefs and explanations given by the eight village elders. For example, on the rainbow (Question 4), 'A rainbow is a colourful sign that appears during and after rainstorms. The rainbow appears when the sun's light rays hit the steam (water vapour) from the rain in the air' (Item 4D). On the moon (Question 6), ‘Some Christian people believe that the sun represents the Father (God) or Jehova Ualare. The sun is hot as it rises which makes God also the Supreme Being. The moon represents the Son (Jesus Christ) or Atute. The stars represent the Holy Spirit or Safu Arahoha Lareva.' (Item 6B). On the sun (Question 7); 'My everyday observations tells me that the sun follows different paths. This is due to the tilt of the earth from January to June and from July to December. Therefore the sun stays in one place. Our earth revolves around the sun' (Item 7A). On the sun again (Question 7) ‘The sun is looked after by an ancestral spirit called epe savora. Epe savora is the tribal ancestor of the Savorip clan. It is also the title of honor for menfolk of the clan. Epe savora helps direct the sun from sunrise to sunset' (Item 7B).

Each of these items had a box, as shown, at the end of each statement for students to circle (between 1 and 4) their responses. The numbers referred to the situations where students had heard about these ideas/beliefs or explanations. The four situations were: home/family/village (1), school (2), church (3) and have never heard the idea, belief or explanation being used (4).
Then students were asked to decide in which places they have heard these explanations being used by circling one of the numbers (1 to 4) provided in the boxes. All the students' responses were coded and entered into a computer file and the data were analysed using a SPSS program to obtain frequencies and means.

The third instrument, *Student Questionnaire 2: Types of Explanations* included open-ended questions and required students to write their responses to the question. The first part of each of these questions asked the students to give the *Toaripi* meaning or word for these concepts. For example, on the moon (Item 8) 'When there is a full moon in the sky, you find it easier to see your way around at night'. The first part of the question asked students to give the *Toaripi* word or meaning for moon. The second part asked students to describe in their own words what the moon is. The third part asked students about what makes the moon shine in the night. The final part asked students about an old village person who may have told them that a young spirit woman called *lau lumori* looks after and guides the moon. Her soft hair is the cloud in the night sky that casts a shadow on the Moon. Students were asked if this was possible and to give a reason why.

### 4.6.3 Administering the instruments

The three instruments, *Traditional Science Beliefs, Student Questionnaire 1: Sources of Explanations* and *Student Questionnaire 2: Types of Explanations* were administered to a sample of 216 students from Grades 7 to 10 at Malalaua Provincial High School in the Malalaua area of the Gulf Province.

The administration of the three instruments took place in the second week of October 1998. It was also during this time that all students had come back from a three-week break. They normally have a week off after term 3 but because the school did not have enough food to feed the students, they had two extra weeks holiday. The three instruments were administered to students during their single free period and single science period each of, a duration time of 40 minutes. It took almost three weeks to complete the total administration prior to the Grade 10 students sitting for their School Certificate examinations. The data collection was timed so that the activities did not disturb nor disrupt the school's daily routine or teaching programs. During
each of the 40 minutes period, the researcher introduced himself to each of the classes (two each of Grades 7 to 10) and also what the research aimed to do. This was clearly demonstrated in the three instruments, which the students had to fill in and complete during the day or night study periods.

Waldrip (1994) claims that it is normal for the majority of boarding schools in PNG to have night study periods, which are supervised individual study periods. It is not uncommon, however, to find many day students attending these night study periods because the majority of day students come from villages with no supply of electricity. Consequently, the availability of the night study periods made it possible for this research to be conducted either during the school day or after school during a night study period.

Permission to conduct the research study was obtained from the Secretary of Education, PNG National Department of Education (NDOE) in Port Moresby (see correspondence in Appendix 4.4 and 4.5) and through the Gulf Provincial Education Secretary. Although no letter of response was received from the Provincial Education Secretary granting permission, the researcher on his own accord approached the school. Upon arrival, the researcher introduced himself to the Principal who was taken by surprise, as he was unaware of the research to be conducted at the school. However, based on his understanding of research projects, he gave permission to carry out the research. This is a common case in PNG where communication between the main NDOE headquarters and the provincial education offices are sometimes ineffective. The privacy of individuals in collecting the data was strictly observed.

Students who were to be interviewed in each grade were also informed beforehand. They were identified and chosen according to the types of responses they gave in the open-ended questions in the third instrument, Student Questionnaire 2: Types of Explanation on natural phenomena. Nine senior students comprising three - one male and two females - from Grade 10 and six - two females and 4 males - from Grade 9 were selected. Only senior students were interviewed because of their good command and fluency in the English language. Most of these students gave interesting explanations and responses to questions such as, ‘using magic spells to

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make and stop rain'. They knew village elders from their villages who had this magic and spells to make and stop rain. If students gave responses such as this during the interview process, further questions were asked to probe and identify why they were saying this.

4.7 Data Analysis

In this study, the process of data collection and analysis cannot be separated entirely. As Goetz and LeCompte (1984) suggest, the timing of analysis and the integration of analysis with other tasks distinguishes a qualitative design from traditional positivistic research. The qualitative data – from the interview transcript were first placed in a computer file and then analysed using interpretive methodology. By triangulation – multiple methods and resources (Lincoln & Guba, 1985; Merriam, 1988; Mathison, 1988) and multiple perceptions (Stake, 1994), reliable inferences were drawn by the researcher about the influence of the elders’ and students’ knowledge bases and beliefs in the two different settings. Thus rich and thick descriptions in both settings could be made, together with some comparisons of certain situations from which learning took place.

The transcripts of the interviews with the village elders in Toaripi were word-processed and stored in a computer file. During the transcribing and translation of the interviews from Toaripi into English, all the main ideas, beliefs and explanations on the ten natural phenomena were analysed using phenomenological analysis (Denzin & Lincoln, 2000; Moustakas, 1994) as a means to discover and identify systematic patterns or relationships among categories (Agar, 1996). According to Moustakas (1994), phenomenological data analysis proceeds through the methodology of reduction, the analysis of specific statements and themes, and a search for all possible meanings. The researcher also sets aside all prejudgements, bracketing his experiences (a return to ‘natural science’) and relying on intuition, imagination and universal structures to obtain a picture of the experience. In phenomenological data analysis, the researcher writes a description of ‘how’ the phenomenon was experienced by participants in the study as ‘structural description’ (Moustakas, 1994) and what was experienced, as ‘textural description’ (Moustakas, 1994). Phenomenological analysis is principally concerned with understanding how
the everyday, intersubjective world (the life world) is constituted. The aim is to grasp how we come to interpret our own and others’ actions as meaningful and to reconstruct the genesis of the objective meanings of action in the intersubjective communication of individuals in the social life-world (Denzin & Lincoln, 2000; p. 192).

The ideas, beliefs and explanations of the village elders were tabulated into four categories as follows: Category 1: Explanations using spirits, magic spells or sorcery; Category 2: Explanations relating to Christianity; Category 3: Explanations relating to personal experience; and Category 4: Explanations relating to modern science. The results are discussed in Chapter 5.

The students’ responses to the items in the Traditional Science Beliefs were analysed using phenomenological analysis (Moustakas, 1994). The numerical data were coded, verified and analysed in terms of frequencies, means and standard deviations using the SPSS program (Coakes & Steed, 1999; Kirk, 1996). In addition, analysis of the mean data on items of traditional beliefs was performed to determine if there were any statistically significant differences among the sample. The results are discussed in Chapter 6.

All the students’ responses to the Student Questionnaire 1: Sources of Explanations were coded and entered into a computer file and the data was verified and analysed using a SPSS program (Coakes & Steed, 1999; Kirk, 1996) to obtain frequencies and means. The results are discussed in Chapter 7.

The transcripts of the students’ written responses to Student Questionnaire 2: Types of Explanations were analysed, word-processed and saved on a computer file. The analysis of responses to the items was tedious and time consuming. However, an attempt was made to learn how much the students understood about the various types of natural phenomena. The responses were analysed as to the nature or type of explanations given which was further supported and strengthened by samples of the interviews with nine students (six Grade 9s and three Grade 10s). The textual data were analysed and some systematic patterns or relationships among categories were identified. The results are discussed in Chapter 8.
Agar (1996) states that some means of discovering systematic patterns or relationships among categories is required for the analysis of texts and observational data. Further, analysis of patterns is usually achieved by some method of indexing or coding of categories. In most cases, the categories emerge from the data in the form of patterns or relationships that are repeated across a range of respondents. Indexing and coding may include taking notes or a specific topic from the texts, actually cutting out sequences of text and then filing them by category (Agar, 1996).

Using the methodology of grounded theory, the patterned relationships among conceptual categories assigned to the data are stated in a formal statement or theory (Glaser & Strauss, 1967; Strauss & Corbin, 1994). Each of the students’ responses was recorded according to grades in which categories were formed according to the types of responses given by the students. For example, to the question on rainbows, ‘Describe in your own words what a rainbow is’- students’ responses are shown in Table 4.5.

Table 4.5 Percentages (and numbers) of students responding to the question ‘Describe in your own words what a rainbow is’.

<table>
<thead>
<tr>
<th>Type of response</th>
<th>Grade levels</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th>Total Percentage (number)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>7</td>
<td>8</td>
<td>9</td>
<td>10</td>
<td></td>
<td></td>
</tr>
<tr>
<td>A curve of different colours that appear after or when there is no more rain.</td>
<td>5.6 (8)</td>
<td>12.8 (20)</td>
<td>22.5 (35)</td>
<td>9.6 (15)</td>
<td></td>
<td>50.0 (78)</td>
</tr>
<tr>
<td>Created by God and a promise that there will be no more flood.</td>
<td>0.6 (1)</td>
<td>3.3 (5)</td>
<td>8.5 (13)</td>
<td>3.9 (6)</td>
<td></td>
<td>16.3 (25)</td>
</tr>
<tr>
<td>Arch of colours formed in rain or spray by the sun’s rays or sun shining through rain.</td>
<td>0 (0)</td>
<td>0 (0)</td>
<td>1.9 (3)</td>
<td>1.9 (3)</td>
<td></td>
<td>3.8 (6)</td>
</tr>
<tr>
<td>Is a man that lives in the sky during our ancestor’s time and has a son.</td>
<td>1.3 (2)</td>
<td>0 (0)</td>
<td>0 (0)</td>
<td>0 (0)</td>
<td></td>
<td>1.3 (2)</td>
</tr>
<tr>
<td>Did not answer/don’t know.</td>
<td>2.6 (4)</td>
<td>9.2 (14)</td>
<td>9.9 (15)</td>
<td>5.3 (9)</td>
<td></td>
<td>27.0 (42)</td>
</tr>
</tbody>
</table>

Furthermore, in some of the questions, the response was supported by a reason. From these tabulated data, the students’ profile of understanding was constructed. The main ideas were chosen by using the students’ responses and not the
researcher's interpretation of them to prevent any degradation of the basic data. The main ideas given by all the students were then combined together, and any areas of differences and similarities identified. The responses were then interpreted in terms of a conceptual framework (or frameworks) if sufficient commonality existed between the students' responses. Two independent researchers also were asked to place the students' responses into one of the four categories. Where disagreements occurred, discussions took place between the researchers to arrive at a mutually agreeable category. The total number of responses given for each grade (Grade 7s: n=15; 8s: n=39; 9s: n=66, 10s: n=33) was totalled and divided by the total number of students (n=153) in the sample to obtain a percentage.

Interviews with two science teachers and curriculum officers about their views on the inclusion of traditional knowledge in the science curriculum also were analysed and the results are presented in Chapter 9.

4.8 Summary

The study combined a range of data sources and research methods to increase confidence in the findings. Multiple data sources, which included interviews and questionnaires, allowed a more accurate description of the ideas, beliefs and explanations that village elders and secondary school student's hold in explaining natural phenomena.

All research instruments used in this study were written in a more basic form of English that was suited for English as Second Language (ESL) speakers. Secondary school students' traditional science beliefs were measured using the Traditional Science Beliefs developed by the researcher. The sources where secondary school students had heard about different explanations for natural phenomena were measured using Student Questionnaire 1: Sources of Explanations. The types of explanations of these phenomena were solicited by open-ended questions in Student Questionnaire 2: Types of Explanations on natural phenomena.

The data were collected by visiting and interviewing six elders in a village in the Gulf Province between October and November 1997. Student data was also collected
by administering three instruments and interviewing a small sample of secondary school students at a rural high school in the same province between October and November 1998. The sample that responded to the pencil and paper instruments were from the 216 students from Grades 7 to 10 in the school. Three Grade 10 and six Grade 9 students were interviewed. The data were analysed using the SPSS program (Coakes & Steed, 1999; Kirk, 1996) to determine the frequencies, means and standard deviations.
CHAPTER 5

VILLAGE ELDERS’ EXPLANATIONS OF
NATURAL PHENOMENA IN PAPUA NEW GUINEA

5.0 Overview of Chapter

This chapter presents and describes the interviews with eight village elders, which probed their beliefs, ideas and explanations on natural phenomena. It is in response to Research Question 1, “What traditional beliefs or stories do village elders in the Gulf Province of Papua New Guinea (PNG) hold in explaining natural phenomena?” The eight village elders involved in this study come from Lelefireu village in the Malalaua area of the Gulf Province between October and November of 1997.

The study is based on an ethnography-interpretive framework (Erickson, 1986) that involved fieldwork conducted through semi-structured interviews (Agar, 1996; Denzin, 1970, Glaser & Strauss, 1967). The interviews were conducted in Toaripi, the language spoken commonly by these elders, and it probed their ideas, beliefs and understanding of natural phenomena. Examples of natural phenomena asked during the interview process included erosion and deposition of the sand on the front beach in the village, drought, red sunrise and sunset, burning, moon, rain, thunder, lightning, rainbow, clouds, and plant growth. These interviews were transcribed and word-processed on a computer file and then translated into English. The analysis and results of the eight village elders’ ideas, beliefs and explanations are discussed in this chapter.

5.1 Background to the Study

5.1.1 An earlier study

This study has its origins from an earlier study on Children's understanding of natural phenomena (Pauka, 1988). It also relates back to the researcher’s early years from 1978 to 1983 teaching secondary school science to Grades 7, 8 and 9 students.
in PNG classrooms and also his involvement in writing distance learning materials from 1983 to 1987 and 1988 to 1994. It was within this period that he became aware of the importance of the traditional knowledge that most students in PNG villages continuously bring to science classrooms. However, little research work has been done in this area in-depth except that of Kelontii’s (1996) study. This interest was the impetus for the researcher to return to his village of Lelefiuru where he interviewed eight village elders on their ideas, beliefs and understanding of natural phenomena.

5.1.2 Maintaining ties with the village

The researcher, although born in Port Moresby, continued to maintain strong ties with his village after his parents moved to Port Moresby in the late 1950s. This relationship with the village was important especially in maintaining custody or having ownership of land, which has coconut trees, betelnut trees and sago palms. His parents were among the first Toaripi people to move into Port Moresby, initially as part of indentured labour of young men (his father) and then as family groups (his mother) after World War 2 (Ryan, 1989). The researcher remembered his mother telling him that she sailed on a lagatoi (double-hulled canoe with crab-claw sails) during the last of the famous Hiri Trade expeditions back to Motuan villages around Port Moresby. During the early Hiri expeditions, the Motuans traded their clays pots for the sago and betelnuts of the Elema people in the Gulf Province (Kiki, 1963).

The researcher’s parents told him many stories of a once beautiful village near the sea and how the village people used to paddle up and down a once fast flowing Meporo river to cut and make sago and plant new gardens. The name Lelefiuru when separated into lele meaning ‘a bird called an egret’ and firu meaning ‘an island’, fully means ‘island of egrets’. Most interesting of all was this long beach near the researcher’s village, which over the years has been gradually eroded away; village elders like his mother blame this change on the use of magic spells (seseva) or sorcery. It is beliefs such as these that interested the researcher into conducting interviews to probe the ideas and beliefs on natural phenomena held in common by the village elders.
It was anticipated that because these village elders live within reach of their own natural environments, perhaps they would have an in-depth understanding in explaining certain ideas (Waldrip & Taylor, 1999). Subsequently, several interviews, which probed the elder’s understanding of ten occurring natural phenomena, were designed to identify the traditional beliefs, worldviews and explanations held by these village elders on natural phenomena.

5.1.3 Interview questions

Interviews were conducted and related to things in nature with which the village elders were familiar in their natural surrounding (see Chapter 3, section 3.7.3). It was important to make this assertion because of the elders’ rich backgrounds. The interviews comprised discussions of ten natural phenomena that included erosion and deposition [erosion and deposition of sand on the front beach of the village]; drought [the effects of the drought (reasons and why)]; plant growth; burning [burning (causes and effects) especially in the areas sago is planted]; sunrise and sunset [causes of haze in the atmosphere, red sunrise and red sunset, meaning of sun]; moon [meaning of moon]; rain [what is rain?]; thunder and lightning [meaning of thunder and lightning]; rainbow [meaning of rainbow]; and clouds [what are clouds?].

5.2 Building A Framework

5.2.1 Four categories of explanations

During the transcribing and translation of the interviews from Toaripi into English, all the main ideas, beliefs and explanations on the ten natural phenomena were sought as a means to discover and identify systematic patterns or relationships among categories (Agar, 1996). For example, Pou, the eldest, commonly referred to spirits and magic spells in his explanations on the sun and moon. Most elders gave explanations relating to Christianity due to the early influences by the missionaries, which is still evident today.
In this instance, four main categories were identified by the researcher through a means of phenomenological analysis (Moustakas, 1994) (see Chapter 3, section 3.8). The principle of phenomenological analysis is concerned with understanding how the everyday, intersubjective world (the life world) is constituted. The aim is to interpret our own and others’ actions as meaningful and to reconstruct the genesis of the objective meanings of action in the intersubjective communication of individuals in the social life-world (Denzin & Lincoln, 2000, p. 192).

The ideas, beliefs and explanations were tabulated into four categories as follows: Category 1: Explanations using spirits, magic spells or sorcery; Category 2: Explanations relating to Christianity; Category 3: Explanations relating to personal experience; and Category 4: Explanations relating to modern science.

During the transcribing and analysis of the interviews, similarities were found amongst the categories of ‘explanations for the personal experience’ with that of ‘explanations relating to modern science’, for each of the ten natural phenomena as illustrated by the examples shown in Figure 5.1. As a result, in the discussions that follow in this chapter, categories 3 and 4 are presented together. However, the four categories are retained separately in Tables 1 to 10 (see Appendix 5).

Figure 5.1 lists the main ideas and explanations based on personal experiences that are consistent with modern science given by the village elders on the ten natural phenomena during the interviews.

5.3 Results

This section describes the explanations based on interviews with eight village elders on the ten natural phenomena which were analysed and classified into the four categories.

5.3.1 Erosion/deposition of sand along the beach (Miri folo ma sa faveai/foreovai)

Eight village elders were asked the following questions about the stages of erosion and deposition.
- On erosion and deposition, 'inland rivers and creeks are blocked due to the felling of trees for food gardens and as a result the water cannot assist in the deposition of sand downstream and onto the beach.'

- On drought, 'the hot sun causes it, is a very long dry season, causes high tide and big waves, no rain for many months, soil is dry because of no water from the rain and people go hungry because of food shortage.'

- On plant growth, 'the water from the rain helps plants to grow, seeds blown by wind causes plant growth in new areas, and mature trees produce seeds which fall to the ground and grow again.'

- On red sunrise and sunset, 'smoke from fires creates the redness in the sky, observations on the sun indicates that the sun's path is different due to the tilt of the earth from January to June and from July to December and the sun stays in one place but the earth revolves around it.'

- On burning, 'burning the forests helps food crops like banana, corn and sweet potato to grow better and burning the bush produces ash and this fertilises the soil.'

- On the moon, 'the sun's rays fall on the moon and makes it shine and the moon controls tides, weather patterns and seasons.'

- On rain, 'the sun heats the water and it changes into steam which rises into the air, moves around and form clouds. As the heavy clouds approach mountains, it falls down as rain again. Rain is brought by the wind which brings black clouds.'

- On thunder and lightning, 'the travelling speed of dark clouds forms thunder and lightning.'

- On rainbow, 'a rainbow is formed when the sun shines on the steam (water vapour) from the water.'

- On clouds, 'clouds are formed when water evaporates and changes into steam when the sun heats it. It rises into the cool air and forms clouds.'

Figure 5.1: Village elders' explanations based on personal experiences that are consistent with modern science
Our village Leleifuru used to be an island in the deep sea. But because of the sea continuously crashing on the beach, it has taken the sand on the beach away to another part of the beach.

What do you think makes the tide come up and then down the beach?

When the tide crashes on the beach, where do you think it takes the sand to?

The tide breaking on the beach makes the sea come in closer to the village and the houses.

So what makes the tide hit the beach and when it hits the beach, where does it take the sand to?

The sea waves, when it crashes on the beach, the sand on the beach does not stay there.

Where do you think the sand goes?

The sea waves, what makes it hit the beach?

Based on the phenomenological analysis of the four categories for explanations, the individual responses of the village elders on erosion and deposition were analysed as follows (see also Table 1 in Appendix 5).

**Category 1: Explanations using spirits, magic spells and sorcery**

- Three of the village elders (Pou, Mai and Tati) said that traditionally and nowadays magic spells (seseva) was used to move the sand along the beach. The sand moves or walks depending on the waves and rapids of the water and deposits it at the requested place. Without use of sorcery the sand will remain in one place and the sand does not get eroded.

- Interestingly, one of the village elders (Mora) did not believe that spells are cast to move the sand along the beach. He said that it is a natural process that occurs where the tides bring in back and forth the sand, which eventually builds, up the beach. He also said that the soil carried down by the rivers helps build up the sand on the beach.

**Category 2: Explanations relating to Christianity**

- Three of the elders (Mai, Mesea and Tati) mentioned that it was a punishment from God (Ualare-Iehova) as most young people are turning away from God and do many wicked things. So as a punishment, the sand on the beach continuously erodes away.
• Three other village elders (Mesa, Ivan and Sevise) said that in former days, there was no erosion because the old people’s beliefs in God were positive and respectful and as a result they were blessed with good things.

Categories 3 and 4: Explanations relating to personal experience and modern science

• Three of the village elders (Mora, Mai and Sevise) said that changes in the wind directions of the wind and tides causes the erosion and deposition of the sand on the beach.

• Four other village elders (Mai, Sari, Tati and Sevise) said that inland rivers and creeks are blocked due to the felling of trees for food gardens and as a result the water cannot assist in the deposition of sand downstream and on to the beach.

• Three more village elders (Mora, Mai and Sevise) said that only tidal waves caused by the wind erodes the soil on the beach.

• Five village elders (Mora, Mesa, Mai, Tati, and Sevise) mentioned that the erosion and deposition of sand on the beach is the result of tidal changes caused by the north-west and south-east trade wind.

• Five of the village elders (Pou, Mora, Sari, Tati and Sevise) said that strong river currents take the sand down to the sea.

• Three of the village elders (Mora, Mesa and Sevise) said that erosion occurs at the mouth of rivers during heavy rainfall.

• Four of the village elders (Sari, Ivan, Tati and Sevise) said that river currents help build the sand up on the beach.

5.3.2 Drought (Mea arara)

Eight village elders were asked the following questions in stages on drought.

There is no rain and the place is very dry. This is the time for rain and village people to plant new gardens. Everyday the sun shines and the place is hot. The rain has not come yet.

What do you think, maybe it happened before when you were a small boy?

What do you think makes the place dry?

What causes a drought?
Based on the phenomenological analysis of the four categories for explanations, the individual responses of the village elders on _drought_ were analysed as follows (see also Table 2 in Appendix 5).

Category 1:  _Explanations using spirits, magic spells and sorcery_

- One of the elders (Pou) believes that magic spells (_seseva_) are cast to either bring or stop rain. He said that the dry season starts from June to October and the wet season starts from November to April. It was interesting to learn from this elder who also mentioned that during rainy days, a type of fish called salmon (_salivera_) is in season. Traditional stories revealed that these fish breed and live in a big rock at the mouth of the river. When the water from the rain covers the rock they all swim out and are carried by the river down to the sea. This is when this fish is in season.

Category 2:  _Explanations relating to Christianity_

- Four of the village elders (Mora, Mai, Ivan and Sari) said that this was a punishment from God as most people have turned away from God (_Ualare Iehova_) and are doing evil and wicked things.
- Two other village elders (Mesea and Sari) related the drought to being a punishment from God (_Ualare Iehova_). They said that at the same time, it was a blessing to warn people of the good times they have had so far.
- Another elder (Ivan) mentioned that it was a sign that people were forgetting God in their everyday lives.

Categories 3 and 4:  _Explanations relating to personal experience and modern science_

- A village elder (Mesea) said that the drought causes people to starve and get hungry. The same village elder mentioned that the sign of leaves dropping off from trees indicates that there is no water in the soil therefore it is dry.
- Another village elder (Ivan) said that the soil is dry because there is no water from the rain and two other village elders (Mai and Mesea) said that food crops die when they are planted.
Five of the village elders (Pou, Mora, Mai, Tati and Sevese) said that the dry season starts between July to November and stated that this dry season was a very long one.

Another village elder (Mora) said the drought causes high tides and big waves. The same elder mentioned that creeks become dry, the river levels are low and the forest burns because it is very dry.

Another village elder (Ivan) said that water in river beds or wells taste sour and have moss growing in them

5.3.3 Plant growth (Asai roi)

Eight village elders were asked the following questions on plant growth.

When the rainy season brings the rain, people go and plant new gardens. They plant crops like corn and the plants grow because there is water from the rain. So when people plant crops like corn, sweet potato and cassava they grow.

What makes them grow?

The betelnut tree and trees in the forest, what makes them grow?

When we burn the bush and later, we find seedlings growing, what makes them grow?

Based on the phenomenological analysis of the four categories for explanations, the individual responses of the village elders on plant growth were analysed as follows (see also Table 3 in Appendix 5).

Category 1: Explanations based on spirits, magic spells and sorcery

- None of the village elders gave explanations for this category.

Category 2: Explanations relating to Christianity

- One of the village elders (Mora) said that God created plants and trees in this world as part of his creation.
Categories 3 and 4: Explanations relating to personal experience and modern science

- One of the village elders (Pou) said that water from rain helps plants to grow quickly. The same elder mentioned that plants do not grow if there is no rain and water in the soil.

- Another village elder (Mesea) mentioned that seeds blown by strong winds and from bird droppings causes plant growth in new areas. Mature trees produce seeds, which fall to the ground and grow again but leaves dropping from trees indicate that there is no water in the soil. This elder was interested to know how different varieties and types of trees come to grow in an area.

5.3.4 Red sunrise/sunset (Sare patei eata fauki ta soa kauri ovoseseai)

Eight village elders were asked the following questions, in stages, on sunrise and sunset.

When you wake up in the morning, you see the sun rising and it is very red.
Why is this so?
When we burn the bush and in the morning when the sun comes up, you see that it is very red. Because there is haze all around created by the smokes from the burning fires. This is the same when the sun sets.
What do you see?
What is happening around us?
What do you think the sun is?
When we see the sun rising and then setting in the evening, what do you think the sun is?
The sun when it rises in the morning, we follow it until it sets in the evening.
What do you think the sun is?
What does it mean?
Does the sun stay in one place or it has many places?
When we see the sun in the sky, does it follow one path or has many paths?
We say the sun is very hot, like when we light our fires with hot roaring flames to cook our food.
Do you think the sun is very hot?
Based on the phenomenological analysis of the four categories for explanations, the individual responses of the village elders on red sunrise and sunset were analysed as follows (see also Table 4 in Appendix 5).

Category 1:  *Explanations based on spirits, magic spells and sorcery*

- An elder (Pou) said that a spirit (*epe savora*) helps and directs the sun in its path from sunrise to sunset. When the sun sets, the place becomes dark. The sun is looked after by the tribal or mythical ancestor (*epe savora*) of the Savoripi clan; hence the honorific title for menfolk of the clan. It is the traditional term for *ivuta* or iguana (Brown, 1968). The same elder mentioned that young boys (*siaresi*) and men (*haro kouresi*) are represented by this spirit (*epe savora*). Young girls (*marisa*) are represented by the spirit woman (*lau lumori*) who looks after the moon. He also said that family clans are determined through this spirit (*epe savora*). For example, the researcher’s father’s (Pauka Uari) clan is called *Marai Touara* while his mother’s (Avoa Arifeac) clan is called *Kaiva Huka*. This particular elder also has a thorough understanding of all the different clans in the village and on folklore.

Category 2:  *Explanations relating to Christianity*

- Five of the village elders (Pou, Ivan, Tati, Mesea and Sevese) said that God created the sun which is very hot, burns all the time and gives warmth to living things.

- Two of the other village elders (Mai and Sari) said that the red sunrise and sunset is a sign interpreted as a punishment from God.

- An elder (Mai) mentioned that it is God’s plan for the sun to rise and set. He also said that the sun represents the Father (God) as God is powerful.

- Three of the elders (Mai, Ivan and Sari) said that it is a promise from God that something is going to happen as in the Bible.
Categories 3 and 4: Explanations relating to personal experience and modern science

- Six of the village elders (Pou, Mora, Mesea, Ivan, Tati and Sevese) said that the sun stays in one place and follows the same path. Interestingly, they mentioned that the earth revolves around the sun.

- One of the elder’s (Mora) observation indicated that the sun when observed follows a different path due to its tilt from January to June and from July to December. This is interesting because this elder can tell when it is time for the dry season and wet season and has a good sense of direction. This elder is also a good fisherman in the village.

- Five of the elders (Pou, Mesea, Mai, Sari and Sevese) said that the red sunrise and sunset were due to the results from burning which gives off smoke into the atmosphere. The smoke causes the redness of the sun in the sky when it rises and sets.

- Another elder (Mesea) mentioned that the sun is a very hot burning furnace.

- Two of the other elders (Mesea and Ivan) said that during rainfall, the rain causes all smoke, smog, haze to disappear. There is bright sunshine after the rain.

- Three of the elders (Sari, Ivan and Tati) said that the sun gives light and heat to the world.

5.3.5 Burning (A vifai)

Eight village elders were asked, in stages, the following questions on burning.

We come to burning. When we burn the bush it burns.
What makes a thing burn?
The fire burning at the sago plots, what makes the fire burn?
Why do we burn the bush?
When we clear the bush then let it dry, we burn it.
Why do you think we burn things?
Based on the phenomenological analysis of the four categories for explanations, the individual responses of the eight village elders on burning were analysed as follows (see also Table 5 in Appendix 5).

**Category 1:** *Explanations based on spirits, magic spells and sorcery*

- None of the village elders gave explanations for this category.

**Category 2:** *Explanations relating to Christianity*

- One of the village elders (Sari) said that the burning was a punishment from God as most people did not know and believe in God. He also said that the burning was also a blessing from God to make people rethink and remind them that God is powerful.

**Categories 3 and 4:** *Explanations relating to personal experience and modern science*

- Two of the village elders (Mora and Mesea) said that burning the bush as a result produces ash, which fertilises the soil for plants to grow after the rain. They also mentioned that burning destroys forests.
- Three other elders (Mora, Mesea and Mai) said that clearing forest for new garden sites by burning helps plant food crops like banana, sweet potato and corn to grow well.
- Three other elders (Pou, Mora and Ivan) said that differences in arguments and jealously cause people to burn gardens and food crops or steal betelnuts. The same elders mentioned that mischievous and careless people light fires and destroy food crops and sago palms.
- Two other elders (Tati and Severse) mentioned that rapid burning takes place in areas where it is very dry and hot.
- Another elder (Severse) said that burning helps to clear and create new footpaths when the bush is cut and left to dry. He also mentioned that burning the bush kills poisonous snakes, wasps and other animals.
5.3.6 Moon (Papare)

Eight village elders were asked, in stages, the following questions about the moon.

*When it is time for the moon, it comes out when the sun sets for the night. When it is very bright, we can walk and see the place clearly from one end to the other end of the village.*
*So what do you think the moon is?*
*Do you think the moon is another world?*
*What do you think it is?*

Based on the phenomenological analysis of the four categories for explanations, the individual responses of the village elders on the moon were analysed as follows (see Table 6 in Appendix 5).

**Category 1:** *Explanations based on spirits, magic spells and sorcery*

- One of the elders (Pou) said that the moon is guided and looked after by a spirit called *lau lumori*. He said that her dark hair is the dark shadow cast on the moon by floating clouds, which block out the sun’s rays. He also mentioned that young beautiful women are identified through this spirit especially when there is a full moon. Thus the exclamation: *A lau lumori ka ka la patei koi* is said when there is a bright full moon coming out ‘what beautiful moon coming up’. Also, during traditional times, young women from each of the clans in the village were admired and adored because their skin was clean and shiny like the full moon on a moonlit night.

**Category 2:** *Explanations relating to Christianity*

- An elder (Mai) said that according to Christian beliefs, the sun represents the Father (God) is hot when it rises because it is the Supreme Being. The moon represents the Son (Jesus Christ) while the stars represent the Holy Spirit.

- Four of the village elders (Mesea, Sevese, Ivan and Sari) said that the moon was created by God as a plan and gets its light from the sun, created also by God.
**Categories 3 and 4:** *Explanations relating to personal experience and modern science*

- One of the elders (Sevese) said that the light given of by the moon is created by the help of the sun’s light. He further mentioned that the moon shines because it is the sun’s ray falling on the moon.

- Another village elder (Ivan) said that the moon controls weather patterns and seasons. He also said that when a new moon comes out it brings rain. He also mentioned that it controls tides and represent each new month of the calendar year.

- Two other elders (Sari and Sevese) said that the moon gives light to the world when it is dark in the night.

**5.3.7 Rain (Lai)**

Eight village elders were asked, in stages, the following questions on rain.

> When it rains from the sky, there is water everywhere. The raindrops fall from the sky when it rains.

> What makes them fall from the sky?

> The black clouds that bring rain, where do you think they come from?

> The rain that falls over the mountains comes down the mountain and goes where?

> The rain that is coming from the black clouds in the sky. When the black clouds go over the mountains, it rains.

> When the raindrops fall, what makes them fall?

Based on the phenomenological analysis of the four categories for explanations, the individual responses of the village elders on *rain* were analysed as follows (see also Table 7 in Appendix 5).

**Category 1:** *Explanations using spirits, magic spells and sorcery*

- One of the elders (Pou) said that magic spells (*seseva*) were used to make rain. He said that the dry season starts from June to October and the wet season starts from November to April. He also mentioned that during rainy days, a type of fish called salmon (*salivera*) is in season. Traditional stories revealed
that these fish breed and live in a big rock at the mouth of the river. When the water covers the rock they all come out.

**Category 2: Explanations relating to Christianity**

- One of the elders (Ivan) said that God created rain as a plan to give water to plants and animals on earth.

**Categories 3 and 4: Explanations relating to personal experience and modern science**

- Each of the village elders (Pou, Mora, Mai, Mesea, Ivan, Tati, Sari and Sevese) said that the sun heats the water and changes it into steam. The steam rises into the air, moves around and forms dark clouds. As the heavy dark clouds approach the mountains, water droplets fall as rain. It flows into rivers and down to the sea. The whole cycle is repeated again.
- An elder (Mesea) referred to the textbook meaning of evaporation and the water cycle and another elder (Tati) said that he was taught by teachers at school about evaporation and the water cycle.
- Two other elders (Pou and Sevese) said that black dark clouds bring rain.
- Two of the other elders (Mai and Tati) said that rain is brought by strong winds which also bring black clouds.
- Another elder (Mesea) said that rain falls in places where there are many trees.
- Another elder (Ivan) said that rain brings water which cools the earth and gives water to all living things.

5.3.8 Thunder and lightning (*Kevaro auka sisorea*)

Eight village elders were asked, in stages, the following questions on thunder and lightning.

*During rainy days, there is a bang of thunder and lightning flashing across the sky.*

_Thunder, what do you think it is?_

_When it rains and the storm is bad, there is thunder and lightning. Thunder, you know is very dangerous and can kill people and split trees._
What do you think is lightning?
Lightning, how and what makes lightning flash?
What do you think is lightning?

Based on the phenomenological analysis of the four categories for explanations, the individual responses of the village elders on thunder and lightning were analysed as follows (see also Table 8 in Appendix 5).

Category 1: Explanations using spirits, magic spells and sorcery

- Two of the village elders (Tati and Sevese) said that magic spells (seveva) are cast. One of these elders (Tati) gave an account of an experience in which a flash of lightning destroyed a line of coconut trees from the beach to the mangroves trees in the swamp, all in one direction. He said he experienced this when he was a young boy at that time when an old man cast a magic spell (seveva) through the use of lightning to take revenge on someone for stealing his coconuts.

Category 2: Explanations relating to Christianity

- One of the village elders (Mai) mentioned that God created thunder and lightning to scare people.
- Two of the elders (Tati and Sevese) said that earthly people have power to destroy trees using lightning, as it is a gift from God.
- Two other elders (Mesea and Sevese) said that God created it during the time of Noah as in the holy Bible.

Categories 3 and 4: Explanations relating to personal experience and modern science

- Two of the village elders (Pou and Sari) said that lightning and thunder are caused due to the travelling speed of dark rainy clouds while another elder (Sari) mentioned that the rapid evaporation and the speed of clouds cause thunder and lightning.
- Three other village elders (Pou, Mora and Sari) said that the formation of many dark clouds causes thunder and lightning and brings rain.
Another elder (Ivan) said that thunder is like a big drum that has been hit and rolled around in the sky.

5.3.9  Rainbow (Lavai)

Eight village elders were asked the following questions, in stages, on rainbow.

_During rainy days there is thunder and lightning. After the rain has stopped, a rainbow sometimes appears._

_What do you think is a rainbow?_

_What makes it appear in the sky?_

Based on the phenomenological analysis of the four categories for explanations, the individual responses of the village elders on rainbow were analysed as follows (see also Table 9 Appendix 5).

**Category 1:**  _Explanations using spirits, magic spells and sorcery_

*  None of the village elders gave explanations for this category.

**Category 2:**  _Explanations relating to Christianity_

*  Six of the village elders (Pou, Mesea, Mai, Sari, Ivan and Tati) said that it occurs after and during rainy season and it is a sign from God to Noah and his family after the Great Flood.

**Categories 3 and 4:**  _Explanations relating to personal experience and modern science_

*  One of the elders (Pou) said that a rainbow is a sign, which appears that stops lightning, thunder and rain.

*  Another elder (Mora) said that it occurs after and during rainy seasons.

*  Three elders (Mora, Ivan and Sevese) said that it is a sign that heavy rain is coming and Sevese mentioned that a rainbow is formed when the sun shines on the steam (water vapour) from the water.

*  Another elder (Sari) also said that it has different colours.
5.4.0 **Clouds (Meae-e)**

Eight village elders were asked in stages the following questions on clouds.

*Clouds, while sitting here and looking up, we can see them up there in the sky.*  
*Sometimes they are white and sometimes they are black or grey.*  
*What brings them here?*  
*What do you think are clouds?*

Based on the phenomenological analysis of the four categories for explanations, the individual responses of the village elders on clouds were analysed as follows (see also Table 10 in Appendix 5).

**Category 1:** *Explanations using spirits, magic spells and sorcery*  
- None of the elders gave any explanations in this category.

**Category 2:** *Explanation relating to Christianity*  
- One of the elders (Mesea) said that God created clouds.

**Category 3 and 4:** *Explanations relating to personal experience and modern science*  
- One of the elders (Pou) said that strong winds blow clouds here. He also said that plenty of cloud cover means the wind is strong.  
- Two of the elders (Mesea and Tati) said that it is caused by evaporation of water, which changes to steam when the sun heats it. It rises into cool air and forms clouds.  
- Another elder (Tati) said that when there is very hot sun, this means that there are many clouds in the sky. The same elder said that a puddle of water when heated by the sun dries up and disappears. The vapour rises and is cooled by the cool air in the sky. It changes and forms black clouds and bring rain. The same elder also said that plenty of black clouds bring rain.
5.4 Conclusions

As has been shown, the analysis of the village elders’ explanations from the recorded interviews were summarised into the four categories of Spirits, magic spells and sorcery; Christianity; Personal experience; and Modern science. Because of sufficient similarities between personal experience and modern science explanations, these were grouped together. The following examples illustrate elders’ beliefs, ideas and explanations on all the natural phenomena for each of these categories.

5.4.1 Category 1: Explanations relating to spirits, magic and spells.

Several elders gave numerous explanations related to spirits, magic spells and sorcery showing that they still hold on strongly to traditional beliefs which can be seen from the way that they perceive, interpret and explain their natural environment surroundings. Having lived closely within their natural environments, they are able to give explanations of natural phenomena from their own personal perspectives and perceptions. Their traditional beliefs and pattern of life evolve around the bush and the jungle near where they live and consequently, these village elders often associate their myths of origin to the natural environment where they live. George’s (1991) study supports and states that traditional beliefs are strong among PNG tribes where a powerful spirit called Patip/Yangela created the universe and everything in it. Each component of the universe is associated with its own spirit, like the spirit of the garden, spirit of the animal, spirit of weather and spirit of the forest. The spirit of lightning is considered to be an angry spirit and this makes the people fearful of it.

The types of beliefs, ideas and explanations relating to the category on explanations using spirits, magic spells and sorcery expressed by four of the village elders (Mai, Pou, Sevese and Tati) are as follows:

- On erosion and deposition, ‘spells are cast which moves the sand on the beach. The sand moves or walks depending on the waves and rapids of the water and deposits at the requested place.
• On sunrise and sunset, 'a spirit called epe savora looks after, helps and guides the sun from sunrise to sunset. Epe Savora is the tribal or mythical ancestor of the Savoripi clan; hence the honorific title for menfolk of the clan. It is the traditional term for ivuta or iguana.'

• On the moon, 'a spirit woman called lau lumori guides and looks after the moon. Her dark hair is the dark shadow cast on the moon by floating clouds which block out the sun’s rays.'

• On rain, 'magic spells (seseva) are cast to bring or stop rain.'

• On lightning, 'magic spells (seseva) are cast to create lightning as a revenge tactic on someone who may be accused of stealing coconuts or betelnuts.'

The explanations relating to spirits, magic spells and sorcery are a central part of PNG culture and are discussed in family groups at home in the village; hence, students may learn these beliefs from their grandparents or parents.

5.4.2 Category 2: Explanations relating to Christianity

Six village elders (Ivan, Mai, Mesea, Mora, Sari, Sevese) gave numerous and interesting ideas, beliefs and explanations that were related to Christianity. These beliefs and explanations are most likely based on these elders’ active involvement in church activities with the village United Church, an influence strongly associated with the teaching by the early missionaries, and attending village mission schools. The following beliefs, ideas and explanations relating to Christianity illustrate this:

• On erosion and deposition of the sand on the beach in front of the village, 'it is a punishment from God as most young people were turning away from God and doing many wicked things. This allows the sand on the beach to continuously erode away. In former days, there was no erosion because the elders’ beliefs in God were positive and respectful and as a result they were blessed with good things.'
• On drought, 'it is a punishment from God as most people have turned away from God and are doing evil and wicked things. It was a punishment but also a blessing to warn people of the good times they have had so far. It is a sign that people are forgetting God in their everyday lives.'

• On plant growth, 'God created plants and trees in this world (God's creation).'

• On sunrise and sunset, 'God created the sun which is very hot, burns all the time and gives warmth to living things. The red sunrise and sunset are signs showing that it is a punishment from God. It is God's plan for the sun to rise and set each day. The sun represents the Father (God) as God is powerful.'

• On burning, 'it is a punishment from God as most people did not know and believe in God. Burning is also a blessing from God to make people rethink and remind them that God is powerful.'

• On the moon, 'the moon represents the Son (Jesus Christ), the sun represents the Father (God) is hot when it rises because it is the Supreme Being while the stars represents the Holy Spirit.' The moon represents the Son (Jesus Christ) as a plan and gets its light from the sun (God).

• On rain, 'God created rain as plan to give water to plants and animals on earth.'

• On thunder and lightning, 'God created them to scare people. They are gifts from God which some people possess and through their powers, they can destroy trees and buildings. God created them during the time of Noah as in the holy Bible.'

• On rainbow, 'it occurs during rainy season and is a sign from God to Noah and his family after the Great Flood in the Bible that there will be no more floods'.

• On clouds, 'God created it.'

The explanations relating to Christianity are most likely an influence by the early Christian missionaries from the London Missionary Society (LMS) who started mission schools to educate villagers such as the elders in this study. Most villages in the Gulf Province have a church, which symbolises the strong influence it has on families and students. However, not all elders explained the natural phenomena in terms of a religious position.
5.4.3 Categories 3 and 4: Explanations relating to personal experience and modern science

An analysis of the village elders’ beliefs, ideas and explanations from the recorded interviews showed that there were similarities amongst explanations of the personal experience category with that of modern science. These ideas and explanations are most likely based on the elders’ education when they attended village mission schools and how they have seen and interpreted these events during their lifetime and associating closely with their natural environment. This is because their traditional beliefs and pattern of life evolves around the bush and the jungle near where they live.

The following beliefs, ideas and explanations relating to personal experience and modern science illustrate this:

- On erosion and deposition, ‘inland rivers and creeks are blocked due to the felling of trees for food gardens. As a result, the water cannot assist in the deposition of sand downstream and on to the beach. This also makes the river get shallow.’

- On drought, ‘the hot sun causes it, is a very long dry season, causes high tide and big waves, no rain for many months, soil is dry because of no water from the rain and people go hungry because of food shortage’.

- On plant growth, ‘the water from the rain helps plants to grow, seeds blown by wind causes plant growth in new areas, and mature trees produce seeds which fall to the ground and grow again.

- On red sunrise and sunset, ‘smoke from fires creates the redness in the sky, observations on the sun indicates that the sun’s path is different due to the tilt of the earth from January to June and from July to December and the sun stays in one place but the earth revolves around it.’

- On burning, ‘burning the forests helps food crops like banana, corn and sweet potato to grow better and burning the bush produces ash and this fertilises the soil.’
On the moon, 'the sun’s rays fall on the moon and makes it shine and the moon controls tides, weather patterns and seasons.'

On rain, 'the sun heats the water and it changes into steam which rises into the air, moves around and form clouds. As the heavy clouds approach mountains, it falls down as train again. Rain is brought by the wind which brings black clouds.'

On thunder and lightning, 'the travelling speed of dark clouds forms thunder and lightning.'

On rainbow, 'a rainbow is formed when the sun shines on the steam (water vapour) from the water.'

On clouds, 'clouds are formed when water evaporates and changes into steam when the sun heats it. It rises into the cool air and forms clouds.'

The explanations relating to personal experience and modern science are strongly influenced by the observations developed over time by these elders who live and interact with their natural environment. The observations and experiences that they have developed and acquired have evolved over time, enabling them to explain ideas meaningfully in a manner, which complements those of modern science. These experiences also may be from the limited science that they learnt at the mission schools.

5.5 Summary

In response to Research Question 1, "What traditional beliefs or stories do village elders have in explaining natural phenomena", this study found that village elders’ beliefs, ideas and explanations were based on Spirits, magic spells and sorcery, Christianity, Personal experience, and Modern science.

For example, Pou, who was the eldest amongst the eight village elders, and Mai, Tati and Sevese commonly referred to magic spells and spirits in their explanations on natural phenomena. This illustrates the fact that these elders who come from the Gulf Province in PNG still significantly hold on to beliefs such as magic spells, spirits and sorcery. These elders also have an invaluable knowledge of folklore and the different
village structures and clan systems. Examples of some of the beliefs that they possess are as follows:

- On erosion and deposition, spells are cast which moves the sand on the beach. The sand moves or walks depending on the waves and rapids of the water and deposits at the requested place.

- On sunrise and sunset, a spirit called epe savora looks after, helps and guides the sun from sunrise to sunset. Epe savora is the tribal or mythical ancestor of the Savoripi clan; hence, the honorific title for menfolk of the clan, which is the traditional term for ivuta or iguana.

- On the moon, a spirit woman called lau lumori guides and looks after the moon. Her dark hair is the dark shadow cast on the moon by floating clouds, which block out the sun’s rays.

- On rain, magic spells (seseva) are cast to bring or stop rain and on lightning, magic spells (seseva) are cast to create lightning as a revenge tactic on someone who may be accused of stealing coconuts or betelnuts.

Mai, Sari and Sevese are involved in church activities as pastors and deacons so most of their explanations were related to Christianity although some were based on their personal experience of living close to the natural environment. Nowadays, in almost every village in the Gulf Province, there is a church and it signifies the importance and the influence that the Christian faith has among families in this villages. Their responses also could be the result of the limited science they learnt while attending mission schools.

Mora, the next oldest who had an in-depth knowledge of the environment, is also a good fishermen and involves himself in church activities. Although he did not believe in magic spells and sorcery, he was able to give explanations from his own experiences that related to modern science. For example, he was able to tell when it was the right time to go out fishing when the moon was out. He also stated that the sun follows different directions according to his observations everyday. When elders give explanations like this, it means that they have experienced this idea or concept
over time and are able to explain it meaningfully which complements with the formal science knowledge.

The rest of the elders (Mesea, Ivan and Tati) gave a variety of explanations from their own experiences that related to modern science as well as being related to Christianity. These could be the result of their mission school education, including limited science education, and their experiences of travelling, living and working around Port Moresby. As mentioned earlier, village elders’ explanations and understanding of their natural environment becomes meaningful to them when they encounter these experiences over time.

Following on from this study with village elders, Chapter 6 describes and discusses secondary school students’ traditional science beliefs in the Gulf Province of PNG. Chapter 7 outlines and examines secondary school students’ sources of explanations on natural phenomena. Chapter 8 solicits the open-ended questions and reports the types of explanations held by secondary school students in the Gulf Province of PNG.
CHAPTER 6

SECONDARY SCHOOL STUDENTS' TRADITIONAL SCIENCE BELIEFS IN PAPUA NEW GUINEA SCHOOLS

6.0 Overview of Chapter

This aim of this chapter is to present and describe a study of secondary school students’ traditional science beliefs in Papua New Guinea (PNG). It is in response to Research Question 2: “What traditional science beliefs do PNG secondary school students hold?”, and attempts to identify and analyse the extent of various traditional ideas and beliefs held by these students while attending and learning formal school science. A questionnaire was designed and based on the ideas, beliefs and explanations of natural phenomena by eight village elders from Lelefi village described in Chapter 5 and additional traditional beliefs of tribal peoples identified in the literature. The resulting questionnaire, Traditional Science Beliefs (see Appendix 4.1) consisting of 40 items written in English, was used to collect students’ understanding of traditional beliefs. It was administered to a sample of 159 students from Grades 7 to 10 in age ranging from 13 to 20 years old at a rural boarding high school in the Gulf Province in PNG. The students’ responses to the items in the questionnaire are discussed in this chapter.

6.1 Design and Procedures

6.1.1 Sample

The sample in this study, consisting of 159 students, was virtually the whole population of the students at the school because it consisted of all secondary science students who came from the same cultural grouping (Toaripi). Differences in cultural groups within PNG can be quite dramatic. It is not unusual to find members of tribes who live no more than two kilometres apart who speak unrelated languages. Most of these students came from different villages, where they were born and grew up, and
have spent a greater portion of their lives in their villages (including community
school). During this time, they interacted socially with their parents, grandparents and
especially with their peers in the games they play. All students were boarders and
attended a rural boarding high school in the Gulf Province in PNG. They were in
Grades 7 (n=48), 8 (n=33), 9 (n=27), and 10 (n=51) with ages ranging from 13 to 20
years.

6.1.2 Instrument

Using the elders’ ideas and beliefs, an instrument developed by the Ghanaian
researcher, Anamuah-Mensah (1998), was adapted and modified with local ideas,
beliefs and knowledge. It was the intention of the researcher to use the instrument by
Anamuah-Mensah (1998) because some traditional beliefs among African tribes
were similar to those among PNG tribes. The final instrument was modified as
shown in Chapter 3 (section 3.6.2).

The instrument was written in English and administered in a science classroom where
the language of instruction was English; however, each student spoke as many as four
local languages in their village communities. The instrument, administered to the
sample in October 1998, took 40 minutes where students were asked to read all the
items very carefully and then circle the number that best reflected their belief. The
researcher was available to answer respondents’ questions during the administration
of the instrument, but it did not appear to pose any major problems.

Using phenomenological analysis (Moustakas, 1994), the items were examined by the
researcher and his supervisors to define four categories, which are discussed in the
following section. The completed 159 questionnaires were coded, verified and
analysed in terms of frequencies, means and standard deviations using the SPSS
program (Coakes & Steed, 1999, Kirk, 1996). The small number in the sample did not
enable the data to be subjected to factor analysis (Stevens, 1992). In addition, analysis
of the mean data on items of traditional beliefs was performed to determine if there
were any statistically significant differences among the sample.
6.2 Results and Discussion

The subsequent analysis provided four categories, as presented in Table 6.2, showing the items, examples and Cronbach alpha reliabilities. Although a feasibility study was not carried out to test the reliability of the items in the questionnaire, the alpha reliabilities for the four categories (see Table 6.1) are comparable to those of Anamuah-Mensah’s (1998) categories.

Table 6.1 Categories of PNG students’ traditional science beliefs and the Cronbach alpha reliabilities of the categories (n=159)

<table>
<thead>
<tr>
<th>Categories</th>
<th>Items</th>
<th>Examples</th>
<th>Cronbach alpha reliability</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Consequences involving humans</td>
<td>1, 2, 3, 8, 11, 14, 20, 31, 37.</td>
<td>Eating pig meat will make you unclean (Item 8).</td>
<td>0.56</td>
</tr>
<tr>
<td>2. Certain events are life-threatening.</td>
<td>7, 15, 16, 17, 18, 19, 30, 35, 36, 39, 40.</td>
<td>Cutting nails at night will cause disease (Item 15).</td>
<td>0.56</td>
</tr>
<tr>
<td>3. Consequences involving nature.</td>
<td>4, 5, 6, 10, 21, 22, 24, 25, 26, 27, 28, 29, 38.</td>
<td>Chickens moving to roost means evening draws near (Item 26).</td>
<td>0.60</td>
</tr>
<tr>
<td>4. Certain events involves spirits.</td>
<td>9, 12, 13, 23, 32, 33, 34.</td>
<td>Sweeping at night invites evil spirits into the house (Item 9).</td>
<td>0.68</td>
</tr>
</tbody>
</table>

6.2.1 Category 1: Consequences involving humans

The first category appears to emphasise the clustering of items that deal with the belief that certain events occur as consequences involving human action. Examples are, ‘Drinking a lot of juice of a fresh young coconut will cure diarrhoea’ (Item 2) and ‘Eating the head of fish frequently will make you more intelligent’ (Item 37). The percentages, mean and standard deviations for items of the first category, Consequences involving humans of the Traditional Science Beliefs are shown in Table 6.2.

For items in this category, 66.7% (i.e. SA<sub>3</sub>=34.6% and A<sub>4</sub>=32.1%) of the students believed that ‘Drinking lots of juice from a young coconut can cure diarrhoea’ (Item
2. Coconut trees are common along the coastal and inland villages and coconut juice provides a soothing alternative to stop the body from dehydrating and diarrhoea will be cured. Over half (53.2%) (i.e. SA₅=25.6% and A₄=27.6%) of the students believed that ‘Pointing at a rainbow can cause a lump to grow under your arm pit’ (Item 20).

Table 6.2 Percentages responses, mean and standard deviation of items for Category 1, Consequences involving humans (n=159)

<table>
<thead>
<tr>
<th>Belief statements</th>
<th>SA₅</th>
<th>A₄</th>
<th>U₃</th>
<th>D₂</th>
<th>SD₁</th>
<th>Mean</th>
<th>Standard Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Eating the eyes of fish will make you see better in the night.</td>
<td>5.1</td>
<td>7.6</td>
<td>47.5</td>
<td>12.7</td>
<td>27.2</td>
<td>2.50</td>
<td>1.20</td>
</tr>
<tr>
<td>2. Drinking a lot of juice of a young coconut will cure diarrhoea</td>
<td>34.6</td>
<td>32.1</td>
<td>18.6</td>
<td>8.3</td>
<td>6.4</td>
<td>3.80</td>
<td>1.19</td>
</tr>
<tr>
<td>3. A pregnant woman who eats a lot of sago soup will have an easy delivery.</td>
<td>10.1</td>
<td>27.8</td>
<td>42.4</td>
<td>8.2</td>
<td>11.4</td>
<td>3.17</td>
<td>1.10</td>
</tr>
<tr>
<td>8. Eating pig meat will make you unclean.</td>
<td>5.7</td>
<td>10.1</td>
<td>30.8</td>
<td>23.3</td>
<td>30.2</td>
<td>2.38</td>
<td>1.18</td>
</tr>
<tr>
<td>11. Do not eat ripe bananas at night or in the morning or the food you will eat will not digest well.</td>
<td>6.3</td>
<td>18.4</td>
<td>23.4</td>
<td>25.3</td>
<td>26.6</td>
<td>2.53</td>
<td>1.24</td>
</tr>
<tr>
<td>14. When a chief is sitting in state, a woman should not attempt to walk across otherwise she will not bear any children.</td>
<td>6.4</td>
<td>14.7</td>
<td>42.3</td>
<td>18.6</td>
<td>17.9</td>
<td>2.73</td>
<td>1.12</td>
</tr>
<tr>
<td>20. If you point at a rainbow, you will get a mokora poi or a lump will grow under your arm pit.</td>
<td>25.6</td>
<td>27.6</td>
<td>26.9</td>
<td>11.5</td>
<td>8.3</td>
<td>3.51</td>
<td>1.23</td>
</tr>
<tr>
<td>31. If you ask the rat for a new tooth in exchange for your old one, it will give you a new one.</td>
<td>25.2</td>
<td>40.6</td>
<td>15.5</td>
<td>11.0</td>
<td>7.7</td>
<td>3.65</td>
<td>1.19</td>
</tr>
<tr>
<td>37. Eating the head of fish frequently will make you more intelligent.</td>
<td>6.9</td>
<td>13.2</td>
<td>50.7</td>
<td>15.8</td>
<td>14.5</td>
<td>2.80</td>
<td>1.04</td>
</tr>
</tbody>
</table>

Almost two thirds (65.8%) (i.e. SA₄=25.2% and A₃=40.6%) of the students believed that ‘A rat will give a new tooth in exchange for an old one’ (Item 31); this is a common belief in the village because rats have very sharp teeth and can tear anything except metal. From experience when the researcher was young, his mother would tell
him to ask the rat for a new tooth if his old one came out. He called the rat by saying, ‘Rat, rat, give me your new tooth and I will give you my old tooth’ and threw his old tooth away. A few weeks later, a new tooth grew and this meant that the rat had heard his wish.

More than 50% (i.e. $D_2=23.3\%$ and $SD_1=30.2\%$) of the students did not believe that ‘Eating pig meat will make you unclean (Item 8) while another 51.9% (i.e. $D_2=25.3\%$ and $SD_1=26.6\%$) did not believe that ‘They should not eat ripe bananas at night or in the morning or the food they eat will not digest very well’ (Item 11). Of interest in this category, and also in the other categories, are the large percentage of students who were undecided about holding or not holding these traditional beliefs on items like ‘Eating the head of fish frequently will make you more intelligent’ (Item 37) (50.7%), ‘Eating the eyes of fish will make you see better in the night’ (Item 1) (47.5%), ‘A pregnant woman who eats a lot of sago soup will have a easy delivery’ (Item 3) (42.4%), and ‘When a chief is sitting in state, a woman should not attempt to walk across otherwise she will not bear any children’ (Item 14) (42.3%). Because it was not possible to conduct follow-up interviews, the researcher cannot comment on the reasons for the high percentage of undecided responses.

The second category of clustered items deal with the belief that certain events are life-threatening. Examples are, ‘A menstruating woman or girl should not prepare meals since those who eat it will get sick’ (Item 7) and ‘A meowing cat in the night means that someone will die’ (Item 36). The percentages, mean and standard deviations of items for the second category, Certain events are life-threatening of the Traditional Science Beliefs are presented in Table 6.3.

For items in this category, 48.7% (i.e. $SA_5=24.7\%$ and $A_4=24.0\%$) of the students had a belief that ‘A menstruating woman/girl should not prepare food since those who eat it will get sick’ (Item 7). Almost two thirds (65%), (i.e. $SA_5=28.7\%$ and $A_4=36.3\%$) of the students believed that ‘A shooting star falling in a particular area meant that someone will die’ (Item 30). This is similar to the finding of Anamwah-Mensah (1998) who stated that this belief is from the belief in astrology that every person’s life is guided by a star. So when the star becomes dislodged from its location, it
signifies the death of that person. Almost two thirds (65.4%), (i.e. \( S_A = 21.4\% \) and \( A_4 = 44\% \)) of the students believed that ‘If one sees a ghost in the night, that means someone will die’ (Item 35). Another 55.8% of the students believed that ‘A cat meowing in the night means someone will die’ (Item 36). This is because villagers such as the researcher’s mother believe that cats are clever and clean and will provide food for the dead after they die.

Almost two thirds (67.9%), (i.e. \( S_A = 35.8\% \) and \( A_4 = 32.1\% \)) of the students had a belief that ‘When a person stepped over urine, this person would get a swelling in the groin’ (Item 39). This is a common belief in the villages and villagers tend to be careful when walking to their latrines. About 43.7%, (i.e. \( S_A = 18.4\% \) and \( A_4 = 25.3\% \)) of the students believe that ‘If men swim downstream of women, they will loose their strength’ (Item 40). This is because of the belief that men are stronger than women.

In this category, no beliefs were generally agreed to by a majority of students although 49.6% (i.e. \( D_2 = 21.9\% \) and \( S_D = 27.7\% \)) did not believe that ‘Cutting nails at night will cause disease’ (Item 15) and 42.2% (i.e. \( D_2 = 23.4\% \) and \( S_D = 18.8\% \)) did not believe that ‘if you urinate into fire you will die’ (Item 19). In this category, a large percentage of students were undecided whether or not ‘If you swallow hair, you will get a goitre’ (Item 18) (49.7%) and ‘If you spit into fire you will get a swollen neck’ (Item 17) (36.9%); and ‘If you urinate into fire you will die’ (Item 19) (36.4%).
6.2.2 Category 2: Certain events are life-threatening

Table 6.3 Percentage of responses, mean and standard deviation of items for Category 2: Certain events are life-threatening.

<table>
<thead>
<tr>
<th>Belief statements</th>
<th>Percentages</th>
<th></th>
<th></th>
<th></th>
<th>Mean</th>
<th>Standard Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>SA5</td>
<td>A4</td>
<td>U3</td>
<td>D2</td>
<td>SD1</td>
<td></td>
</tr>
<tr>
<td>7. A menstruating woman/girl should not prepare meals since those who eat it will get sick.</td>
<td>24.7</td>
<td>24.0</td>
<td>24.7</td>
<td>15.6</td>
<td>11.0</td>
<td>3.36</td>
</tr>
<tr>
<td>15. Cutting nails at night will cause disease.</td>
<td>12.3</td>
<td>32.3</td>
<td>21.9</td>
<td>27.7</td>
<td>2.46</td>
<td>1.19</td>
</tr>
<tr>
<td>16. If you step onto a spit of betelnut, you will get a disease.</td>
<td>29.2</td>
<td>34.4</td>
<td>11.7</td>
<td>9.1</td>
<td>3.31</td>
<td>1.15</td>
</tr>
<tr>
<td>17. If you spit into fire you will get a swollen neck.</td>
<td>20.0</td>
<td>36.9</td>
<td>18.5</td>
<td>17.2</td>
<td>2.81</td>
<td>1.14</td>
</tr>
<tr>
<td>18. If you swallow hair you will have a goitre.</td>
<td>23.6</td>
<td>49.7</td>
<td>8.3</td>
<td>8.3</td>
<td>3.19</td>
<td>1.01</td>
</tr>
<tr>
<td>19. If you urinate into fire you will die.</td>
<td>11.0</td>
<td>10.4</td>
<td>36.4</td>
<td>23.4</td>
<td>18.8</td>
<td>2.71</td>
</tr>
<tr>
<td>30. A shooting star falling in the sky in a particular area means someone will die.</td>
<td>28.7</td>
<td>36.3</td>
<td>19.1</td>
<td>11.5</td>
<td>4.5</td>
<td>3.73</td>
</tr>
<tr>
<td>35. If you see a ghost or karisu in the night, someone will die.</td>
<td>21.4</td>
<td>44.0</td>
<td>18.2</td>
<td>10.1</td>
<td>6.3</td>
<td>3.64</td>
</tr>
<tr>
<td>36. A meowing cat in the night means that someone will die.</td>
<td>17.3</td>
<td>38.5</td>
<td>25.0</td>
<td>12.2</td>
<td>7.1</td>
<td>3.47</td>
</tr>
<tr>
<td>39. If you step over urine, you will get a swelling in the groin or kapo fare.</td>
<td>36.8</td>
<td>32.1</td>
<td>18.9</td>
<td>7.5</td>
<td>5.7</td>
<td>3.85</td>
</tr>
<tr>
<td>40. If men swim downstream of women, they will lose their strength.</td>
<td>18.4</td>
<td>25.3</td>
<td>46.8</td>
<td>6.3</td>
<td>3.2</td>
<td>3.49</td>
</tr>
</tbody>
</table>

6.2.3 Category 3: Consequences involving nature

The third category clusters items that deal with the belief that certain events occur as consequences involving nature. Examples are 'You cover all mirrors during a storm or else lightning will bounce off the mirror and kill you' (Item 6) and 'The moon causes moonsick or papare eka in females' (Item 38). The percentages, mean and
standard deviations of the items of the third category, Consequences involving nature, of the Traditional Science Beliefs are shown in Table 6.4.

For items in this category, 51.9% (i.e. $S_{A_5}=21.4\%$ and $A_4=30.5\%$) of the students believe that 'If there is a spell of hot days, a heavy downpour of rain is expected' (Item 5). This is due to the changing weather patterns along the coastal regions with which most villagers are familiar with. Almost half (50%) (i.e. $S_{A_5}=19.6\%$ and $A_4=30.4\%$) of the students believe that 'Lightning can kill if a person does not cover all mirrors during a storm' (Item 6). Stories of villagers been struck and killed by lightning have been passed around so students are aware of it but only a few have seen people killed by it.

Anamuah-Mensah’s (1998) research identified students not knowing how lightning is formed, how it can travel from one place to another, covering a mirror can prevent reflection and eventually prevent death. Over 50% (i.e. $D_2=22.8\%$ and $SD_1=29.1\%$) of the students believe that ‘The evening star Oa Miri-Mirou represents a planet called Venus’ (Item 21) and another 43.1% (i.e. $S_{A_5}=20.9\%$ and $A_4=22.2\%$) of the students believe that ‘The morning star Oa Malala also represents a planet called Venus’ (Item 22). This is because the sky is clear most of the time during the year in these Toaripi villages from Cape Possession to the Avei mouth of the Purari River in the Gulf Province so it is common to see the morning star especially in the mornings and the evening star in the evenings.
Table 6.4  Percentage responses, mean and standard deviation of items for Category 3: *Consequences involving nature* (n=159)

<table>
<thead>
<tr>
<th>Belief statements</th>
<th>Percentages</th>
<th></th>
<th></th>
<th></th>
<th>Mean</th>
<th>Standard Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>SA5 7.6</td>
<td>A4 24.2</td>
<td>U3 38.2</td>
<td>D2 18.5</td>
<td>SD1 11.5</td>
</tr>
<tr>
<td>4. When one is young and plant seeds, they will not bear a lot of fruit.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>2.98</td>
<td>1.09</td>
</tr>
<tr>
<td>5. If there is a spell of very hot days, a heavy downpour of rain is expected.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>3.35</td>
<td>1.30</td>
</tr>
<tr>
<td>6. You cover all mirrors during a storm or else lightning will bounce off the</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>3.34</td>
<td>1.26</td>
</tr>
<tr>
<td>mirror and kill you.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10. If the navel string (umbilical cord) is planted under a coconut tree, the tree</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>2.92</td>
<td>1.06</td>
</tr>
<tr>
<td>will bear many fruits.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>21. The evening <em>Oa Miri-Mirou</em> represents a planet called Venus.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>3.58</td>
<td>1.06</td>
</tr>
<tr>
<td>22. The morning star <em>Oa-Malala</em> represents a planet called Venus.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>3.35</td>
<td>1.19</td>
</tr>
<tr>
<td>24. Darkness without the chirping of cicadas means the sun is out and it is</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>3.18</td>
<td>0.95</td>
</tr>
<tr>
<td>getting light.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>25. Ants and centipedes moving from lying areas and drains to higher ground</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>2.89</td>
<td>1.09</td>
</tr>
<tr>
<td>means it is going to rain.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>26. Chicken moving to roost means evening draws near.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>3.48</td>
<td>1.17</td>
</tr>
<tr>
<td>27. Dancing bright flames indicated rain sometimes.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>2.97</td>
<td>0.90</td>
</tr>
<tr>
<td>28. The chirping of a particular bird tells of visitors drawing near.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>3.52</td>
<td>0.96</td>
</tr>
<tr>
<td>29. Leafy potato and yam plants tell of underdeveloped tubers.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>3.10</td>
<td>1.02</td>
</tr>
<tr>
<td>38. The moon causes 'moonsick' or <em>papare eka</em> in females.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>3.73</td>
<td>1.13</td>
</tr>
</tbody>
</table>

Another strongly held belief found among 59.2% (i.e. SA5=17.8% and A4=41.4%) of the students was that of ‘Chickens moving to roost which meant that evening was drawing near’ (Item 26). Because the villagers raise a lot of chickens, it is common knowledge that chickens roosting in the evening means that night is coming. Over
half (54.5%) (i.e. $SA_5=13.5\%$ and $A_4=41\%$) of the students believe that 'The chirping of a particular bird tells of visitors drawing near' (Item 28). This is common in areas in the forest where there is rich bird life and it is in areas such as this that villagers make gardens. So villagers are familiar with various birdcalls and from the chirping of a particular one will make them become aware if visitors are approaching. Finally, under this category it was found that 78.4% of the students believe that 'The moon causes 'moonsick' or *papare eka* in females' (Item 38). This stems from the belief that when there is a moon out, the women tend not to prepare food because they are menstruating. If they prepare food, then the food is seen to be unhealthy and those who eat it may fall ill.

Few students disagreed with the beliefs in this category, *Consequences involving nature*, the greatest being 30% (i.e. $D_2=18.5\%$ and $SD_1=11.5\%$) for 'When one is young and plant seeds, they will not bear a lot of fruit' (Item 4). Consistent with the previous two categories, a large percentage of students were undecided about the beliefs, ranging from 54.5% who were undecided about 'Darkness without the chirping of cicadas means the sun is out and it is getting light' (Item 24), and 50.6% for 'If a navel string (umbilical cord) is planted under a coconut tree, the tree will bear many fruits' (Item 10) to 9.6%, "The moon causes 'moonsick' or *papare eka* in women" (Item 38).

### 6.2.4 Category 4: Events involving spirits

The fourth category clustered items that deal with *events involving spirits*. Examples are 'If you cast a spell or *seseva* to move sand on *Pariva* beach, the sand will move to another part of the beach' (Item 23) and 'A full moon is also referred to as *lau lumori*, the young spirit woman who looks after and guides the moon' (Item 33). The percentages, mean and standard deviations of items for Category 4, *Events involving spirits*, of the Traditional Science Beliefs are shown in Table 6.5.

Over 50% (i.e.$SA_5=21.7\%$ and $A_4=28.7\%$) of the students believe that 'The sun is looked after by the tribal ancestor called *epe savora* (Item 34). During traditional times, *epe savora* was a honorific title given to one of the clans call the Savoripi clan.
PNG ancestors used to say that *epe savora* represented the time when the sun rises in the morning and shines throughout the whole day till it went down. This meant that villagers worked during the time when the sun was hot till it went down. *Epe Savora* is also the traditional term for *ivuta* or *iguana* which does not get scared of the sun’s heat. It sleeps and sticks to a tree during the day and does not run away till the sun goes down and continues to sleep on the tree till morning.

Table 6.5  Percentage responses, mean and standard deviation for Category 4, *Events involving spirits.*

<table>
<thead>
<tr>
<th>Belief statements</th>
<th>SA5</th>
<th>A4</th>
<th>U3</th>
<th>D2</th>
<th>SD1</th>
<th>Mean</th>
<th>Standard Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>9. Sweeping at night invites evil spirits into the house.</td>
<td>4.4</td>
<td>23.4</td>
<td>43.0</td>
<td>12.0</td>
<td>17.1</td>
<td>2.86</td>
<td>1.10</td>
</tr>
<tr>
<td>12. If you wake up in the morning with rashes at the corners of your lips, you may have seen a <em>karisu</em> or ghost the previous day.</td>
<td>5.7</td>
<td>15.9</td>
<td>39.5</td>
<td>22.3</td>
<td>16.6</td>
<td>2.72</td>
<td>1.10</td>
</tr>
<tr>
<td>13. If you don’t put charcoal into your soup or stew which is kept overnight, a <em>saukuru</em> or bush spirit will put its fingers in it and spoil it.</td>
<td>10.1</td>
<td>15.2</td>
<td>44.3</td>
<td>12.7</td>
<td>17.7</td>
<td>2.87</td>
<td>1.18</td>
</tr>
<tr>
<td>23. If you cast a spell or <em>seseva</em> to move sand on Pariva beach, the sand will move to another part of the beach.</td>
<td>23.4</td>
<td>32.3</td>
<td>25.3</td>
<td>12.0</td>
<td>7.0</td>
<td>3.53</td>
<td>1.17</td>
</tr>
<tr>
<td>32. To launch a boat, food should be prepared and offered to the spirits of our forefathers to seek their favour and good luck.</td>
<td>9.5</td>
<td>28.5</td>
<td>41.5</td>
<td>11.4</td>
<td>9.5</td>
<td>3.17</td>
<td>1.07</td>
</tr>
<tr>
<td>33. A full moon is also referred to as <em>lau lumori</em>, the young spirit woman who looks after and guides the Moon.</td>
<td>18.9</td>
<td>37.7</td>
<td>32.1</td>
<td>8.2</td>
<td>3.10</td>
<td>3.60</td>
<td>0.99</td>
</tr>
<tr>
<td>34. The Sun is looked after by the tribal ancestor called <em>epe savora</em>. <em>Epe savora</em> is the honorific title for the Savoripi clan and is the traditional term for <em>ivuta</em> or iguana.</td>
<td>21.7</td>
<td>28.7</td>
<td>37.6</td>
<td>7.6</td>
<td>4.5</td>
<td>3.55</td>
<td>1.05</td>
</tr>
</tbody>
</table>

Similar to the previous category, a small percentage of students disagreed with the beliefs about *Events involving spirits*. More than one third (38.4%) (i.e. D2=22.3% and SD1=16.1%) of students did not believe that ‘If you wake up in the morning with rashes at the corners of your lips, you may have seen a *karisu* or ghost the previous day’ (Item 12) and 30.4% (i.e. D2=12.7% and SD1=17.7%) did not believe that ‘If you don’t put charcoal into your soup or stew which is kept overnight, a *saukuru* or bush
spirit will put its fingers into it and spoil it' (Item 13). About 40% of the students were undecided about four items in this category, including items 12 and 13 and ‘To launch a boat, food should be prepared and offered to the spirits of our forefathers to seek their favour and good luck’ (Item 32) and ‘Sweeping at night invites evil spirits into the house’ (Item 9).

6.2.5 Differences among groups

Analysis of the responses for gender, grade and date of birth showed that there were no statistically significant differences for the group mean for the four categories of the Traditional Science Beliefs questionnaire. In terms of total scores on the questionnaire, there also were no statistically significant differences for gender (F=0.90, p>0.05), grade level (F=1.85, p>0.05), and date of birth (F=1.06, p>0.05).

6.3 Conclusion

The study revealed that approximately 50% of the students agreed with 19 out of the 40 belief statements. Of the four categories, more than 50% of the students agreed with belief statements for 3 items of consequences involving humans, 5 items involving certain events are life-threatening, 6 items involving consequences of nature and 3 items involving events involving spirits.

Among the four categories, a high percentage of students were undecided about holding or not holding traditional beliefs on 4 items involving consequences involving humans, 3 items involving certain events are life-threatening, 3 items of consequences involving nature, and 4 items involving events involving spirits. Most likely, these students were reluctant to show that they strongly believed in these belief statements but were not able to admit it as they thought it was too overwhelming and so rejected these statements. Of course, these students may have heard these ideas from their parents or grandparents who hold traditional beliefs. For example, magic spells (seseva) or sorcery (maeasiri) (pointing the bone) have been practised by village elders and then passed on to the younger generation. Examples are spells cast on betelnut trees to stop people from stealing and spells cast on the beach to move it
as a revenge of the death of a daughter or argument with village people. It is also likely that students who were undecided about holding or not holding traditional beliefs did not fully understand the belief statements that were written in English so were unable to decide which ones they strongly believed in. The relatively low percentage of students who disagreed with some of the statements may have heard these beliefs but oppose them because they think they are for the older people and not for the younger generation to hold onto in this modern world.

6.4 Summary

The students involved in this study came from different villages where they have spent a greater portion of their lives, including community school education. The beliefs they strongly hold may have originated from their social interactions with their grandparents and parents in the villages, their peers and the games they play. Although the students spent most of their secondary school education away from their villages, many still maintained these beliefs strongly when attending science classes. If the students, after formal science learning, still continue to hold such traditional beliefs, then it is likely the elders in the village community (with a large percentage being illiterate) still have power over these beliefs. This study identified traditional views that many students saw as being non-viable school views but views that they themselves could privately hold. Waldrip and Taylor (1999a) defined this separation of views and apparent de-valuing as compartmentalisation. It is contended that secondary school students use the different sources of explanations to help them explain and understand formal science concepts that they have heard used at home, in the family or village, in church, or at school. Chapter 7 discusses the sources of explanations that PNG secondary school students use in explaining and understanding natural phenomena.
CHAPTER 7

SECONDARY SCHOOL STUDENTS’ UNDERSTANDING OF NATURAL
PHENOMENA IN PAPUA NEW GUINEA:
SOURCES OF EXPLANATIONS

7.0 Overview of Chapter

The theme of this chapter is to present and describe the sources of secondary school students’ explanations and understanding of natural phenomena in Papua New Guinea (PNG). It is in response to Research Question 3: ‘What are the sources of explanations that secondary school students give for natural phenomena?’ The chapter describes the purpose, methods, designs and procedures of the questionnaire used in this study, and the results of these secondary school students’ responses to the sources of the statements on natural phenomena.

7.1 Purpose of the Study

The primary purpose of this study was to identify the sources of explanations and understanding of natural phenomena held by secondary school students in terms of their cultural, religious, personal and school science experiences. These explanations were related to spirits, spells and magic, personal experience, religion, and modern science. The analysis was based on the ideas, beliefs, explanations and interpretations from the analysis of the interviews with eight village elders. This study attempted to identify the situations (places) where students state that they had heard these explanations, whether at home, in the family or village, at school, church, or they have never heard of them been used.

7.2 Method, Design and Procedures

Four kinds of explanations: 1) spirits, magic spells and sorcery, 2) personal experiences, 3) religion, and 4) modern science based on the analysis of interviews
with eight village elders were used to solicit student responses to a questionnaire (Students Questionnaire 1: Sources of Explanations - see Appendix 3.2) consisting of 11 questions based on clouds, erosion and deposition, drought, plant growth, sun, moon, rain, thunder and lightning, rainbow, wind, and burning. Students were asked to respond by identifying the places (situations) where they had heard the explanations being used: 1) home/family/village; 2) school; 3) church; or 4) they have never heard them used. The questionnaire was administered to a sample of 185 students in Grades 7 (n=39), 8 (n=26), 9 (n=55) and 10 (n=65) ages 13 to 20 years in October 1998 at a rural high school in the Gulf Province. The administration time was 40 minutes with the researcher available to answer respondents' questions. However, the answering of the questionnaire did not pose any major problems.

Sample items: On the formation of clouds (Question1), ‘In the forest, water on the ground dries up and disappears as the hot sun heats it. It changes into steam and rises into the air. As it rises, it cools in the cool air in the sky. Then it becomes clouds’ (Item 1A-modern science). On clouds (Question 1) again; ‘A cloud is the soft hair of a spirit woman called lau lumori who guides and looks after the moon. Her soft hair is the cloud in the night sky that casts a shadow on the moon’ (Item 1D-spirits, magic spells and sorcery). On erosion and deposition (Question 5), ‘People cast spells or sesevu and utter magic words to move the sand on the beach in my village. As the seas water hits the sand, it makes the sand walk and move along the beach. The sand settles in the requested places and builds up’ (Item 5A-spirits, magic spells and sorcery). On erosion and deposition (Question 5) again, ‘The sand on the beach in my village gets eroded and deposited somewhere all the time. This is a punishment from God because the people do not worship God. If people worship God, then the beach will build up again on the beach’ (Item 5C - religion).

Statements for the items in the questionnaire were rotated in each question so that students did not automatically think, for example, that item A of every statement in the questions only referred to spirits, magic spells and sorcery. In nine of the questions, all the statements for the items were rotated so that they referred to spirits, magic spells and sorcery, personal experience, religion and modern science. The
other two questions had statements for items that only referred to either one or two of the four kinds of explanations.

Each of these items had a box which contained numbers (1 to 4) (see Appendix 7), at the end of each statement and students were asked to decide in which places they had heard these explanations being used by circling one of the numbers (1 to 4) provided in the boxes. The total sample used in this study was 185 students. All the students’ responses from the 185 questionnaires were coded and entered into a computer file and the data was analysed using a SPSS program (Coakes & Steed, 1999; Kirk, 1996) to obtain the frequencies. Students sometimes chose more than one location where they have heard the explanations, so the total number of responses is greater than the number of students which is 185. Consequently, there are more than 185 responses for most items. When the percentage of students is used, this means percentage of student respondents. This difference is noted at the end of the discussion of each statement. The analysis of the results is discussed as follows question by question.

7.3 Results and Discussion

This section describes how students responded when they were given four situations to choose from by identifying the place they have heard the explanations used for the natural phenomena.

7.3.1 Question 1: Clouds

Four statements (see Table 7.1) of explanations about clouds were given and students were asked to choose in which particular place they have heard these explanations being used.
Table 7.1 Students’ responses in percentages (and student numbers) to statements on clouds (Question 1) (n=185)

<table>
<thead>
<tr>
<th>Statements</th>
<th>Home/ family/ village</th>
<th>School</th>
<th>Church</th>
<th>Have not heard it used</th>
<th>More than one response</th>
</tr>
</thead>
<tbody>
<tr>
<td>1A. In the forest, water on the ground dries up and disappears as the hot sun heats it. It changes into steam and rises into the air. As it rises, it cools in the cool air in the sky. Then it becomes clouds.</td>
<td>2.7 (5)</td>
<td>90.4 (170)</td>
<td>0.5 (1)</td>
<td>1.1 (2)</td>
<td>5.3 (10)</td>
</tr>
<tr>
<td>1B. The wind helps to form clouds. Strong winds make the water evaporate faster. Strong winds also bring plenty of black clouds in the sky. This means that heavy rain is going to fall.</td>
<td>29.2 (54)</td>
<td>48.6 (90)</td>
<td>0.5 (1)</td>
<td>9.2 (17)</td>
<td>12.5 (24)</td>
</tr>
<tr>
<td>1C. God created the earth and everything in it. God created clouds so that the rain gives water to plants and animals. The water also cools the hot ground.</td>
<td>2.7 (5)</td>
<td>2.0 (4)</td>
<td>77.7 (146)</td>
<td>3.2 (6)</td>
<td>14.4 (27)</td>
</tr>
<tr>
<td>1D. A cloud is the soft hair of a spirit woman called tau lamori who guides and looks after the moon. Her soft hair is the cloud in the night sky that casts a shadow on the moon.</td>
<td>44.4 (83)</td>
<td>2.1 (4)</td>
<td>1.1 (2)</td>
<td>50.8 (95)</td>
<td>1.6 (3)</td>
</tr>
</tbody>
</table>

For statement 1A (modern science) to the question on clouds, 2.7% of the students (n=5) have heard it at home, in the family and in the village. Interestingly, the majority (90.4%) of the students (n=170) have heard it being used in school while 0.5% (n=1) have heard it in church. Another 1.1% of the students (n=2) have never heard of this explanation being used while 5.3% (n=10) gave more than one response.

For statement 1B (personal experience), 29.2% of the students (n=54) have heard it at home, in the family and in the village. Another 48.6% (n=90) have heard it being used at school while 0.5% of the students (n=1) have heard it in church. Finally, about 9.2% (n=17) of the students stated that they have never heard of this explanation being used while 12.4% (n=23) gave more than one response.
For statement 1C (religion) to the question on clouds, 2.7% of the students (n=5) have heard it at home, in the family and in the village. Another 2.0% (n=4) have heard it at school while the majority (77.7%) of the students (n=146) have heard it in church. Another 3.2% (n=6) have never heard this explanation being used while 14.4% (n=27) gave more than one response.

For statement 1D (spirits, magic spells and sorcery), 44.4% of the students (n=83) have heard it at home, in the family and in the village. Another 2.1% (n=4) have heard it at school while 1.1% of the students (n=2) have heard it in church. Interestingly over half (50.8%) of them (n=95) have never heard of this explanation being used. When students claim that they have never heard about something, it could be the result of religious education by which they think that it is uneducated to express verbally a belief in traditional ideas. Another reason is that they have not associated well with the elders and do not wish to identify publicly with traditional knowledge as it might make them appear to be uneducated. Another 1.6% (n=3) gave more than one response.

7.3.2 Question 2: Rain

Four statements (see Table 7.2) of explanations about rain were given and students were asked to choose in which particular place they have heard these explanations being used.

For statement 2A (modern science) to the question on rain, 7.4% of the students (n=14) have heard this explanation being used at home, in the family and in the village. The majority (82.4%) of students (n=155) have heard it in school while 0.5% (n=1) have heard it in church. Finally 3.7% of the students (7) stated that they have never heard of this explanation being used while another 5.9% (n=11) gave more than one response.

For statement 2B (spirits, magic spells and sorcery), interestingly the majority (81.4%) of the students (n=153) have heard this explanation been used at home, in the family and in the village. Another 3.2% (n=6) stated that they have heard it in
school while 0.5 % of the students (n=1) have heard it in church. Finally, another 11.7% of them (n=22) stated that they have never heard of this explanation being used while 3.2% (n=6) gave more than one response.

Table 7.2 Students’ responses in percentages (and student numbers) to statements on rain (Question 2) (n=185)

<table>
<thead>
<tr>
<th>Statements</th>
<th>Home/ family/village</th>
<th>School</th>
<th>Church</th>
<th>Have not heard it used</th>
<th>More than one response</th>
</tr>
</thead>
<tbody>
<tr>
<td>2A. The sun heats the water and changes into steam. The steam rises into the cool air, moves around and forms clouds. The wind blows the clouds into the mountains. As they get closer to the mountains, they become heavy and fall down as rain. The rainwater flows into rivers and down to the sea. The whole cycle starts over again.</td>
<td>7.4 (14)</td>
<td>82.4 (155)</td>
<td>0.5 (1)</td>
<td>3.7 (7)</td>
<td>5.9 (11)</td>
</tr>
<tr>
<td>2B. People cast and use spells to bring rain. As the spells are cast, the wind becomes strong and brings many black clouds. The rain falls to the ground with the help of the strong wind. During the rainy season, a fish called <em>salivera</em> appear living in a big rock at the mouth of the river. As the rainwater rises and covers the rock, the fish swim out, down the river and into the open sea.</td>
<td>81.4 (153)</td>
<td>3.2 (6)</td>
<td>0.5 (1)</td>
<td>11.7 (22)</td>
<td>3.2 (6)</td>
</tr>
<tr>
<td>2C. The wind brings many black clouds in the sky. As the black clouds bump into one another, they create lightning and thunder. This causes the clouds to break up into pieces and fall as rain. The rain gives water to plants and animals.</td>
<td>10.8 (20)</td>
<td>51.1 (95)</td>
<td>4.3 (8)</td>
<td>26.3 (49)</td>
<td>7.5 (14)</td>
</tr>
<tr>
<td>2D. God created clouds in order to bring rain to earth. It only rains when God wants it to rain. He causes it to rain so that plants and animals can survive. The water also helps to cool off the hot ground.</td>
<td>5.0 (9)</td>
<td>5.6 (10)</td>
<td>69.8 (125)</td>
<td>10.1 (18)</td>
<td>9.5 (17)</td>
</tr>
</tbody>
</table>

For statement 2C (personal experience) to the question on rain, 10.8% of the students (n=20) have heard it at home, in the family and in the village. Over half (51.1%) of the students (n=95) have heard it in school while 4.3% of them (n=8) have heard it in church. Finally, another 26.3% of the students (n=49) have never heard it being used while 7.5% (n=14) gave more than one response.
For statement 2D (religion), 5% of students (n=9) have heard it at home, in the family and in the village. Another 5.6% of the students (n=10) have heard it in school while over two thirds (69.8%) (n=125) have heard it in church; 10.1% of the students(18) stated that they have never heard of this explanation being used. Finally, another 9.5% (n=17) gave more than one response.

7.3.3 Question 3: Lightning/thunder

Four statements (see Table 7.3) of explanations about lightning and thunder were given and students were asked to choose in which particular place they have heard these explanations being used.

Table 7.3 Students’ responses in percentages (and student numbers) to statements on lightning/thunder (Question 3) (n=185)

<table>
<thead>
<tr>
<th>Statements</th>
<th>Home/ family/ village</th>
<th>School</th>
<th>Church</th>
<th>Have not heard it used</th>
<th>More than one response</th>
</tr>
</thead>
<tbody>
<tr>
<td>3A. People use and cast spells to make lightning and thunder. Good spirits gave these two wonders to people on earth as a gift and blessing. People use it to destroy things when other people make them angry.</td>
<td>67.6 (127)</td>
<td>2.1 (4)</td>
<td>4.8 (9)</td>
<td>21.8 (41)</td>
<td>3.7 (7)</td>
</tr>
<tr>
<td>3B. Two dark rain clouds quickly traveling in opposite directions bump into each other. As they bump, they heat the air up and make it hot. The air becomes so hot that it creates lightning and thunder.</td>
<td>12.2 (23)</td>
<td>36.7 (69)</td>
<td>1.1 (2)</td>
<td>45.2 (85)</td>
<td>4.8 (9)</td>
</tr>
<tr>
<td>3C. Lightning and thunder are both wonders of the world created by God. These two things are signs to scare people. They are signs to show people the great power of God.</td>
<td>5.9 (11)</td>
<td>0.5 (1)</td>
<td>64.2 (120)</td>
<td>23.0 (43)</td>
<td>6.4 (12)</td>
</tr>
<tr>
<td>3D. Lightning and thunder are both formed when dark rainy clouds move past one another at a fast rate. As they heat up the air, this forms thunder and lightning. The sound of lightning and thunder is like a drum being cracked, hit and rolled across the sky.</td>
<td>22.9 (43)</td>
<td>52.1 (98)</td>
<td>3.2 (6)</td>
<td>13.8 (26)</td>
<td>8.0 (15)</td>
</tr>
</tbody>
</table>
For statement 3A (spirits, magic spells and sorcery) to the question on lightning and thunder, over two thirds (67.6%) of the students (n=127) have heard it at home, in the family and in the village. Only 2 percent (n=4) have heard it at school while another 4.8% of the students (n=9) have heard it in church. Finally, 21.8% of the students (n=41) stated that they have never heard of this explanation being used while another 3.7% (n=7) gave more than one response.

For statement 3B (modern science), 12.2% of the students (n=23) have heard it at home, in the family and in the village. Over one third (36.7%) (n=69) have heard it in school while another 1.1% of the students (n=2) have heard it in school. Interestingly over one quarter (45.2%) of the students (n=85) have never heard of this explanation being used. When students claim that they have never heard something, it could be the result of not being able to fully understand how thunder and lightning are formed when they were taught this in their science lessons. Finally, another 4.8% (n=9) gave more than one response.

For statement 3C (religion) to the question on lightning and thunder, 5.9% of the students (n=11) have heard it at home, in the family and in the village. Another 0.5% (n=1) have heard it at school while over two thirds (64.2%) of the students (n=120) have heard it in church. Another 23% of the students (n=43) have never heard of this explanation being used. Again when students claim that they have not heard about something, it could be the result of religious education by which they think that it is uneducated to express verbally belief in traditional ideas. Finally, another 6.4% (n=12) gave more than one response.

For statement 3D (personal experience), 22.9% of the students (n=43) have heard it at home, in the family and in the village. Over half (52.1%) (n=98) have heard it at school while another 3.2% (n=6) have heard it in church. Finally, another 13.8% of the students (n=26) have never heard of this explanation being used before while 8% (n=15) gave more than one response.
7.3.4 Question 4: Rainbows

Four statements (see Table 7.4) of explanations on rainbow were given and students were asked to choose in which particular place they have heard these explanations being used.

For statement 4A (personal experience) to the question on rainbows, over one third (37.2%) of the students (n=70) have heard it being explained at home, in the family and in the village. Another 25.5% (n=48) have heard it in school while another 7.4% of the students (n=14) have heard it in church. Finally, 11.7% of the students (n=22) have never heard of it being explained while another 18.1% (n=34) gave more than one response.

For statement 4B (religion), 2.1% of the students (n=4) have heard it at home, in the family and in the village. Another 2.7% of the students (n=5) have heard it at school while the majority (73.9%) (n=139) have heard it in church. Another 11.7% of the students (n=22) stated that they have never heard of this explanation being used before while 9.6% (n=18) gave more than one response.

Table 7.4 Students’ responses in percentages (and student numbers) to statements on rainbows (Question 4) (n=185)

<table>
<thead>
<tr>
<th>Statements</th>
<th>Home/family/village</th>
<th>School</th>
<th>Church</th>
<th>Have not heard it used</th>
<th>More than one response</th>
</tr>
</thead>
<tbody>
<tr>
<td>4A. A rainbow is a colourful sign that appears after lightning and thunder have occurred. This also stops the rain from falling down.</td>
<td>37.2 (70)</td>
<td>25.5 (48)</td>
<td>7.4 (14)</td>
<td>11.7 (22)</td>
<td>18.1 (34)</td>
</tr>
<tr>
<td>4B. A rainbow is a colourful sign created by God. It is God’s promise to the people on earth that there will never be another Great Flood again.</td>
<td>2.1 (4)</td>
<td>2.7 (5)</td>
<td>73.9 (139)</td>
<td>11.7 (22)</td>
<td>9.6 (18)</td>
</tr>
<tr>
<td>4C. A rainbow is a colourful sign that appears in the sky. It means that heavy rain is coming.</td>
<td>17.0 (32)</td>
<td>8.0 (15)</td>
<td>2.7 (5)</td>
<td>69.1 (130)</td>
<td>3.2 (6)</td>
</tr>
<tr>
<td>4D. A rainbow is a colourful sign that appears during and after rainstorms. The rainbow appears when the sun’s light rays hit the steam (water vapour) from the rain in the air.</td>
<td>5.4 (10)</td>
<td>60.8 (113)</td>
<td>2.7 (5)</td>
<td>25.8 (48)</td>
<td>5.3 (10)</td>
</tr>
</tbody>
</table>
For statement 4C (personal experience) to the question on rainbows, 17% of the students (n=32) have heard it at home, in the family and in the village. Another 8% (n=15) have heard it in school while another 2.7% of the students (n=5) have heard it in church. Over two thirds (69.1%) of the students (n=130) stated that they have never heard this explanation being used. This may be related to their own experiences of living in an environment where there is always heavy rainfall during the rainy season between November and April. So if a rainbow appears during a rainstorm, this means that there is no more heavy rain coming. Finally, another 3.2% of the students (n=6) gave more than one response.

For statement 4D (modern science), 5.4% of the students (n=10) have heard it at home, in the family and in the village. Over two thirds (60.8%) (n=113) have heard it at school and another 2.7% (n=5) have heard it in church. Another 25.8% of the students (n=48) stated that they have never heard of this explanation being used. They do not see that it is the rays of sunlight that hit millions and millions of raindrops and their reflections from the raindrops forms the rainbow in the sky. Finally, another 5.4% of the students (n=10) gave more than one response.

7.3.5 Question 5: Erosion/deposition

Four statements (see Table 7.5) of explanations about erosion and deposition were given and students were asked to choose in which particular place they have heard this explanations being used.
Table 7.5  Students' responses in percentages (and student numbers) to statements on erosion and deposition (Question 5) (n=185)

<table>
<thead>
<tr>
<th>Statements</th>
<th>Home/family/village</th>
<th>School</th>
<th>Church</th>
<th>Have not heard it used</th>
<th>More than one response</th>
</tr>
</thead>
<tbody>
<tr>
<td>5A. People cast spells or <em>seseva</em> and utter magic words to move the sand on the beach in my village. As the sea water hits the sand, it makes the sand walk and move along the beach. The sand settles in the requested places and builds up.</td>
<td>74.1 (143)</td>
<td>1.0 (2)</td>
<td>18.7 (36)</td>
<td>3.1 (6)</td>
<td>3.1 (6)</td>
</tr>
<tr>
<td>5B. The changes in the wind's direction and tides cause the sand on the beach in my village to be eroded. This removes the sand and deposits it somewhere on the beach. The two processes helps to build up the sand on the beach in my village.</td>
<td>31.9 (60)</td>
<td>37.2 (70)</td>
<td>0.5 (1)</td>
<td>22.9 (43)</td>
<td>7.4 (14)</td>
</tr>
<tr>
<td>5C. The sand on the beach in my village gets eroded and deposited somewhere all the time. This is a punishment from God because the people do not worship God. If people worship God, then the sand will build up again on the beach.</td>
<td>12.4 (23)</td>
<td>0 (40)</td>
<td>40.0 (74)</td>
<td>41.1 (76)</td>
<td>6.5 (12)</td>
</tr>
<tr>
<td>5D. The currents from the rivers near my village have become weak. This is because trees are cut which fall into the river. As they fall in, they block off the flow of the river. This stops the eroded sand being taken down to the open sea. Therefore it does not help build up the sand on the beach in my village.</td>
<td>27.7 (52)</td>
<td>22.9 (43)</td>
<td>0.5 (1)</td>
<td>42.5 (80)</td>
<td>6.4 (12)</td>
</tr>
</tbody>
</table>

For statement 5A (spirits, magic spells and sorcery) of the question on erosion and deposition, over two thirds (74.1%) of the students (n=143) have heard the explanation being mainly used at home, in the family and in the village. Another one percent (n=2) have heard it being used in school and 18.7% (n=36) have heard it in church while 3.1% of the students (n=6) have not heard it being used. Finally, another 3.1% of the students (n=6) gave more than one response.

For statement 5B (modern science), nearly one third (31.9%) of the students (n=60) have heard it at home, in the family and in the village while over another one third (37.2%) of the students (n=70) have heard it being used in school. About 0.5% of the student (n=1) have heard it being used in church and 22.9% of the students
(n=43) have never heard of this explanation being used. This may be because students do not see natural forces at work, which erodes the sand on their beach and deposits it in another place. Students may be combining what they hear at school with what they have learnt at home. They could be substituting 'wind' for 'spirit' when they talk about this. Finally, another 7.4% of the students (n=14) gave more than one response.

For statement 5C (religion) of the question on erosion and deposition, 12.4% (n=23) have heard it being used at home, in the family and in the village. Another 40% (n=74) of the students have heard it being used in church while another 41.1% (n=76) never heard of this explanation being used. Most of the students do not believe that the sand on the beach in their villages gets eroded as a result of punishment from God. When students claim that they haven't heard about something, it could be that they think that it is uneducated to express verbally beliefs in traditional ideas. Finally, another 6.5% of the students (n=12) gave more than one response.

For statement 5D (personal experience), 27.7% of the students (n=52) have heard it used at home, in the family and in the village. Another 22.9% of the students (n=43) have heard it being used in schools while 0.5% of the student (n=1) have heard it in church. However, 42.6% of the students (n=80) have never heard of this explanation being used, which is very interesting. This stems from the fact that although they live close to their natural environment, they do not see natural forces at work eroding the sand on their beaches and depositing it in another place. Finally, another 6.4 % (n=12) gave more than one response.

7.3.6  Question 6: Moon

Four statements (see Table 7.6) of explanations about the moon were given and students were asked to choose in which particular place they have heard these explanations being used.
<table>
<thead>
<tr>
<th>Statements</th>
<th>Home/ family/village</th>
<th>School</th>
<th>Church</th>
<th>Have not heard it used</th>
<th>More than one response</th>
</tr>
</thead>
<tbody>
<tr>
<td>6A. In the past, some people believe that a young spirit woman called <em>tau tumori</em> guides and looks after the moon. Her soft hair is the cloud in the night sky that casts a shadow on the moon.</td>
<td>55.6 (104)</td>
<td>1.1 (2)</td>
<td>0.5 (1)</td>
<td>39.6 (74)</td>
<td>3.2 (6)</td>
</tr>
<tr>
<td>6B. Some Christian people believe that the sun represents the Father (God) or <em>Iehova Ualare</em>. The sun is hot as it rises which makes God also the supreme being. The moon represents the Son (Jesus Christ) or <em>Atua</em>. The stars represent the Holy Spirit or <em>Safa Arakoha Lareva</em>.</td>
<td>7.0 (13)</td>
<td>2.7 (5)</td>
<td>38.7 (72)</td>
<td>47.3 (88)</td>
<td>4.3 (8)</td>
</tr>
<tr>
<td>6C. My own observations of the moon tells me that it is a natural body in space. It has no light of its own. When the moon shines, it is really the reflecting light from the sun. The bright light on the moon is created by the sun's rays that falls on the moon.</td>
<td>7.5 (14)</td>
<td>61.8 (115)</td>
<td>1.6 (3)</td>
<td>25.3 (47)</td>
<td>3.8 (7)</td>
</tr>
<tr>
<td>6D. Some people believe that the moon represents each month of the calendar year. It controls weather patterns and tides. We get rain when there is a new moon every month during the rainy season.</td>
<td>39.8 (70)</td>
<td>31.3 (55)</td>
<td>0.6 (1)</td>
<td>15.3 (27)</td>
<td>13.0 (23)</td>
</tr>
</tbody>
</table>

For statement 6A (spirits, magic spells and sorcery) of the question on the moon, over half (55.6%) of the students (n=104) have heard it being used at home, in the family and in the village. Another 1.1% of them (n=2) have heard it at school while another 0.5% (n=1) have heard it in church. Over one third (39.6%) of the students (n=74) stated that they have never heard of this explanation being used which may be because they have not associated well with the elders and do not wish to identify publicly with traditional knowledge as it might make them appear to be uneducated. Finally, another 3.2% of the students (n=6) gave more than one response.

For statement 6B (religion), 7% of the students (n=13) have heard it at home, in the family and in the village. Another 2.7% of them (n=5) have heard it in school while
over one third (38.7%) (n=72) have heard it in church. Another 47.3% of the students (n=88) stated that they have never heard of this explanation being used while 4.3% (n=8) gave more than one answer.

For statement 6C (modern science) to the question on the moon, 7.5% of the students (n=14) have heard this explanation being used at home, in the family and in the village. Almost two thirds (61.8%) (n=115) have heard it at school while about 1.6% of them (n=3) have heard it in church. Another 25.3% of the students (n=47) stated that they have never heard of this explanation being used. This may be because these students may have not fully understood this explanation about the moon although they may have learnt it in their science lessons. Finally, another 3.8% of the students (n=7) gave more than one response.

For statement 6D (personal experience), over one third (39.8%) of the students (n=70) have heard it at home, in the family and in the village. Another 31.3% of them (n=55) have heard it at school while about 0.6% (n=1) have heard it in church. Another 15.3% of the students (n=27) stated that they have never heard of this explanation being used while 13.1% (n=23) gave more than one response.

7.3.7 Question 7: Sun

Four statements (see Table 7.7) of explanations about the sun were given and students were asked to choose in which particular place they have heard the explanations being used.

For statement 7A (modern science) of the question on sun, 5.4% of the students (n=10) have heard this explanation being used at home, in the family and in the village. Over two thirds (79.6%) of the students (n=148) have heard it being used in school while 2.2% of the students (n=4) have heard it in church. Finally, another 7% of the students (n=13) have never heard of this explanation being used while another 5.9% (n=11) gave more than one response.
For statement 7B (spirits, magic spells and sorcery) of the question on sun, over half (50.3%) of the students (n=94) have heard it being used at home, in the family and in the village. Another one percent of the students (n=2) have heard it being used in school and another one percent (n=2) in church also. Another 43.5% of the students (n=81) stated that they have never heard of this explanation being used. This may be because they have not associated well with the elders and do not wish to identify publicly with traditional knowledge, as it would make them appear to be uneducated. Finally, 3.8% of the students (n=7) gave more than one response.

Table 7.7  Students’ responses in percentages (and student numbers) to statements on the sun (Question 7) (n=185)

<table>
<thead>
<tr>
<th>Statements</th>
<th>Home/ family/ village</th>
<th>School</th>
<th>Church</th>
<th>Have not heard it used</th>
<th>More than one response</th>
</tr>
</thead>
<tbody>
<tr>
<td>7A. My everyday observations tells me that the sun follows different paths. This is due to the tilt of the earth from January to June and from July to December. Therefore the sun stays in one place. Our earth revolves around the sun.</td>
<td>5.4 (10)</td>
<td>79.6 (148)</td>
<td>2.2 (4)</td>
<td>7.0 (13)</td>
<td>5.8 (11)</td>
</tr>
<tr>
<td>7B. The sun is looked after by an ancestral spirit called <em>epe savora</em>. <em>Epe savora</em> is the tribal ancestor of the <em>Savoripi</em> clan. It is also the title of honor for menfolk of the clan. <em>Epe savora</em> helps direct the sun from sunrise to sunset.</td>
<td>50.5 (94)</td>
<td>1.1 (2)</td>
<td>1.1 (2)</td>
<td>43.5 (81)</td>
<td>3.8 (7)</td>
</tr>
<tr>
<td>7C. The sun was created by God in the beginning. The sun is hot and gives light and warmth to all plants and animals on earth. We depend on the sun because sunset means we can rest till morning. When the sun rises again, we wake up and go on with our daily work.</td>
<td>15.7 (29)</td>
<td>9.7 (18)</td>
<td>58.9 (109)</td>
<td>1.6 (3)</td>
<td>14.1 (26)</td>
</tr>
<tr>
<td>7D. The sun is like a very hot fire burning in a furnace. The sun does not stay in one place but visits many places. When the sun sets, that means it has gone to another part of the world.</td>
<td>14.2 (26)</td>
<td>41.5 (76)</td>
<td>1.1 (2)</td>
<td>35.5 (65)</td>
<td>7.7 (14)</td>
</tr>
</tbody>
</table>
For statement 7C (religion) of the question on sun, 15.7% of the students (n=29) have heard it being used at home, in the family and in the village. Another 9.7% of the students (n=18) have heard it being used in school and over half (58.9%) of the students (n=109) have heard this explanation being used in church. Finally, another 1.6% of the students (n=3) have not heard of this explanation being used while 14.1% (n=26) gave more than one response.

For statement 7D (personal experience) of the question on sun, 14.2% of the students (n=26) have heard it being used at home, in the family and in the village. Another 41.5% (n=76) have heard it being used in school while another 1.1% of the students (2) have heard it in church. Finally, over one third (35.5%) of the students (n=65) stated that they have never heard of this explanation being used while 7.7% (n=14) gave more than one response.

7.3.8 Question 8: Plant growth

Four statements (see Table 7.8) of explanations about plant growth were given and students were asked to choose in which particular place they have heard the explanations being used.
Table 7.8 Students’ responses in percentages (and student numbers) to statements on plant growth (Question 8) (n=185)

<table>
<thead>
<tr>
<th>Statements</th>
<th>Home/family/village</th>
<th>School</th>
<th>Church</th>
<th>Have not heard it used</th>
<th>More than one response</th>
</tr>
</thead>
<tbody>
<tr>
<td>8A. All plants grow because they take in water from the soil. The water gets into the soil after the rain has come down. When there is no water in the soil, the leaves of the plants fall off and they die.</td>
<td>5.3 (10)</td>
<td>73.3 (137)</td>
<td>0</td>
<td>4.8 (9)</td>
<td>16.6 (31)</td>
</tr>
<tr>
<td>8B. Some Christian people believe that when God created the earth, he also created plants and trees. Plants grow because God cares for them. God provides the sun to help plants grow.</td>
<td>5.9 (11)</td>
<td>7.0 (13)</td>
<td>64.7 (121)</td>
<td>8.0 (15)</td>
<td>14.4 (27)</td>
</tr>
<tr>
<td>8C. Some seedlings are dispersed by animal with the help of water, wind and animals. The seedlings grow into large trees when there is enough water and good fertile soil.</td>
<td>8.1 (15)</td>
<td>67.2 (125)</td>
<td>3.2 (6)</td>
<td>11.3 (21)</td>
<td>10.2 (19)</td>
</tr>
<tr>
<td>8D. Plants grow from seeds from bird droppings in an area. They also grow from seeds, which fall from big trees to the ground. They grow well in fertile soil with plenty of water.</td>
<td>26.7 (48)</td>
<td>54.4 (98)</td>
<td>2.2 (4)</td>
<td>3.9 (7)</td>
<td>12.8 (23)</td>
</tr>
</tbody>
</table>

For statement 8A (modern science) of the question on plant growth, 5.3% of the students (n=10) have heard it being used at home, in the family and in the village. The majority (73.3%) (n=137) have heard it in school while another 4.8% of them (n=9) have not heard it being used before. Finally, another 16.6% of the students (n=31) gave more than one response.

For statement 8B (religion), 5.9% of the students (n=11) have heard it at home, in the family and in the village. Another 7% (n=13) have heard it in school while over two thirds (64.7%) of them (n=121) have heard it in church. Another 8% of the students (n=15) stated that they have never heard it being used while 14.4% (n=27) gave more than one response.

For statement 8C (modern science) to the question on plant growth, 8.1% of the students (n=15) have heard it being used at home, in the family and in the village. Interestingly over two thirds (67.2%) of them (n=125) have heard it being used in
school while another 3.2% (n=6) have heard it in church. Finally, another 11.3% of the students (n=21) stated that they have never heard it being used while 10.2% (n=19) gave more than one response.

For statement 8D (modern science), 26.7% of the students (n=48) have heard it being used at home, in the family and in the village. Over half (54.4%) of them (n=98) have heard it being used in school while another 2.2% (n=4) have heard it in church. Finally, another 3.9% of them (n=7) stated that they have never heard of it being used while 12.8% (n=23) gave more than one response.

7.3.9 Question 9: Drought

Four statements (see Table 7.9) of explanations on drought were given and students were asked to choose in which particular place they have heard these explanations being used.

For statement 9A (personal experience) to the question on drought, over one third (32.2%) of the students (n=59) have heard it at home, in the family and in the village. Again over one third (33.3%) of them (n=61) have heard it at school while 0.5% of the students (n=1) have heard it in church. Another 16.4% of them (n=30) stated they have never heard of it being used. When students claim that they have not heard something, this may mean that they did not understand the explanation given here as it typifies a situation that although they live close to their natural environment, they are not able to see and identify clearly nature at work. Finally, another 17.5% (n=32) gave more than one response.

For statement 9B (modern science), over one third (33.3%) of the students (n=61) have heard it at home, in the family and in the village. Again over one third (35.5%) of them (n=65) have heard it at school while another 1.6% (n=3) have heard it in church. Finally, another 15.3% of the students (n=28) have never heard of this explanation being used while 14.3% (n=26) gave more than one response.
For statement 9C (religion) to the question on drought, 14.8% of the students (n=27) have heard it at home, in the family and in the village. Another 2.7% of them (n=5) have heard it in school while over half (56%) of the students (n=102) have heard it in church. Finally, another 11.5% of the students (n=21) stated that they have never heard it being used while 14.8% (n=27) gave more than one response.

Table 7.9 Students' responses in percentages (and student numbers) to statements on drought (Question 9) (n=185)

<table>
<thead>
<tr>
<th>Statements</th>
<th>Home/family/village</th>
<th>School</th>
<th>Church</th>
<th>Have not heard it used</th>
<th>More than one response</th>
</tr>
</thead>
<tbody>
<tr>
<td>9A. The start of the dry season from June to October each year means there is a drought. This is also the start of the strong winds, the south-east winds and north-west winds. During this time the sea is rough with high tides. People do not usually plant food crops in their gardens around this time.</td>
<td>32.2 (59)</td>
<td>33.3 (61)</td>
<td>0.5 (1)</td>
<td>16.4 (30)</td>
<td>17.6 (32)</td>
</tr>
<tr>
<td>9B. A continuous period of little or no rain means there is a drought. When this happens the demand for water is greater than the amount available. In areas where drought is short-lived, there is loss of food crops and the use of water is restricted.</td>
<td>33.3 (61)</td>
<td>35.5 (65)</td>
<td>1.6 (3)</td>
<td>15.3 (28)</td>
<td>14.3 (26)</td>
</tr>
<tr>
<td>9C. Some people believe a drought is a sign and punishment from God. This is because most people have turned against God and are doing evil and wicked things. A drought is also a sign that we are nearing the year 2000.</td>
<td>14.8 (27)</td>
<td>2.7 (5)</td>
<td>56.0 (102)</td>
<td>11.5 (21)</td>
<td>14.8 (27)</td>
</tr>
<tr>
<td>9D. In the past, the drought means the start of the dry season or pisahu usually around May or June. At this time village people cut and burn forests and built new fences around their new gardens. The actual dry season with the severe heat from the sun starts around August to October. It is usually very dry this time of the year because there is no rain.</td>
<td>55.4 (102)</td>
<td>12.5 (23)</td>
<td>1.6 (3)</td>
<td>16.8 (31)</td>
<td>13.6 (25)</td>
</tr>
</tbody>
</table>

For statement 9D (personal experience), over half (55.4%) of the students (n=102) have heard it at home, in the family and in the village. Another 12.5% (n=23) have heard it in school while another 1.6% (n=3) have heard it in church. Another 11.5% of the students (n=31) stated that they have never heard it being used. Again this is
because they may not have associated with the village elders and do not wish to identify publicly with traditional knowledge as it might make them appear to be uneducated. Finally, 13.6% (n=25) gave more than one response.

7.3.10 Question 10: Burning

Four statements (see Table 7.10) of explanations about burning were given and students were asked to choose in which particular place they have heard these explanations being used.

Table 7.10 Students’ responses in percentages (and student numbers) to statements on burning (Question 10) (n=185)

<table>
<thead>
<tr>
<th>Statements</th>
<th>Home/family/village</th>
<th>School</th>
<th>Church</th>
<th>Have not heard it used</th>
<th>More than one response</th>
</tr>
</thead>
<tbody>
<tr>
<td>10A. Village people in the past cut forests and bush towards the end of the dry season. They cleared the bush to plant new gardens. As the bush dried, they burnt it. This made the ground bare so that they can dig the soil and plant their food crops. Burning helped because the ash from the burnt materials made the soil fertile. As a result food crops grew strong and healthy with water from the rain during the rainy season.</td>
<td>56.5 (104)</td>
<td>19.6 (36)</td>
<td>1.1 (2)</td>
<td>2.7 (5)</td>
<td>20.1 (37)</td>
</tr>
<tr>
<td>10B. In the past people cleared and burnt the bush to clear their pathways. They also burnt the bush to chase harmful animals away. Burning also gets rid of rubbish and makes the place clean.</td>
<td>52.7 (96)</td>
<td>17.0 (31)</td>
<td>1.6 (3)</td>
<td>9.9 (18)</td>
<td>18.7 (34)</td>
</tr>
<tr>
<td>10C. Burning occurs because village people have differences and arguments or because someone has been caught stealing. They light fires to destroy each other’s food gardens, betelnut trees and sago palms etc. As a result, other people’s gardens and cash crops are destroyed in the burning process.</td>
<td>66.1 (121)</td>
<td>7.7 (14)</td>
<td>2.2 (4)</td>
<td>19.1 (35)</td>
<td>4.9 (9)</td>
</tr>
<tr>
<td>10D. In the past, village people cleared and burned the forest to let more light in. Burning the bush materials as a result produces ash, which fertilises the soil. Food crops grow well as the soil is fertile and contains water from the rain.</td>
<td>33.7 (59)</td>
<td>31.4 (55)</td>
<td>3.4 (6)</td>
<td>19.4 (34)</td>
<td>12.0 (21)</td>
</tr>
</tbody>
</table>
For statement 10A (personal experience) to the question on drought, over half (56.5%) of the students (n=104) have heard it at home, in the family and in the village. Another 19.6% of them (n=36) have heard it in school while about 1.1% of the students (n=2) have heard it in church. Finally, another 2.7% of them (n=5) stated that they have never heard of it being used while another 20.1% (n=37) gave more than one response.

For statement 10B (personal experience), over half (52.7%) of the students (n=96) have heard it at home, in the family and in the village. Another 17% of them (n=31) have heard it in school while another 1.6% (n=3) have heard it in church. Finally, another 9.9% of the students (n=18) stated that they have never heard it being used while another 18.7% (n=34) gave more than one response.

For statement 10C (personal experience) to the question on drought, almost two thirds (66.1%) of the students (n=121) have heard it at home, in the family and in the village. Another 7.7% of them (n=14) have heard it in school while another 2.2% of the students (n=4) have heard it in church. Another 19.1% (n=35) stated that they have never heard of it being used. Finally, another 4.9% (n=9) gave more than one response.

For statement 10D (personal experience), over one third (33.7%) of the students (n=59) have heard it at home, in the family and in the village. Again about one third (31.4%) of them (n=55) have heard it in school while another 3.4% of the students (n=6) have heard it in church. Another 19.4% of them (n=34) stated that they have never heard it being used. Finally, another 12% (n=21) gave more than one response.

7.3.11 Question 11: Wind

Four statements (see Table 7.11) of explanations about wind were given and students were asked to choose in which particular place they have heard these explanations being used.
For statement 11A (modern science) to the question on wind, 10.9% of the students (n=20) have heard it being used at home, in the family and in the village. Over half (55.7%) of the students (n=102) have heard it in school while another 0.5% (n=1) have heard it in church. Finally, another 22.4% of the students (n=41) stated that they have never heard it being used while another 10.4 % (n=19) gave more than one response.

For statement 11B (religion), 15.2% of the students (n=28) have heard it at home, in the family and in the village. Another 2.7% of them (n=5) have heard it at school while over half (53.8%) of them (n=99) have heard it in church. Finally, another 14.1% of the students (n=26) stated that they have never heard of this explanation being used while the same percentage (n=26) gave more than one response.

Table 7.11 Students’ responses in percentages (and student numbers) to statements on wind (Question 11) (n=185)

<table>
<thead>
<tr>
<th>Statements</th>
<th>Home/family/village</th>
<th>School</th>
<th>Church</th>
<th>Have not heard it used</th>
<th>More than one response</th>
</tr>
</thead>
<tbody>
<tr>
<td>11A. Large masses of moving air are set in motion by the even heating of the earth’s surface. When there is strong wind, there are plenty of clouds in the sky.</td>
<td>10.9 (20)</td>
<td>55.7 (102)</td>
<td>0.5 (1)</td>
<td>22.4 (41)</td>
<td>10.4 (19)</td>
</tr>
<tr>
<td>11B. Large masses of strong moving air are created and formed by God or Iehova Ualare. This strong wind sometimes blow peoples’ houses down and destroy food gardens. This is to punish wicked people because of their sinful activities on earth.</td>
<td>15.2 (28)</td>
<td>2.7 (5)</td>
<td>53.8 (99)</td>
<td>14.1 (26)</td>
<td>14.1 (26)</td>
</tr>
<tr>
<td>11C. Moving air masses are set in motion by the uneven heating of the earth’s surface. When the wind is strong, it brings many black clouds and heavy rain.</td>
<td>17.5 (32)</td>
<td>56.3 (103)</td>
<td>3.3 (6)</td>
<td>12.6 (23)</td>
<td>10.4 (19)</td>
</tr>
<tr>
<td>11D. Moving air masses are created and formed by spirits or mearovaeka arahohoa to warm the earth’s surface. Sometimes strong winds bring many black clouds with heavy rain. The heavy rains can cause flooding and landslides.</td>
<td>44.8 (82)</td>
<td>16.4 (30)</td>
<td>6.0 (11)</td>
<td>21.3 (39)</td>
<td>11.5 (21)</td>
</tr>
</tbody>
</table>
For statement 11C (personal experience) to the question on wind, 17.5% of the students (n=32) have heard it at home, in the family and in the village. Over half (56.3%) of them (n=103) have heard it in school while about 3.3% (n=6) have heard it in church. Finally, another 12.6% of the students (n=23) stated that they have never heard of it being used while another 10.4% (n=19) gave more than one response.

For statement 11D (spirits, magic spells and sorcery), 44.8% of the students (n=82) have heard it at home, in the family and in the village. Another 16.4% of them (n=30) have heard it in school while another 6% (n=11) have heard it in church. Another 21.3% of the students (n=39) stated that they have never heard it being used. Again this may be because they have not associated well with the elders and do not wish to identify publicly with traditional knowledge as it might make them appear to be uneducated. Students may be combining what they hear at school with what they have learnt at home. They could be substituting ‘wind’ for ‘spirits’ when they talk about this. Finally, another 11.5% (n=21) gave more than one response.

7.4 Student Responses in Relation to Categories

In this study, all secondary school students' responses to the eleven questions were tallied in terms of the sources from which they obtained their ideas of these explanations, whether these were 1) home/village/family, 2) school, 3) church, or 4) they have never heard of these explanations being used. The greatest student responses to the statements for each explanation are summarised under each of these four categories as follows.

7.4.1 Category 1: Home/village/family

The following examples are illustrative of the various explanations given by secondary school students on natural phenomena that they have heard been used at home, in the village and family. These explanations mostly likely exist because the students have associated more with their parents, grandparents who may have an influence in passing on the various explanations on natural phenomena based on spirits, spells and magic.
On clouds (Question 1), 44.4% of the students (n=83) chose the explanation ‘A cloud is the soft hair of a spirit woman called lau lumori who guides and looks after the moon. Her soft hair is the cloud in the night sky that casts a shadow on the moon’ (Item 1D-spirits, magic spells and sorcery).

On rain (Question 2), 81.4% of the students (n=153) chose the explanation ‘People cast and use spells to bring rain. As the spells are cast, the wind becomes strong and brings many black clouds. The rain falls to the ground with the help of the strong wind. During the rainy season, a fish called salivera (salmon) appear living in a big rock at the mouth of the river. As the rain water rises and covers the rock, the fish swim out, down the river and into the open sea’ (Item 2B-spirits, magic spells and sorcery).

On lightning and thunder (Question 3) 67.6% of the students (n=127) chose the explanation ‘People use and cast spells to make lightning and thunder. Good spirits gave these two wonders to people on earth as a gift and blessing. People use it to destroy things when other people make them angry’ (Item 3A-spirits, magic spells and sorcery).

On rainbows (Question 4), 37.2% of the students (n=70) chose the explanation ‘A rainbow is a colourful sign that appears after lightning and thunder have occurred. This also stops the rain from falling down’ (Item 4A-personal experience).

On erosion and deposition (Question 5), 74.1% of the students (n=143) chose the explanation ‘People cast spells or seseva and utter magic words to move the sand on the beach in my village. As the sea water hits the sand, it makes the sand walk and move along the beach. The sand settles in the requested places and builds up’ (Item 5A-spirits, magic spells and sorcery).

On moon (Question 7), 55.6% of the students (n=104) chose the explanation ‘In the past, some people believe that a young spirit woman called lau lumori guides and looks after the moon. Her soft hair is the cloud in the night sky that casts a shadow on the moon’ (Item 6A-spirits, magic spells and sorcery).
On the sun (Question 7), 50.5% of the students (n=94) chose the explanation ‘The sun is looked after by an ancestral spirit called epe savora. Epe savora is the tribal ancestor of the Savoripi clan. It is also the title of honor for menfolk of the clan. Epe savora helps direct the sun from sunrise to sunset (Item 7B-spirits, magic spells and sorcery).

On plant growth (Question 8), 26.7% of the students (n=48) chose the explanation ‘Plants grow from seeds from bird droppings in an area. They also grow from seeds, which fall from big trees to the ground. They grow well in fertile soil with plenty of water’ (Item 8D-modern science). However, more than half of the students (54.4%) have heard the explanation at school.

On drought (Question 9), 55.4% of the students (n=102) chose the explanation ‘In the past, the drought means the start of the dry season or pisahu usually around May or June. At this time village people cut and burn forests and built new fences around their new gardens. The actual dry season with the severe heat from the sun starts around August to October. It is usually very dry this time of the year because there is no rain’ (Item 9D-personal experience).

On burning (Question 10), 56.5% of the students (n=104) chose the explanation ‘Village people in the past cut forests and bush towards the end of the dry season. They cleared the bush to plant new gardens. As the bush dried, they burnt it. This made the ground bare so that they can dig the soil and plant their food crops. Burning helped because the ash from the burnt materials made the soil fertile. As a result food crops grew strong and healthy with water from the rain during the rainy season’ (Item 10A-personal experience). Again on burning (Question 10), 52.7% of the students (n=96) chose the explanation ‘In the past people cleared and burnt the bush to clear their pathways. They also burnt the bush to chase harmful animals away. Burning also gets rid of rubbish and makes the place clean’ (Item 10B-personal experience). Again on burning (Question 10), 66.1% of the students (n=121) chose the explanation ‘Burning occurs because village people have differences and arguments or because someone has been caught stealing. They light fires to destroy each other’s food gardens, betel nut trees and sago palms etc. As a
result, other people’s gardens and cash crops are destroyed in the burning process (Item 10C-personal experience). Finally on burning (Question 10), 33.7% of the students (n=59) chose the explanation ‘In the past, village people cleared and burned the forest to let more light in. Burning the bush materials as a result produces ash, which fertilises the soil. Food crops grow well as the soil is fertile and contains water from the rain’ (Item 10D-personal experience). All these statements relate to personal experience.

On wind (Question 11), 44.8% of the students (n=82) chose the explanation ‘Moving air masses are created and formed by spirits or mearoaeka arahoha to warm the earth’s surface. Sometimes strong winds bring many black clouds with heavy rain. The heavy rains can cause flooding and landslides’ (Item 11D-spirits, magic spells and sorcery).

7.4.2 Category 2: School

The majority of school-aged students chose scientific explanations of natural phenomena in terms of what they had learned in school or from their personal experiences and continuous interactions with their natural environment. The following examples are illustrative of the various explanations given by secondary school students on natural phenomena that they have learned in school science and from their own experiences with the natural environment.

On clouds, (Question 1), 90.4% of the students (n=170) chose the explanation ‘In the forest, water on the ground dries up and disappears as the hot sun heats it. It changes into steam and rises into the air. As it rises, it cools in the cool air in the sky. Then it becomes clouds’ (Item 1A-modern science). Again on clouds (Question 1), 48.6% of the students (n=90) chose the explanation; ‘The wind helps to form clouds. Strong winds make the water evaporate faster. Strong winds also bring plenty of black clouds in the sky. This means that heavy rain is going to fall (Item 1B-personal experience).
On rain (Question 2), 82.4% of the students (n=155) chose the explanation ‘The sun heats the water and changes into steam. The steam rises into the cool air, moves around and forms clouds. The wind blows the clouds into the mountains. As they get closer to the mountains, they become heavy and fall down as rain. The rain water flows into rivers and down to the sea. The whole cycle starts over again (Item 2A-modern science). On rain (Question 2) again, 51.1% of the students (n=95) chose the explanation ‘The wind brings many black clouds in the sky. As the black clouds bump into one another, they create lightning and thunder. This causes the clouds to break up into pieces and fall as rain. The rain gives water to plants and animals (Item 2C-personal experience).

On thunder and lightning (Question 3), over half (52.1%) of the students (n=98) chose the explanation ‘Lightning and thunder are both formed when dark rainy clouds move past one another at a fast rate. As they heat up the air, this forms thunder and lightning. The sound of thunder and lighting is like a drum being cracked, hit and rolled across the sky’ (Item 3D-personal experience).

On rainbows (Question 4), over two thirds (60.8%) of the students (n=113) chose the explanation ‘A rainbow is a colourful sign that appears during and after rainstorms. The rainbow appears when the sun’s light rays hit the steam (water vapour) from the rain in the air’ (Item 4D-modern science).

On erosion and deposition (Question 5), over one third (37.2%) of the students (n=70) stated they had learnt the following explanation at school or from their own personal experiences. ‘The changes in the winds direction and tides cause the sand on the beach in my village to be eroded. The two processes helps built up the sand on the beach in my village’ (Item 5B-personal experience).

On the moon (Question 6), over two thirds (61.8%) of the students (n=115) chose the explanation ‘My own observations of the moon tells me that it is a natural body in space. It has no light of its own. When the moon shines, it is really the reflecting light from the sun. The bright light on the moon is created by the sun’s rays that fall on the moon’ (Item 6C-modern science).
For the sun (Question 7), over two thirds (79.6%) of the students (n=148) again stated that they had learnt the following explanation at school and from their own experiences. 'My everyday observations tell me that the sun follows different paths. This is due to the tilt of the earth from January to June and from July to December. Therefore the sun stays in one place. Our earth revolves around the sun' (Item 7A-modern science).

On plant growth (Question 8), 73.3% of the students (n=137) chose the explanation 'All plants grow because they take in water from the soil. The water gets into the soil after the rain has come down. When there is no water in the soil, the leaves of the plants fall off and they die' (Item 8A-modern science). On plant growth again (Question 8), over two thirds (67.2%) of the students (n=125) chose the explanation 'Some seedlings are dispersed by animal with the help of water, wind and animal. The seedlings grow into large trees when there is enough water and good fertile soil' (Item 8C-modern science). On plant growth again, 54.4% of the students (n=98) chose the explanation 'Plants grow from seeds from bird droppings in an area. They also grow from seeds, which fall from big trees to the ground. They grow well in fertile soil with plenty of water' (Item 8D-modern science).

On drought (Question 9), over one third (35.5%) of the students (n=65) chose the explanation 'A continuous period of little or no rain means there is a drought. When this happens the demand for water is greater than the amount available. In areas where drought is short-lived, there is loss of food crops and the use of water is restricted' (Item 9B-modern science).

On burning (Question 10), over one third (31.4%) of the students (n=55) chose the explanation that they have learnt at school or from their own personal experience. 'In the past, village people cleared and burnt the forest to let more light in. Burning the bush materials as a result produces ash, which fertilises the soil. Food crops grow well as the soil is fertile and contains water from the rain' (Item 10D-personal experience).
Finally on wind (Question 11), over half (56.3%) of the students (n=103) chose the explanation ‘Moving air masses are set in motion by the uneven heating of the earth’s surface. When the wind is strong, it brings many black clouds and heavy rain’ (Item 11C-personal experience). Again on wind (Question 11), 55.7% of the students (n=102), chose the explanation ‘Large masses of moving air are set in motion by the even heating of the earth’s surface. When there is strong winds, there are plenty of clouds in the sky’ (Item 11A-modern science).

7.4.3 Category 3: Church

The following examples are illustrative of the various explanations given by secondary school students on natural phenomena, which they have heard in church. These responses may have been dominated and influenced by the Christian religion and also their attendance at church services.

On clouds (Question 1), 77.7% of the students (n=146) chose the following explanations ‘God created the earth and everything in it. God created clouds so that the rain gives water to plants and animals. The water also cools the hot ground’ (Item 1C-religion).

On rain (Question 2), over two thirds (69.8%) of the students (n=125) chose the explanation ‘God created clouds in order to bring rain to earth. It only rains when God wants it to rain. He causes it to rain so that plants and animals can survive. The water also helps to cool off the hot ground’ (Item 2D-religion).

On lightning and thunder (Question 3), over two thirds (64.2%) of the students (n=120) chose the explanation ‘Lightning and thunder are both great wonders of the world created by God. These two things are signs to scare people. They are signs to show people the great power of God’ (Item 3C-religion).

On rainbows (Question 4), 73.9% of the students (n=139) chose the explanation ‘A rainbow is a colourful sign created by God. It is God’s promise to the people on earth that there will never be another Great Flood again’ (Item 4B-religion).
For erosion and deposition (Question 5), 40% of the students (n=74) chose the explanation ‘The sand on the beach in my village gets eroded and deposited somewhere all the time. This is a punishment from God because the people do not worship God. If people worship God, then the sand will build up again on the beach’ (Item 5C-religion).

On the moon (Question 6), over one third (38.7%) of the students (n=72) chose the explanation ‘Some Christian people believe that the sun represents the Father (God) or Jehovah Ualare. The sun is hot which makes God also the Supreme Being. The moon represents the Son (Jesus Christ) or Atute. The stars represent the Holy Spirit or Safu Arahoha Lareva’ (Item 6B-religion).

On the sun (Question 7), over half (58.9%) of the students (n=109) chose the explanation ‘The sun was created by God in the beginning. The sun is hot and gives light and warmth to all plants and animals on earth. We depend on the sun because sunset means we can rest till morning. When the sun rises again, we wake up and go off to our daily work’ (Item 7C-religion).

On plant growth (Question 8), over two thirds (64.7%) of the students (n=121) chose the explanation ‘Some Christian people believe that when God created the earth, he also created plants and trees. Plants grow because God cares for them. God provides the sun to help plants grow’ (Item 8B-religion).

On drought (Question 9), over half (56%) of the students (n=102) chose the explanation ‘Some people believe a drought is a sign and punishment from God. This is because most people have turned against God and are doing evil and wicked things. A drought is also a sign that we are nearing the year 2000’ (Item 9C-religion).

On wind (Question 11), over half (53.8%) of the students (n=99) chose the explanation ‘Large masses of air are created and formed by God or Jehovah Ualare. This strong wind sometimes blow peoples’ houses down and destroy food gardens.'
This is to punish wicked people because of their sinful activities of earth’ (Item 11B-religion).

7.4.4 Category 4: Have never heard the explanations been used

The following examples are illustrative of the various explanations on natural phenomena that secondary school students have not heard. When students claim that they have never heard explanations about something, it could be the result of religious education by which they think that it is uneducated to express belief in traditional ideas. Also when students claim that they have not heard something explained, it could be the result of not understanding the explanations of natural phenomena in science lessons. If students are referring to beliefs such as spirits, magic spells and sorcery, then this may be because they have not associated well with the elders and do not wish to identify publicly with traditional knowledge as it might make them appear to be uneducated.

On clouds (Question 1), 50.8% of the students (n=95) stated that they had never heard the explanation ‘A cloud is the soft hair of a spirit woman called lau lumori who guides and looks after the moon. Her soft hair is the cloud in the night sky that casts a shadow on the moon’ (Item 1D-spirits, magic spells and sorcery).

On lightning and thunder (Question 3), 45.2% of the students (n=85) stated that they had never heard the explanation ‘Two dark rain clouds quickly travelling in opposite directions bump into each other. As they bump, they heat the air up and make it hot. The air becomes so hot that it creates lightning and thunder (Item 3B-modern science).

On rainbows (Question 4), 69.1% of the students (n=130) stated that they had never heard the explanation ‘A rainbow is a colourful sign that appears in the sky. It means that heavy rain is coming’ (Item 4C-personal experience).

On erosion and deposition (Question 5), 41.1% of the students (n=76) stated that they had never heard the explanation ‘The sand on the beach in my village gets
eroded and deposited somewhere all the time. This is a punishment from God because the people do not worship God. If people worship God, then the sand will build up again on the beach' (Item 5C-religion). On erosion and deposition (Question 5) again, 42.6% of the students (n=80) stated that they had never heard the explanation 'The currents from the rivers near my village have become weak. This is because trees are cut which fall into the river. As they fall in, they block off the flow of the river. This stops the eroded sand being taken down to the open sea. Therefore it does not help build up the sand on the beach in my village' (Item 5D-personal experience).

On the moon (Question 6), 39.6% of the students (n=74) stated that they had never heard the explanation 'In the past, some people believe that a young spirit woman called lau lumori guides and looks after the moon. Her soft hair is the cloud in the night sky that casts a shadow on the moon' (Item 6A-spirits, magic spells and sorcery). On the moon (Question 6) again, 47.3% of the students (n=88) stated that they had never heard the explanation 'Some Christian people believe that the sun represents the Father (God) or Jehovah Ualare. The sun is hot as it rises which makes God also the Supreme Being. The moon represents the Son (Jesus Christ) or Atate. The stars represent the Holy Spirit or Safu Arahoha Lareva (Item 6B-religion).

On the sun (Question 7), 43.5% of the students (n=81) stated that they had never heard the explanation 'The sun is looked after by an ancestral spirit called epe savora. Epe savora is the tribal ancestor of the Savoripi clan. It is also the title of honor for menfolk of the clan. Epe savora helps direct the sun from sunrise to sunset' (Item 7B-spirits, magic spells and sorcery). On the sun (Question 7) again, 35.5% of the students (n=65) stated that they had never heard the explanation 'The sun is like a very hot fire burning in a furnace. The sun does not stay in one place but visits many places. When the sun sets, that means it has gone to another part of the world' (Item 7D-personal experience).

On wind (Question 11), 22.4% of the students (n=41) stated that they had never heard the explanation 'Large masses of moving air are set in motion by the even heating of the earth's surface. When there is strong wind, there are plenty of clouds
in the sky' (Item 11A-modern science). Again on wind (Question 11), 21.3% of the students (n=39) stated that they had never heard the explanation ‘Moving air masses are created and formed by spirits or mearoavaela arahoha to warm the earth’s surface. Sometimes strong winds bring many black clouds with heavy rain. The heavy rains can cause flooding and landslides’ (Item 11D-spirits, magic spells and sorcery).

7.5 Summary

In response to Research Question 3: ‘What are the sources of explanations that secondary school students give for natural phenomena?’, the sources of the explanations identified by these 185 students in this study were largely dependent on context referring to spirits, spells, and magic, and religion in providing explanations of natural phenomena in the home, family and village, and scientific explanations from school or from their own personal experiences within their natural environment. It seems that the sources of explanations identified by many students when referring to spirits, spells and magic did agree with those given by the village elders described in Chapter 5. This illustrates the fact that elders from the Gulf Province still may influence beliefs such as magic spells, spirits and sorcery. Similarly, students in this study may come from families with grandparents who have such beliefs as they have stated that they have heard explanations that relate to spirits and magic spells at home, in the family and in the village. Furthermore, parents of these students may know of these stories from the elders and so are able to pass them on to their children.

A few explanations referred to the church as the source which is because most students come from families where the Christian religion is strong and practised everyday. This is the result of the early influence of the missionaries of the London Missionary Society (LMS) who may have taught several of the village elders in the study discussed in Chapter 5. An elder, who is religious has power and influence over traditional beliefs and may discard them for religious beliefs.
Most secondary school-aged students identified the source of scientific explanations of natural phenomena in terms of what they had learnt at school or from their personal experiences and interactions with their natural environment. This can be seen from the way they perceive, interpret and explain their own natural environment and surroundings. This is also because they have lived closely within their natural environment and so are able to give explanations within and from their own perspective and perception which complements with those of science.

However, many had heard explanations of the same phenomena about spirits, spells and magic that came from the village, in the family and home. This study revealed that students identified the source of ideas to explain natural phenomena that they have heard at home, in the family and village, religious knowledge in church, and their science and personal knowledge in the school setting. It is likely that their explanations based on their own traditional knowledge cannot be identified in a school setting but that this may be identified by interviews or questionnaires in the students' local language be given to students in their villages (as opposed to school). In addition, so as not to diminish the value of this traditional knowledge, science education programs are needed that are able to consider and harmonise traditional knowledge with school science. As this chapter identified and described the sources of explanations PNG secondary school students use in explaining natural phenomena, Chapter 8 will describe the various types of explanations these students use in explaining and understanding natural phenomena.
CHAPTER 8

SECONDARY SCHOOL STUDENTS’ UNDERSTANDING OF
NATURAL PHENOMENA IN PAPUA NEW GUINEA:
TYPES OF EXPLANATIONS

8.0 Overview of Chapter

The theme of this chapter is to present and describe the various types of explanations used by secondary school students’ in explaining and understanding natural phenomena in Papua New Guinea (PNG). It is in response to Research Question 4: ‘What types of explanations do secondary PNG school students give for natural phenomena?’ In this chapter, the purpose of this study, methods, designs and procedures precede the results and discussions of the types of explanations that secondary school students’ use in response to the open-ended questions (Student Questionnaire 2: Types of Explanations Used) on natural phenomena.

Secondary school students give various types of explanations to describe and explain scientific concepts. In this study, students were asked to give answers to open-ended questions on natural phenomena. The students’ answers are classified into categories reflecting the percentages (and number of students) against the different types of responses and explanations. A category of failure to respond or explain, if included, refers to responses such as ‘don’t know’, ‘no idea’ or ‘did not answer’ (did not give a written response). The researcher considers that this mode of presentation provides a cohesive record of the investigation as most of it is descriptive in nature. This chapter has been written in a style to ensure that what is data, and what is interpretation or comment will be obvious from the text. The researcher’s intention was to survey a variety of stimulus events about natural phenomena, previously described in the section on ‘questionnaires’ in Chapter 4.
8.1 Purposes of the study

The primary purpose of this study was to investigate the various ideas and explanations about natural phenomena held and used by a sample of 153 secondary school students. The researcher’s intention was to survey a variety of stimulus events about natural phenomena, previously described in the section on ‘questionnaires’ in Chapter 4. The major interest in this investigation was not directed towards the correctness of a response or an explanation, but towards the nature of the response itself, for example, whether it suggested a physical or non-physical explanation of a phenomena. Furthermore, the study sought to identify the ideas and explanations of the students in the sample. Hence, the data presented are mainly descriptive in terms of frequencies and percentages.

8.2 Method, Design and Procedures

The Student Questionnaire 2: Types of Explanations Used (see Appendix 4.3) for this study contained open-ended questions on erosion, deposition, plant growth, rain, thunder, lightning, rainbow, moon, sun, wind, clouds and drought. Students were asked to write down their responses to the questions on natural phenomena on the questionnaire. The questionnaire was written in English and administered in a science classroom where the language of instruction was English, however each student spoke as many as four local languages in their village communities. The questionnaire was administered to a sample of 153 students from Grades 7 (n=15), 8 (n=39), 9 (n=66) and 10 (n=33) with ages ranging from 13 to 20 years in October 1998 at a rural high school in the Gulf Province. The administration time for this questionnaire took about 200 minutes (one double period and two single periods over two weeks interposed by three days per administration) with the researcher available to answer respondents’ questions on all occasions. However, the answering of the questionnaires did not pose any major problems.

The analysis of the responses to the questionnaire was tedious and time consuming. The analysed data was entered and stored into a computer file (see section 4.7 Data Analysis in Chapter 4). Follow-up interviews were conducted with 9 students (six
Grade 9s and three Grade 10s) and recorded on audio tape in order to justify and support the various responses to the questions in the open-ended questionnaire. It was decided to interview only the senior grades because of the favourable written responses given by the students in the questions. Also the senior students displayed a favourable command of English so we were able to express themselves clearly and meaningfully. The analysis of the responses to the open-ended questionnaire is discussed in the following section.

The 153 questionnaires with the students’ responses were analysed and an attempt was made to learn how much the students understood in terms of the various questions asked on the above natural phenomena. Responses were categorised in terms of the nature or the types of explanations or descriptions. The textual data, which contained the transcripts of students’ responses were analysed and some systematic patterns or relationships among categories were discovered (see phenomenological data analysis in Chapter 4).

An example of the questions used in the Student Questionnaire 2: Types of Explanations Used is on erosion (Question 1): ‘In their science lessons, students may have heard and used the word ‘erosion’ to help explain various activities within their natural surrounding. The first part of the question asked students to give the Toaripi meaning or word for ‘erosion’. The second part asked students to describe in their own words what erosion is. The final part asked students that an old person might have told them that someone in their village can make the sand move on the beach to another place. This person may cast magic spells or use seseva to move the sand and place it on another part of the beach. They were asked if they think this can happen and give a reason as to why (see Appendix 4.3). The sections below discuss the types of responses to all the questions in the form of short descriptions and the cumulative data represented in tables as percentages and number of students across the four grades. A category of failure to respond or explain if included refers to responses such as ‘don’t know’, ‘did not answer - no written response’, ‘no idea’ or ‘not sure’.
8.3 Results and Discussions

8.3.1 Erosion

Students were asked if, in their science lessons, they may have heard and used the word erosion to help explain various activities within their natural surrounding.

a) The first part of the question asked students to give the Toaripi meaning or word for erosion. Forty-six students (29.8%) gave the meaning similar to mea ma sa ovi soeai (soil carried away by water) and mea faveai = [verb transitive - of water, rivers, sea to wash away (beach, banks) to erode soil]. Twenty-nine students (18.6%) gave other meanings such as favi (of soil sand, to dig up and foforukai (fall into pieces). Eighty-one students (51.7%) did not give the Toaripi meaning or word for erosion.

This was especially noticeable among 40 of the Grade 9 students (26%). These students may be fluent in their own language but cannot easily interpret the meaning into English. Table 8.1 shows the types of students’ responses within the grades. A majority of the students in Grade 10 (11%) (n=17) who are Toaripi speakers were able to give the Toaripi meaning except for the lower grades.

<table>
<thead>
<tr>
<th>Type of response</th>
<th>Grade levels</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>7</td>
</tr>
<tr>
<td>Mea ma sa ovi soeai/mea faveai.</td>
<td>0 (0)</td>
</tr>
<tr>
<td>Favil/foforuka.</td>
<td>3 (5)</td>
</tr>
<tr>
<td>Did not answer/don’t know.</td>
<td>6 (10)</td>
</tr>
</tbody>
</table>

These students have attended primary school in their villages and high school away from their villages and all speak Toaripi, yet it is interesting to see that students give different range of meanings for the concept ‘erosion’. It is evident from the responses that the older students (Grade 10) tend to speak and understand the language better than the younger students (Grades 7, 8 and 9). The older students were able to interpret the definition of the concept erosion from the English meaning into the
Toaripi meaning. This can be seen in Table 8.1 where the younger students [10 Grade 7s (6%), 18 Grade 8s (11.7%) and 40 Grade 9s (26%)] gave a response stating that they may not know, were not sure, or did not attempt an answer to the concept ‘erosion’. The reason may be either they did not know the meaning or they were unable to define the meaning in English first and then interpret it later into Toaripi and then actually write it fully out in Toaripi. Another reason is that probably the younger students speak Toaripi fluently and are unable to write it. Also they may not have fully understood the concept from explanations given by their teachers in earlier grades.

b) The second part of the question asked students to describe erosion in their own words. Sixty-nine students (45%), mainly from Grade 9 (19.6%) (n=30) stated ‘soil washed away by water, rain or flood’ while ten students (6.2%) gave other responses such as ‘water that comes up surrounding the house’. Seventy-four students (48.3%) did not give a response to the question. Table 8.2 shows students’ responses within the four grades.

In the interviews conducted with the students, all nine stated that erosion is the washing away of top soil by fast flowing water, rain and wind. A sample interview conducted with a Grade 10 male student, Sari illustrates this. When asked to explain the meaning of erosion, Sari stated, “Erosion is something to do with the soil. There are so many ways that soil erosion takes place. Sometimes the wind blows it away” and that “sometimes erosion takes place when there is rain and the soil is washed away by rain.”

Table 8.2  Percentages (and students numbers) of types of responses to the question: ‘Describe erosion in your own words.’

<table>
<thead>
<tr>
<th>Type of explanation</th>
<th>Grade levels</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>7</td>
</tr>
<tr>
<td>Soil washed away by water, rain or flood.</td>
<td>0 (0)</td>
</tr>
<tr>
<td>Water that comes up surrounding the house etc.</td>
<td>2.0 (3)</td>
</tr>
<tr>
<td>Did not answer/don’t know.</td>
<td>7.8 (12)</td>
</tr>
</tbody>
</table>
c) The third part of the question asked students about an old person telling them that someone in their village can make the sand move to another part of the beach. This person may cast magic spells or use seseva to move the sand. Then the students were asked if they thought this could happen and give a reason as to why. A 'yes' response was made by 63 students (41.1%) who stated that this old person may be angry with someone for stealing his things or the old person's relatives may be involved in a fight so he takes revenge. Also some village people do not respect village elders or they may be jealous. An interesting response given by a student who experienced it in 1994 when an old man who came from a different village got married to an old woman from the student's village. When the old woman died, the old man said some magic spells and the beach in the student's village went right inside. A 'no' response was made by 37 students (24.4%) who stated that they have never heard such stories like this before and have not seen it with their own eyes. Furthermore, they also said that they do not believe in magic and that sometimes traditional stories are not true as these are natural processes working and only God can remove it, not man. Fifty-three students (34.5%) did not give a response to the question. Table 8.3 shows the students' responses across the four grades.

In the interviews conducted with the students, five students (four Grade 9s and one Grade 10) had this experience and stated that these people might be angry with some people from another village. They also stated that when there is a fight, these things happen as it is their custom and belief. The sample interview with a Grade 9 male student, Sabath, acknowledged that an old person may use magic spells, "Because when you make magic spells, the sea will be rough and when it breaks on the beach, once it goes back, it takes the sand with it." When asked by the researcher whether it was the old people or young people that are doing this, Sabath stated that "old people who have got this magic spells" but acknowledged that "it is a bit hard to understand and the language they use is quite hard."
Table 8.3  Percentages (and student numbers) of types of responses to the question: 'An old village person might have told you that someone in your village can make the sand move on the beach to another place. This person may cast magic spells or use seseva to move the sand and place it on another part of the beach. Do you think this can happen?..... Why?.....'

<table>
<thead>
<tr>
<th>Type of response</th>
<th>Grade levels</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>7</td>
<td>8</td>
</tr>
<tr>
<td>Yes. This person may be angry for stealing his things, this person's relatives may be involved in a fight, village people have no respect or this person and because of jealousy.</td>
<td>3.2 (5)</td>
<td>12.4 (19)</td>
</tr>
<tr>
<td>No. Never heard of stories like this, don't believe in magic, traditional stories are not true and it is a natural process only God can move the sand.</td>
<td>3.2 (5)</td>
<td>5 (7)</td>
</tr>
<tr>
<td>Did not answer/don't know.</td>
<td>3.2 (5)</td>
<td>8.5 (13)</td>
</tr>
</tbody>
</table>

Four students (two Grade 9s and two Grade 10s) interviewed were not sure about magic spells because erosion is something like nature or it can happen like during rainy season, when rain falls, it causes erosion. Soro, a Grade 9 male student, stated that “because erosion, it's something like nature. Like when rain falls, it causes erosion.”

8.3.2 Deposition

Students were asked if, in their science lessons, they may have heard and used the word deposition to help explain various activities in nature.

a) The first part of this question asked students to give the Toaripi meaning or word for deposition. Thirty-two students (20.9%) gave the meaning starting with mea (soil), mea ma sa ovi se mai ve ape voa eavi lea iri voa la miri posa la uriai foromai vei (water carries the soil down to the mouth of the river and lets it settle there and builds up the beach). If deposition was defined within a Toaripi context then it would mean 'mea ma sa toa ti eta mea everave arori voa eata ou topiari loi (soil hit
by water and then taken and deposited onto the top of the previous layer). Another ten students (6.6%) gave other meanings such as orai (boil), miri posa (sand bank), mipairoi (to plant). One hundred and eleven students (72.4%), mainly Grade 9s (35.3%) (n=54), did not give a response to this question. This is because most of them could not identify what the Toaripi meaning for deposition was which they could not interpret easily into English. Table 8.4 shows students’ responses within the four grades.

Table 8.4 Percentages (and student numbers) of types of responses to the question: ‘Give the Toaripi meaning or word for deposition.’

<table>
<thead>
<tr>
<th>Type of response</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mea ma sa ovi simai voa eavi iri voa la miri posa la uriai foromai vei (water carries the soil down to the mouth of the river and lets it settle and build up the beach).</td>
<td>3.3 (5)</td>
<td>4.6 (7)</td>
<td>6.5 (10)</td>
<td>6.5 (10)</td>
<td>20.9 (32)</td>
</tr>
<tr>
<td>Orai (boil), miri posa (sand bank), mipairoi (to plant).</td>
<td>1.3 (2)</td>
<td>2.0 (3)</td>
<td>1.3 (2)</td>
<td>2.0 (3)</td>
<td>6.6 (10)</td>
</tr>
<tr>
<td>Did not answer/don’t know.</td>
<td>5.2 (8)</td>
<td>18.9 (29)</td>
<td>35.3 (54)</td>
<td>13.0 (20)</td>
<td>72.4 (111)</td>
</tr>
</tbody>
</table>

b) The second part of this question asked students to give the meaning of deposition in their own words. Sixty-six students (43.2%), mainly Grade 9s (21.2%) (n=31), stated that deposition is ‘the building up of soil carried down by river’ or ‘when eroded soil come to a certain place’. They also said ‘settling down of materials caused by erosion and deposited at the mouth of river’. Another thirty-six (24.3%) gave other meanings such as ‘something to change’ or ‘washing away soil’ or ‘an object or thing not in correct position to where it was’ or ‘caused when factories throw waste into river’ or ‘adding nutrients to the soil’ and ‘when you want your money to be kept at the bank’. Over one third (33.2%) of the students (n=42) did not give a response to the question, which is evident among Grade 8s (n=24) and 9s (n=23). Table 8.5 shows students’ responses across the four grades.

In the interviews conducted with the students, six (four Grade 9 and two Grade 10) stated that deposition is the settling of soil in one place or when the water comes
down near the mouth of the river, it leaves the soil and flows out into the ocean. A sample interview with Sarea, a Grade 9 male student illustrates this. When asked by the researcher what deposition means, Sarea stated, “deposition is soil or sand that is being washed away by flood or river, washed away by river and it is carried down to the corner or a hollow place and it is heaped up to form land.”

The other three students (two Grade 9s and a Grade 10) gave other meanings. For example, one stated that ‘deposition is the washing away of soil’ while the other stated that ‘deposition is an object or anything which is not in a correct position where it was’. The third student was not sure of the meaning of deposition.

Table 8.5 Percentages (and student numbers) of types of responses to the question: ‘Describe in your own words what deposition is.’

<table>
<thead>
<tr>
<th>Type of response</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>‘Building up of soil carried down by river/when eroded soil come to a certain place, settling down of materials caused by erosion and deposits at mouth of river.'</td>
<td>3.3 (5)</td>
<td>4.5 (7)</td>
<td>20.3 (31)</td>
<td>15.0 (23)</td>
<td>43.2 (66)</td>
</tr>
<tr>
<td>‘Something to change/washing away of soil/an object not in correct position to where it was/caused when factories throw waste into river’</td>
<td>4.8 (7)</td>
<td>5.2 (8)</td>
<td>7.8 (12)</td>
<td>5.9 (9)</td>
<td>23.7 (36)</td>
</tr>
<tr>
<td>Did not answer/don’t know</td>
<td>2.0 (3)</td>
<td>15.6 (24)</td>
<td>15.0 (23)</td>
<td>0.6 (1)</td>
<td>33.2 (42)</td>
</tr>
</tbody>
</table>

c) The third part of the question asked students about a young villager telling them that he or she can cast magic spells or use seveva to move the sand and deposit it on another part of the beach in their villages. Then they were asked if they believed that this person can do it and to give a reason why. Twenty-eight students (18.2%) said ‘yes’ and stated that this person may be angry with the people collecting shellfish or fishing in the river or all the village people know this person can do it as he or she has got the spirit of magic spells so he or she can be a powerful magician. Fifty-three students (34.6%) said ‘no’ and stated that they have not seen anybody doing this as
this person is too young to use magic so he cannot do it; only God can as it occurs naturally and they do not believe in seseva. Finally, 72 students (47.1%) did not give a response to the question. Table 8.6 shows students’ responses across the four grades.

In the interviews with the students, four (two Grade 9s and two Grade 10s) said ‘yes’ and stated that they have had this experience, especially Lucy, a Grade 9 female student who stated that “I have noticed this type of things happening in my village near the water front where it is deep now and shallow before.” Another Grade 9 student stated that because his grandparents used magic spells to destroy other sorcerers land when their grandchildren died. A Grade 10 female student stated that people do these things because they have the spirit of magic to remove the sand.

A Grade 10 male student stated that it happens sometimes but he has not seen it. The other 5 students (four Grade 9s and a Grade 10) said ‘no’ and two Grade 9 students stated that they have never seen anybody doing it so they do not believe in magic. One of them stated that it is something that happens in nature and and when rain falls, deposition will always take place. Three (two Grade 9s and a Grade 10) stated that they were not sure of the response to this question.

Table 8.6  Percentages (and student numbers) of types of responses to the question: ‘A young villager may have told you that he/she can cast magic spells or use seseva to move the sand and deposit it on another place of the beach in your village. Do you think this person can do it?. Why?.....’

<table>
<thead>
<tr>
<th>Type of response</th>
<th>Grade levels</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>7</td>
<td>8</td>
</tr>
<tr>
<td>Yes. Angry with people collecting shellfish or fishing in the river/all the village people know this person can do it/he has got the spirit of magic spells/he can be a powerful magician.</td>
<td>1.3 (2)</td>
<td>5.2 (8)</td>
</tr>
<tr>
<td>No. They have seen anybody doing this/young to use magic/he cannot do it only God can/occurs naturally/do not believe in seseva</td>
<td>5.2 (8)</td>
<td>5.2 (8)</td>
</tr>
<tr>
<td>Did not answer/don’t know</td>
<td>3.3 (5)</td>
<td>15.0 (23)</td>
</tr>
</tbody>
</table>
8.3.3 *Plant growth*

Students were asked if they might have helped their parents to cut and clear the forest to make place for new gardens during their school holidays. Did they help their parents to plant new food crops like yams, taro, sweet potato and banana. Did they also notice that new plants had started to grow in the place where they helped to clear all the trees and bush.

a) The first part of the question asked students to give the *Toaripi* meaning or word for plant growth. Seventy students (45.8%), mostly 28 Grade 9s (18.3%) gave the meaning *etou/tola mere ve asai, itoi ta mai*. Three students (2%) gave the meaning *larietou* (food)/ou *choipi* while 83 students (52.3%) did not give an answer, as they were not able to identify and interpret the *Toaripi* meaning clearly. Table 8.7 shows the students’ responses within the four grades.

<table>
<thead>
<tr>
<th>Type of response</th>
<th>Grade levels</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>7</td>
</tr>
<tr>
<td><em>Etou/tola mere ve asai, itoi ta mai.</em></td>
<td>4.6 (7)</td>
</tr>
<tr>
<td><em>Larietou</em> (food)/ou <em>choipi.</em></td>
<td>0 (0)</td>
</tr>
<tr>
<td>Did not answer/don’t know.</td>
<td>5.2 (8)</td>
</tr>
</tbody>
</table>

b) The second part of the question asked students to describe plant growth in their own words. Ninety-six students (62.87%) gave the description ‘plants grow from seeds, roots, cuttings and shoots with the help of sunlight, water and nutrients from the soil.’ Seventeen students (11.1%) described plant growth as those planted by people in a fence while some grow by themselves. Also plant growth was described as a process which plants get big from being small. Finally, 40 students (26.1%) did not give a response as they did not know or attempt the answer to this question. Table 8.8 shows the students’ responses within the four grades.
Table 8.8  Percentages (and student numbers) of types of responses to the question: 'Describe in your own words how plants grow.'

<table>
<thead>
<tr>
<th>Type of response</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plants grow from seeds, roots, cuttings and shoots which the help of sunlight, water and nutrients in the soil.</td>
<td>5.9 (9)</td>
<td>13.7 (21)</td>
<td>31.4 (48)</td>
<td>11.8 (18)</td>
<td>62.8 (96)</td>
</tr>
<tr>
<td>Plants are grown by people in a fence while some grow by themselves. Also plant growth is a process in which plants get big from being small.</td>
<td>0 (0)</td>
<td>5.2 (8)</td>
<td>3.3 (5)</td>
<td>2.6 (4)</td>
<td>11.1 (17)</td>
</tr>
<tr>
<td>Did not answer/don't know.</td>
<td>3.9 (6)</td>
<td>6.5 (10)</td>
<td>8.5 (13)</td>
<td>7.2 (11)</td>
<td>26.1 (40)</td>
</tr>
</tbody>
</table>

From the interviews conducted with the students, five (three Grade 9s and two Grade 10s) stated that plants grow from the stem, branches and seeds. The other four (three Grade 9s and a Grade 10) did not give the correct responses. The sample interview with Sarea, a Grade 9 male student, illustrates that plants grow from seeds; he stated that "plants grow like a flower" and that "it bears fruit and has seeds".

c) The third question asked students about what makes plants grow? One hundred and twenty-seven students (82.9%) stated that "plants grow from seedlings and the stem and the roots take in water and nutrients from the soil with the help of sunlight to make the plant grow". Only four students (2.7%) stated that there are so many ways to grow plants by building shelter to protect sunshine, plants bear fruit and give us shade. Finally, 22 students (14.4%) did not give a response to the question. Table 8.9 show the students' responses within the four grades.

Table 8.9  Percentages (and student numbers) of types of responses to the question: 'What makes plants grow?'

<table>
<thead>
<tr>
<th>Type of response</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grow by seedling, stems and the roots take in water and nutrients from the soil with the help of sunlight.</td>
<td>6.4 (10)</td>
<td>20.9 (32)</td>
<td>36.6 (56)</td>
<td>19 (29)</td>
<td>82.9 (127)</td>
</tr>
<tr>
<td>So many ways to grow plants by building shelter to protect sunshine. Plants bear fruit and give us shade.</td>
<td>0 (0)</td>
<td>0.7 (1)</td>
<td>1.3 (2)</td>
<td>0.7 (1)</td>
<td>2.7 (4)</td>
</tr>
<tr>
<td>Did not answer/don't know.</td>
<td>3.3 (5)</td>
<td>3.9 (6)</td>
<td>5.2 (8)</td>
<td>2 (3)</td>
<td>14.4 (22)</td>
</tr>
</tbody>
</table>
All nine students interviewed stated that plants grow with the help of sunlight, water and nutrients or mineral salts from the soil. For example, Lucy a Grade 9 female student, stated that “plants grow by the use of water and the help of the mighty sunlight” and that they needed a lot of nutrients, water and sunlight which make them bear beautiful flowers and fruit.”

d) The last part of the question asked students about how they can make plants grow better. One hundred and twenty-one students (79.1%), mostly 52 Grade 9s (34%), stated that they could make plants grow better by adding fertilisers (manures), nutrients and watering them. Eight students (5.3%) stated that by looking after them, cutting grass and cleaning around them, making plots and fences to keep animals and human beings out will make plants grow better. Finally, 24 students (15.6%) did not give a response to the question. Table 8.11 show the students’ responses within the four grades.

Table 8.10 Percentages (and student numbers) of types of responses to the question: ‘How can you make plants grow better?’

<table>
<thead>
<tr>
<th>Type of response</th>
<th>Grade 7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adding fertilisers, manures, nutrients and watering them.</td>
<td>5.2 (8)</td>
<td>22.9 (35)</td>
<td>34 (52)</td>
<td>17 (26)</td>
<td>79.1 (121)</td>
</tr>
<tr>
<td>By looking after them, cutting grass and cleaning around them, making plots and fences to keep animals out.</td>
<td>1.3 (2)</td>
<td>0.7 (1)</td>
<td>3.3 (5)</td>
<td>0 (0)</td>
<td>5.3 (8)</td>
</tr>
<tr>
<td>Did not answer/don’t know</td>
<td>2.6 (4)</td>
<td>5.2 (8)</td>
<td>5.2 (8)</td>
<td>2.6 (4)</td>
<td>15.6 (24)</td>
</tr>
</tbody>
</table>

8.3.4 Rain

The description on rain stated that during rainy season, we see rain falling down from the sky. This is a time when there is plenty of water to wash with and drink.

a) The first part of this question asked students to give the Toaripi word or meaning for rain. One hundred and thirty-four students (87.6%), mostly 58 Grade 9s (37.9%), gave the correct term for rain as lai. This is because students are fully aware of the
huge amount of rain that falls in their villages which floods the villages situated near and at the mouths of two big rivers called the Lake Kamu and Taure. The other 19 students (12.4%) of the students did not give a response to the question as they did not know the Toaripi word or term for rain. Table 8.11 show the students’ responses within the four grades.

Table 8.11  Percentages (and student numbers) of types of responses to the question: ‘Give the Toaripi meaning or word for rain.’

<table>
<thead>
<tr>
<th>Type of response</th>
<th>Grade levels</th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>7</td>
<td>8</td>
<td>9</td>
<td>10</td>
<td>Total</td>
</tr>
<tr>
<td><code>Lai auai.</code></td>
<td>8.5 (13)</td>
<td>19.6 (30)</td>
<td>37.9 (58)</td>
<td>21.6 (33)</td>
<td>87.6 (134)</td>
</tr>
<tr>
<td>Did not answer/don’t know.</td>
<td>1.3 (2)</td>
<td>5.9 (9)</td>
<td>5.2 (8)</td>
<td>0 (0)</td>
<td>12.4 (19)</td>
</tr>
</tbody>
</table>

b) The second part of this question asked students to explain in their own words how rain comes. One hundred and twenty students (78.4%), mostly 52 Grade 9s (34%) stated that dark clouds bring rain and that water heated by the sun from the sea, lakes and transpiration from plants which goes up into the sky to form clouds and falls as rain again. The other 20 students (13.2%) stated that rain comes from the sky during wet seasons brought by the south-east and north-west winds. Thirteen students (8.4%) did not give a response to the question. Table 8.12 show the students’ responses within the four grades.

Table 8.12  Percentages (and student numbers) of types of responses to the question: ‘In your own words, explain how rain comes.’

<table>
<thead>
<tr>
<th>Type of response</th>
<th>Grade levels</th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>From black clouds when water heated by the sun from sea, lakes and transpiration</td>
<td>7</td>
<td>8</td>
<td>9</td>
<td>10</td>
<td>Total</td>
</tr>
<tr>
<td>which goes up into the sky and forms clouds and falls as rain again.</td>
<td>7.8 (12)</td>
<td>19.6 (30)</td>
<td>34.0 (52)</td>
<td>17.0 (26)</td>
<td>78.4 (120)</td>
</tr>
<tr>
<td>Comes from the sky during the wet season brought by the southeast and northwest</td>
<td>2.0 (3)</td>
<td>5.9 (9)</td>
<td>3.3 (5)</td>
<td>2.0 (3)</td>
<td>13.2 (20)</td>
</tr>
<tr>
<td>winds.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Did not answer/don’t know.</td>
<td>0 (0)</td>
<td>0 (0)</td>
<td>5.8 (9)</td>
<td>2.6 (4)</td>
<td>8.4 (13)</td>
</tr>
</tbody>
</table>
c) The third part of this question asked students about where rain comes from. Ninety-six students (62.8%) stated that rain comes from clouds through the processes of evaporation, transpiration, condensation and precipitation (water cycle). Forty-four (28.7%) stated that rain comes from the sky or heaven or air and comes with the wind or when thunder and lightning strike on the other side of the mountain. The other 13 students (8.5%) did not give a response to the question. Table 8.13 show the students’ responses across the four grades.

Table 8.13: Percentages (and student numbers) of types of responses to the question: ‘Where does rain come from?’

<table>
<thead>
<tr>
<th>Type of response</th>
<th>Grade levels</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>7</td>
</tr>
<tr>
<td>From clouds through the process of evaporation, transpiration, condensation, precipitation (water cycle).</td>
<td>4.6 (7)</td>
</tr>
<tr>
<td>From the sky or heaven or air and comes with the wind or when lightning and thunder strike on the other side of the mountains.</td>
<td>4.5 (7)</td>
</tr>
<tr>
<td>Did not answer/don’t know.</td>
<td>0.7 (1)</td>
</tr>
</tbody>
</table>

All nine students interviewed stated that rain comes from dark, black clouds when water evaporates from the sea, rivers and swamps. In the interview with Sari, a Grade 10 male student, he states that “rain comes from clouds, and sometimes, the clouds are really from when water is evaporating from the sea, rivers, swamps whatsoever and then they are formed together as clouds and they are moving around on top. Whenever it is heavy then it falls as rain.” When asked what makes them move to the top, Sari explained “the rain comes with strong winds.”

d) The fourth part of the question asked students whether anyone in their villages can bring rain, who can and how can this person bring rain. Eighty-four students (54.9%) said ‘yes’ and stated that mainly magicians (seseva karu) who are village elders bring rain by saying magic spells (seseva) and singing traditional songs. Some of the students also stated that these people are either their uncles or grandfathers. Twenty-one students (13.7%) said ‘no’ and stated that it was only God who created
everything on earth and will bring rain to them through his blessings and rain comes from the clouds. Finally, 48 students (31.4%) did not give a response to the question. Table 8.14 give the students’ responses across the four grades.

Table 8.14 Percentages (and student numbers) of types of responses to the question: ‘Can anyone in your village bring rain? ...... Who? ............. How? ...........

<table>
<thead>
<tr>
<th>Type of response</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes. Magicians (<em>seseva karu</em>). By saying magic spells and singing a traditional song.</td>
<td>5.9 (9)</td>
<td>11.1 (17)</td>
<td>26.1 (40)</td>
<td>11.8 (18)</td>
<td>54.9 (84)</td>
</tr>
<tr>
<td>No. God. God created everything on earth and will bring rain to them through his blessings.</td>
<td>1.3 (2)</td>
<td>5.2 (8)</td>
<td>3.9 (6)</td>
<td>3.3 (5)</td>
<td>13.7 (21)</td>
</tr>
<tr>
<td>Did not answer/don’t know.</td>
<td>.2.6 (4)</td>
<td>9.2 (14)</td>
<td>13.1 (20)</td>
<td>6.5 (10)</td>
<td>31.4 (48)</td>
</tr>
</tbody>
</table>

When asked if anyone in their villages can bring rain, who can and how, eight students (five Grade 9s and three Grade 10s) said ‘yes’ and stated that some people called rainmakers or magicians, sorcerers or people with spells (*seseva karu*) who are mainly village elders or can bring rain. Two of the grade 9 students stated that they are old people whom they know by name in their villages. All eight students stated that these people use magic spells or *seseva* to bring the rain. Only four of these students have seen these people doing it in front of them and have experienced it. For example, Margaret, a Grade 10 female student, explained that “one of the village elders can bring rain” and she was able to name the person who is a very old man. She further explained that “he used to make and use some magic words” but she has never seen him doing this.

e) The last part of the question asked students whether anyone in their villages can stop rain, who and how this person can stop the rain. Seventy-two students (47.1%) said ‘yes’ and stated that magicians (*seseva karu*) or sorcerers who are mainly village elders and they can stop the rain by saying magic spells (*seseva*). Nineteen students (12.4%) said ‘no’ and stated that only God can and it is God who can bring rain and
stop it. Finally, 52 students (34.1%) did not give a response to the question. Table 8.15 shows students’ responses across the four grades.

Seven students (four Grade 9s and three Grade 10s) interviewed believed that some people would say ‘yes’ and stated these are village elders, magicians and sorcerers. They do this by casting and using spells, saying magic spells and words to stop the rain. Again about four of this students are familiar with these people in their respective villages and have seen it in front of them and have experienced it. For example, Margaret, a Grade 10 female student explained that her uncle though he is not old, can stop the rain —“he used to talk and use banana leaves to stop the rain” and she has seen him do it.

<table>
<thead>
<tr>
<th>Type of response</th>
<th>Grade levels</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>7</td>
</tr>
<tr>
<td>Yes. Magicians or sorcerers who are mainly village elders. By saying magic spells (seseva).</td>
<td>5.2 (8)</td>
</tr>
<tr>
<td>No. God. God brings rain and stops it.</td>
<td>1.3 (2)</td>
</tr>
<tr>
<td>Did not answer/don’t know.</td>
<td>3.3 (5)</td>
</tr>
</tbody>
</table>

8.3.5 Thunder

Students were asked if they might have heard a loud noise in the sky during rainy seasons. In their science lessons, they may have learnt about what this noise is already, which is called thunder.

a) The first part of the question asked the students to give the Toaripi word or meaning for thunder. Ninety-seven students (63.4%) gave the Toaripi word sisorea. Another 14 students (9.2%) gave other meanings such as kevaro (lightning), mea tutururu (ground shaking), ovora (wind) and mea uru (black clouds). Finally, 42
students (27.4%) did not give a response to this question. Table 8.16 show the students’ responses across the four grades.

**Table 8.16** Percentages (and student numbers) of types of responses to the question: ‘Give the Toaripi word or meaning for thunder.’

<table>
<thead>
<tr>
<th>Type of response</th>
<th>Grade levels</th>
<th></th>
<th></th>
<th></th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>7</td>
<td>8</td>
<td>9</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td><em>Sisorea.</em></td>
<td>7.2 (11)</td>
<td>13.1 (20)</td>
<td>26.8 (41)</td>
<td>16.3 (25)</td>
<td>63.4 (97)</td>
</tr>
<tr>
<td><em>Kevaro</em> (lightning), <em>mea tutururu</em> (ground shaking), <em>ovora</em> (wind), <em>mea uru</em> (black clouds).</td>
<td>1.3 (2)</td>
<td>2.0 (3)</td>
<td>4.6 (7)</td>
<td>1.3 (2)</td>
<td>9.2 (14)</td>
</tr>
<tr>
<td>Did not answer/don’t know.</td>
<td>1.3 (2)</td>
<td>10.5 (16)</td>
<td>11.7 (18)</td>
<td>3.9 (6)</td>
<td>27.4 (42)</td>
</tr>
</tbody>
</table>

b) The second part of this question asked students to explain in their own words what thunder is? Twenty-six students (17%) stated that when two heavy clouds moving at high speed collide into each other, they produce thunder. Another 73 students (47.8%) stated that thunder is a loud noise like a drum that comes from the sky during a storm. Another 11 students (7.2%) stated that thunder is a natural disaster that destroys houses and food gardens. Finally, 43 students (28%) did not give a response to this question. Table 8.17 show the students’ responses across the four grades.

**Table 8.17** Percentages (and student numbers) of types of responses to the question: ‘In your own words, explain what thunder is.’

<table>
<thead>
<tr>
<th>Type of response</th>
<th>Grade levels</th>
<th></th>
<th></th>
<th></th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Two heavy clouds moving at high speed and colliding into each other produces thunder.</td>
<td>2.0 (3)</td>
<td>3.3 (5)</td>
<td>6.5 (10)</td>
<td>5.2 (8)</td>
<td>17 (26)</td>
</tr>
<tr>
<td>A loud noise like a drum being hit that comes from the sky during a storm.</td>
<td>3.9 (6)</td>
<td>10.5 (16)</td>
<td>24.2 (37)</td>
<td>9.2 (14)</td>
<td>47.8 (73)</td>
</tr>
<tr>
<td>A natural disaster that comes after lightning during a rainstorm that destroys houses and gardens.</td>
<td>2 (3)</td>
<td>1.3 (2)</td>
<td>3.3 (5)</td>
<td>0.6 (1)</td>
<td>7.2 (11)</td>
</tr>
<tr>
<td>Did not answer/don’t know.</td>
<td>2.0 (3)</td>
<td>10.4 (16)</td>
<td>9.1 (14)</td>
<td>6.5 (10)</td>
<td>28.0 (43)</td>
</tr>
</tbody>
</table>
c) The third part of this question asked students how thunder comes about. Twelve students (7.8%) stated that thunder comes when two heavy clouds collide into each other. Sixty-nine students (45.6%) stated that thunder comes when it rains and when lightning occurs. Another six students (3.9%) stated that thunder comes when people have differences and use and say magic spells (*seseva*) to the rain. Finally, 66 students (43.1%) did not give a response to the question. Table 8.18 show the students’ responses across the four grades.

<table>
<thead>
<tr>
<th>Type of response</th>
<th>Grade levels</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>7</td>
<td>8</td>
</tr>
<tr>
<td>Comes when two heavy clouds collide into each other.</td>
<td>0 (0)</td>
<td>1.3 (2)</td>
</tr>
<tr>
<td>Comes when it rains and when lightning occurs.</td>
<td>4.6 (7)</td>
<td>13.1 (20)</td>
</tr>
<tr>
<td>Comes when people have differences and use or say magic spells (<em>seseva</em>) to the rain.</td>
<td>1.3 (2)</td>
<td>0 (0)</td>
</tr>
<tr>
<td>Did not answer/don’t know.</td>
<td>3.9 (6)</td>
<td>11.1 (17)</td>
</tr>
</tbody>
</table>

From the interviews about thunder and how it comes about, only four students (two Grade 9s and two Grade 10s) stated that it comes about when clouds meet together, or is the sound produced when clouds collide into each other or the crashing of rolling clouds. Tom, a Grade 9 male student stated, “thunder is a cracking noise. Cracking of black clouds when they come and bump each other. They make a sound.” When asked by the researcher if the black clouds travel very fast and make a big noise when they come together and bump, Tom agreed and stated, “thunder comes like a group, like a group of clouds.”

d) The last part of the question asked students if there was any way of stopping thunder and how. Twenty-eight students (18.3%) said ‘yes’ and stated that using and saying magic spells (*seseva*) will stop thunder. Another four students (2.6%) said ‘no’ and stated that only God can stop it while 13 students (8.4%) said ‘no’ and stated that they cannot do anything, as it is a natural thing. Forty-nine students (32%)
said ‘no’ but did not describe how. Finally, 59 students (38.5%) did not give a response to the question. Table 8.19 shows the students’ responses across the four grades.

Table 8.19: Percentages (and student numbers) of types of responses to the question: ‘Is there any way of stopping thunder? ....... How? ......’

<table>
<thead>
<tr>
<th>Type of response</th>
<th>Grade levels</th>
<th>Grade levels</th>
<th>Grade levels</th>
<th>Grade levels</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>7</td>
<td>8</td>
<td>9</td>
<td>10</td>
</tr>
<tr>
<td>Yes. By using and saying magic spells (seseva).</td>
<td>3.3 (5)</td>
<td>5.2 (8)</td>
<td>8.5 (13)</td>
<td>1.3 (2)</td>
</tr>
<tr>
<td>No. Only God can stop it.</td>
<td>0 (0)</td>
<td>0 (0)</td>
<td>2 (3)</td>
<td>0.6 (1)</td>
</tr>
<tr>
<td>No. We can’t as it is a natural thing.</td>
<td>0.6 (1)</td>
<td>2.6 (4)</td>
<td>4.6 (7)</td>
<td>0.6 (1)</td>
</tr>
<tr>
<td>No. No reason given.</td>
<td>0.6 (1)</td>
<td>9.2 (14)</td>
<td>5.9 (9)</td>
<td>16.3 (25)</td>
</tr>
<tr>
<td>Did not answer/don’t know.</td>
<td>5.2 (8)</td>
<td>8.5 (13)</td>
<td>22.2 (34)</td>
<td>2.6 (4)</td>
</tr>
</tbody>
</table>

8.3.6 Lightning

Students were asked if they had seen a large bright spark sometimes appear in the sky following a big bang of thunder during the rainy season. In their science lessons, they might have learnt this already and call it lightning.

a) The first part of the question asked students to give the Toaripi word or meaning for lightning. Over two thirds (66.7%) of the students (n=102) gave the Toaripi word kevaro for lightning. Another 16 students (10.4%) gave other meanings like eau iare’ (wind) and sisorea (thunder) while 35 students (22.9%) did not give a response to the question. Table 8.20 show the students’ responses across the four grades.

Table 8.20 Percentages (and student numbers) of types of responses to the question: ‘Give the Toaripi word or meaning for lightning.’

<table>
<thead>
<tr>
<th>Type of response</th>
<th>Grade levels</th>
<th>Grade levels</th>
<th>Grade levels</th>
<th>Grade levels</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>7</td>
<td>8</td>
<td>9</td>
<td>10</td>
</tr>
<tr>
<td>Kevaro.</td>
<td>4.6 (7)</td>
<td>13.1 (20)</td>
<td>31.4 (48)</td>
<td>17.6 (27)</td>
</tr>
<tr>
<td>Eau iare (wind) and sisorea (thunder), abalibali.</td>
<td>2.0 (3)</td>
<td>3.9 (6)</td>
<td>3.9 (6)</td>
<td>0.6 (1)</td>
</tr>
<tr>
<td>Did not answer/don’t know.</td>
<td>3.3 (5)</td>
<td>8.5 (13)</td>
<td>7.8 (12)</td>
<td>3.3 (5)</td>
</tr>
</tbody>
</table>

205
b) The second part of this question asked students to describe in their own words what lightning is. Sixteen students (10.5%) described lightning as sparks given off by colliding clouds or natural electricity. Over half (52.9%) of the students (n=81) described it as a flash of light across the sky during thunderstorms and rainy seasons. Another 56 students (36.6%) did not give a response to the question. Table 8.21 show the students’ responses across the four grades.

Table 8.21 Percentages (and student numbers) of types of responses to the question: 'Describe in your own words what lightning is.'

<table>
<thead>
<tr>
<th>Type of response</th>
<th>Grade levels</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>7</td>
<td>8</td>
</tr>
<tr>
<td>Sparks given off by colliding clouds or natural electricity.</td>
<td>0 (9)</td>
<td>2.0 (3)</td>
</tr>
<tr>
<td>A flash of light across the sky during thundersstorms and rainy seasons.</td>
<td>5.2 (8)</td>
<td>11.8 (18)</td>
</tr>
<tr>
<td>Did not answer/don't know.</td>
<td>4.6 (7)</td>
<td>11.8 (18)</td>
</tr>
</tbody>
</table>

In interviews, only two students (one Grade 9 and 10) stated that lightning is a light produced by colliding clouds or it comes when there are only thick white clouds in the sky. Sari, a Grade 10 male student, said, “Lightning is the light produced by the colliding clouds.”

c) The third part of the question asked students about how lightning comes about. Ten students (6.6%) stated that lightning comes at a faster rate when clouds collide or when black clouds appear during thunderstorms. Another 63 students (41.2%) stated that lightning comes after every thunder as a bright light when it is raining. Over half (51.4%) of the students (n=78) did not give a response to the question. Table 8.22 show the students’ responses across the four grades.
Table 8.22  Percentages (and student numbers) of types of responses to the question: ‘How does lightning come about?’

<table>
<thead>
<tr>
<th>Type of response</th>
<th>Grade levels</th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>7</td>
<td>8</td>
<td>9</td>
<td>10</td>
<td>Total</td>
</tr>
<tr>
<td>Comes at a faster rate when clouds collide or when black clouds appear during thunderstorms.</td>
<td>0 (0)</td>
<td>0.7 (1)</td>
<td>3.3 (5)</td>
<td>2.6 (4)</td>
<td>6.6 (10)</td>
</tr>
<tr>
<td>Comes after every thunder as a bright light when it is raining.</td>
<td>3.3 (5)</td>
<td>11.1 (17)</td>
<td>20.3 (31)</td>
<td>6.5 (10)</td>
<td>41.2 (63)</td>
</tr>
<tr>
<td>Did not answer/don’t know.</td>
<td>6.5 (10)</td>
<td>13.7 (21)</td>
<td>19.6 (30)</td>
<td>12.4 (19)</td>
<td>52.2 (78)</td>
</tr>
</tbody>
</table>

d) The last part of the question asked students if there was any way of stopping lightning and how. Eighteen students (11.8%) said ‘yes’ and stated that by using and saying magic spells (seseva) to stop lightning. Another 27 students (17.7%) said ‘no’ and stated that it occurs naturally and no one can stop it. Three students (2%) said ‘no’ and stated that God created it and can stop it as God gives us lightning for our wrong doings. Over two thirds (68.5%) of the students (n=105) did not give a response to the question. Table 8.23 show the students’ responses across the four grades.

Table 8.23  Percentages (and student numbers) of types of responses to the question: ‘Is there any way of stopping lightning? ......... How? .........’

<table>
<thead>
<tr>
<th>Type of response</th>
<th>Grade levels</th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>7</td>
<td>8</td>
<td>9</td>
<td>10</td>
<td>Total</td>
</tr>
<tr>
<td>Yes, By using and saying magic spells (seseva).</td>
<td>2.0 (3)</td>
<td>3.3 (5)</td>
<td>5.2 (8)</td>
<td>1.3 (2)</td>
<td>11.8 (18)</td>
</tr>
<tr>
<td>No. It occurs naturally and no one can stop it.</td>
<td>2.0 (3)</td>
<td>5.9 (9)</td>
<td>9.8 (15)</td>
<td>0 (0)</td>
<td>17.7 (27)</td>
</tr>
<tr>
<td>No. God created it and can stop it as he give us lightning for the wrongs we have done.</td>
<td>0 (0)</td>
<td>0 (0)</td>
<td>2.0 (3)</td>
<td>0 (0)</td>
<td>2.0 (3)</td>
</tr>
<tr>
<td>Did not answer/don’t know.</td>
<td>5.8 (9)</td>
<td>16.3 (25)</td>
<td>26.1 (40)</td>
<td>20.3 (31)</td>
<td>68.5 (105)</td>
</tr>
</tbody>
</table>
8.3.7 Rainbow

Students were asked if in their science lessons, after a heavy rain sometimes, they might have seen the shape of a semi-circle appear with different colours in the sky. In their science lessons, they may have learnt this already and call it a rainbow.

a) The first part of the question asked students to give the Toaripi word or meaning for a rainbow. Almost half (49.6%) of the students (n=76) gave the meaning lavai (rainbow), karoro hariaharia (different colours), lai sa kaleitita karoro (colours after the rain). Another eighteen students (11.8%) gave other meanings such as hawaiisi, miai, ava vapava, kamaila, ou'u evai ea' a, wambinanago, irekaisip, and asaga. Over one third (38.6%) of the students (n=59) did not give a response to the question. Table 8.24 show the students' responses across the four grades.

Table 8.24 Percentages (and student numbers) of types of responses to the question: 'Give the Toaripi word or meaning for a rainbow.'

<table>
<thead>
<tr>
<th>Type of response</th>
<th>Grade levels</th>
<th></th>
<th></th>
<th></th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>7</td>
<td>8</td>
<td>9</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>Lava', karoro hariaharia, lai sa kaleitita karoro.</td>
<td>5.9 (9)</td>
<td>6.5 (10)</td>
<td>24.8 (38)</td>
<td>12.1 (19)</td>
<td>49.6 (76)</td>
</tr>
<tr>
<td>Hawaiisi, miai, lava vapava, kamaila, ou'u evai ea' a, wambinanago, irekaisip, asaga.</td>
<td>2.0 (3)</td>
<td>4.6 (7)</td>
<td>5.2 (8)</td>
<td>0.0 (0)</td>
<td>11.8 (18)</td>
</tr>
<tr>
<td>Did not answer/don't know.</td>
<td>2.0 (3)</td>
<td>14.3 (22)</td>
<td>13.1 (20)</td>
<td>9.2 (14)</td>
<td>38.6 (59)</td>
</tr>
</tbody>
</table>

b) The second part of this question asked students to describe in their own words what a rainbow is. Over 50% of the students (n=78) stated that a rainbow is a curve of different colours that appear after and when there is no more rain. Another 25 students (16.3%) stated that a rainbow is created by God and is a promise that there will be no more floods. Another six students (3.8%) stated that a rainbow is a arch of colours formed in rain or spray by the sun's ray or sun shining through rain. Another two students (1.3%) stated that a rainbow is a man who lives in the sky during our ancestor's time and has a son while 42 students (27%) did not give a response to the question. Table 8.25 show the students' responses across the four grades.
Table 8.25  Percentages (and student numbers) of types of responses to the question: ‘Describe in your own words what a rainbow is.’

<table>
<thead>
<tr>
<th>Type of response</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>A curve of different colours that appear after or when there is no more rain.</td>
<td>5.2</td>
<td>13.1</td>
<td>22.9</td>
<td>9.8</td>
<td>51.0</td>
</tr>
<tr>
<td>Created by God and a promise that there will be no more flood.</td>
<td>0.6</td>
<td>3.3</td>
<td>8.5</td>
<td>3.9</td>
<td>16.3</td>
</tr>
<tr>
<td>Arch of colours formed in rain or spray by the sun’s rays or sun shining through rain.</td>
<td>0</td>
<td>0</td>
<td>1.9</td>
<td>1.9</td>
<td>3.8</td>
</tr>
<tr>
<td>Is a man that lives in the sky during our ancestor’s time and has a son.</td>
<td>1.3</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1.3</td>
</tr>
<tr>
<td>Did not answer/don’t know.</td>
<td>2.6</td>
<td>9.2</td>
<td>9.9</td>
<td>5.3</td>
<td>27.0</td>
</tr>
</tbody>
</table>

c) The third part of the question asked students if anyone can stop or make a rainbow, who can and how. Four students (2.7%) said ‘yes’ and stated that magic people, who do it by saying magic words and putting leaves in the ground. Another 21 students (13.8%) said ‘no’ and stated that God can and it is a sign to show there will be no more flood as he created it. Another 14 students (9.2%) of the students said ‘no’ and stated that no one can, as it is a natural thing and can appear and disappear by itself. Over one third of the students (37.9%) (n=58) said ‘no’ and did not give a response as to who can and how. Finally, again over one third of the students (36.4%) (n=56) did not give a response to the question. Table 8.26 show the students’ responses across the four grades.

Table 8.26  Percentages (and student numbers) of types of responses to the question: ‘Can anyone make or stop a rainbow? ... Who? ... How?....

<table>
<thead>
<tr>
<th>Type of response</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes. Magic people. By saying magic words and putting leaves in the ground.</td>
<td>1.3</td>
<td>0.7</td>
<td>0</td>
<td>0.7</td>
<td>2.7</td>
</tr>
<tr>
<td>No. God. A sign to show no more flood as he created it.</td>
<td>2.0</td>
<td>2.0</td>
<td>7.8</td>
<td>2.0</td>
<td>13.8</td>
</tr>
<tr>
<td>No. No one. It’s a natural thing and can appear and disappear by itself.</td>
<td>2.0</td>
<td>2.0</td>
<td>5.2</td>
<td>0</td>
<td>9.2</td>
</tr>
<tr>
<td>No. Don’t know. Don’t know.</td>
<td>0.7</td>
<td>8.5</td>
<td>13.1</td>
<td>15.6</td>
<td>37.9</td>
</tr>
<tr>
<td>Did not answer/don’t know.</td>
<td>3.9</td>
<td>12.4</td>
<td>16.9</td>
<td>3.2</td>
<td>36.4</td>
</tr>
</tbody>
</table>
d) The last part of the question asked students if it was a good idea to make or stop a rainbow and why. Thirty-six students (23.5%) said 'no' and stated that it is a natural thing and a sign for rain to stop. Another 33 students (21.5%) said ‘no’ and stated that God created it. Another 19 students (12.4%) said ‘no’ and did not give a reason while 65 students (42.4%) did not give a response. Table 8.27 shows the students' responses across the four grades.

Table 8.27 Percentages (and student numbers) of types of responses to the question: 'Is it a good idea to make or stop a rainbow? ............ Why?'

<table>
<thead>
<tr>
<th>Type of response</th>
<th>Grade levels</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>7</td>
<td>8</td>
<td>9</td>
<td>10</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No. Because it is a natural thing and a sign for rain to stop.</td>
<td>3.9 (6)</td>
<td>3.3 (5)</td>
<td>11.1 (17)</td>
<td>5.2 (8)</td>
<td>23.5 (36)</td>
<td></td>
</tr>
<tr>
<td>No. God created it.</td>
<td>2.0 (3)</td>
<td>4.5 (7)</td>
<td>12.4 (19)</td>
<td>2.6 (4)</td>
<td>21.5 (33)</td>
<td></td>
</tr>
<tr>
<td>No. Don’t know.</td>
<td>0 (0)</td>
<td>2.6 (4)</td>
<td>7.2 (11)</td>
<td>2.6 (4)</td>
<td>12.4 (19)</td>
<td></td>
</tr>
<tr>
<td>Did not answer/don’t know.</td>
<td>3.9 (6)</td>
<td>15.0 (23)</td>
<td>12.4 (19)</td>
<td>11.1 (17)</td>
<td>42.4 (65)</td>
<td></td>
</tr>
</tbody>
</table>

8.3.8 Moon

Students were asked why when there is a full moon in the sky, they find it easier to see their way around at night.

a) The first part of the question asked students to give the Toaripi word or meaning for the moon. One hundred and seven students (69.9%) gave the word papa. Another 14 students (9.3%) gave other meanings such as lau lumori, iakari, salima, kaminga, ngoon, zawa, lea parea, and kunup. Finally, another 32 students (20.8%) did not give a response. Table 8.28 show the students' responses across the four grades.
Table 8.28  Percentages (and student numbers) of types of responses to the question: ‘Give the Toaripi word or meaning for the moon.’

<table>
<thead>
<tr>
<th>Type of response</th>
<th>Grade levels</th>
<th></th>
<th></th>
<th></th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>7</td>
<td>8</td>
<td>9</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>Papare.</td>
<td>7.1 (11)</td>
<td>14.4 (22)</td>
<td>30.1 (46)</td>
<td>18.3 (28)</td>
<td>69.9 (107)</td>
</tr>
<tr>
<td>Lau lumori, takari, salima, kaminga, ngoon, zawa, lea parea, kunup</td>
<td>0.7 (1)</td>
<td>3.3 (5)</td>
<td>5.3 (8)</td>
<td>0 (0)</td>
<td>9.3 (14)</td>
</tr>
<tr>
<td>Did not answer/don’t know</td>
<td>1.9 (3)</td>
<td>7.8 (12)</td>
<td>7.8 (12)</td>
<td>3.3 (5)</td>
<td>20.8 (32)</td>
</tr>
</tbody>
</table>

b) The second part of the question asked students to describe in their own words what the moon is. Seventy-four students (48.4%) gave the description of the moon as a round and bright body, which shines in the night sky. Another 16 students (10.4%) stated that the moon is a natural satellite of the earth, orbits around it and reflects the sun’s rays to the earth at night. Another nine students (6%) stated that the moon is a planet and orbits around earth and shines at night. Another five students (3.3%) stated that the moon is created by God, which gives light to all mankind. Another five students (3.3%) of the students stated that when the moon shines bright in the night, it is the hair of the moon or lau lumori’s soft hair. Finally, 44 students (28.6%) did not give a response to the question. Table 8.29 show the students’ responses across the four grades.

c) The third part of the question asked students about what makes the moon shine in the night. Forty students (26.2%) stated that it is the reflected light from the sun that makes the moon shine in the night. Another 12 students (7.9%) stated that the moon shines in the night when there are no clouds covering the moon at night or when the sky is full of stars. Two students (1.3%) stated that God created the moon and makes it shine brighter to give light to earth where there is darkness. Over two thirds of the students (62.7%) (n=99) did not give a response to the question. Table 8.30 shows the students’ responses across the four grades.
Table 8.29  Percentages of types of responses to the question: 'Describe in your own words what the moon is.'

<table>
<thead>
<tr>
<th>Type of response</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Is round and bright and shines in the night.</td>
<td>4.6 (7)</td>
<td>12.4 (19)</td>
<td>22.9 (35)</td>
<td>8.5 (13)</td>
<td>48.4 (74)</td>
</tr>
<tr>
<td>A natural satellite of the earth, orbits around it and reflects the sun's rays to the earth at night.</td>
<td>0 (0)</td>
<td>1.3 (2)</td>
<td>5.8 (9)</td>
<td>3.3 (5)</td>
<td>10.4 (16)</td>
</tr>
<tr>
<td>A planet which orbits around earth and shines at night.</td>
<td>0.7 (1)</td>
<td>0.7 (1)</td>
<td>2.0 (3)</td>
<td>2.6 (4)</td>
<td>6.0 (9)</td>
</tr>
<tr>
<td>Created by God, which gives light to all mankind.</td>
<td>0.7 (1)</td>
<td>0 (0)</td>
<td>2.6 (4)</td>
<td>0 (0)</td>
<td>3.3 (5)</td>
</tr>
<tr>
<td>When it shines bright in the night, it is the hair of the moon or <em>lau lumori</em>'s soft hair.</td>
<td>0 (0)</td>
<td>0 (0)</td>
<td>1.3 (2)</td>
<td>2.0 (3)</td>
<td>3.3 (5)</td>
</tr>
<tr>
<td>Did not answer/don't know.</td>
<td>3.9 (6)</td>
<td>11.1 (17)</td>
<td>8.4 (13)</td>
<td>5.2 (8)</td>
<td>28.6 (44)</td>
</tr>
</tbody>
</table>

Table 8.30  Percentages (and student numbers) of types of responses to the question: 'What makes the moon shine in the night?'

<table>
<thead>
<tr>
<th>Type of response</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>The reflected light from the sun.</td>
<td>3.3 (5)</td>
<td>4.6 (7)</td>
<td>10.5 (16)</td>
<td>7.8 (12)</td>
<td>26.2 (40)</td>
</tr>
<tr>
<td>No cloud covering the moon, shines at night when the sky is full of stars.</td>
<td>0 (0)</td>
<td>3.3 (5)</td>
<td>3.9 (6)</td>
<td>0.7 (1)</td>
<td>7.9 (12)</td>
</tr>
<tr>
<td>God the creator makes the moon shine and brighter to give light to earth where there is darkness.</td>
<td>0 (0)</td>
<td>0 (0)</td>
<td>1.3 (2)</td>
<td>0 (0)</td>
<td>1.3 (2)</td>
</tr>
<tr>
<td>Did not answer/don't know.</td>
<td>6.5 (10)</td>
<td>17.6 (27)</td>
<td>27.5 (42)</td>
<td>13.0 (20)</td>
<td>64.6 (99)</td>
</tr>
</tbody>
</table>

Three students (two Grade 9s and one Grade 10) interviewed about what makes the moon shine in the night, stated the light from the sun makes the moon shine in the night. Mary, a female Grade 10 student, explained “the moon shines because of the energy from the sun as heat and light.”

d) The last part of the question asked students about an old village person who may have told them that a young spirit woman called *lau lumori* looks after and guides the moon. Her soft hair is the cloud in the night sky that casts a shadow on the moon.
and students were asked if this was possible. Fifteen students (9.9%) said 'yes' and stated that their ancestors might have told them the old stories (*papa fari*) and they have heard village people say *lau lumori* when they see the moon coming up. Another 14 students (9.2%) said either 'yes' or 'don’t know' and stated that they have never heard of it. Another five students (3.4%) said 'no' and stated that the moon was created by God and nobody created it. Another four students (2.7%) said 'no' and did not give a reason. Over two thirds of the students (75.1%) (n=115) did not give a response to the question. Table 8.31 show the students' responses across the four grades.

<table>
<thead>
<tr>
<th>Type of response</th>
<th>Grade levels</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>7</td>
<td>8</td>
</tr>
<tr>
<td>Yes. Their ancestors might have told them old stories (<em>papa fari</em>) and have heard village people say <em>lau lumori</em> when they see the moon coming up.</td>
<td>2.0 (3)</td>
<td>2.0 (3)</td>
</tr>
<tr>
<td>Don't know/yes. Because never heard of it.</td>
<td>2.6 (4)</td>
<td>0.7 (1)</td>
</tr>
<tr>
<td>No. Made by God and nobody can do it.</td>
<td>0 (0)</td>
<td>0 (0)</td>
</tr>
<tr>
<td>No. Don't know.</td>
<td>0 (0)</td>
<td>0.7 (1)</td>
</tr>
<tr>
<td>Did not answer/don't know.</td>
<td>5.2 (8)</td>
<td>22.2 (34)</td>
</tr>
</tbody>
</table>

8.3.9 Sun

Students were told that the sun appears to rise in the morning in the east and set in the evening in the west. The sun gives light and keeps us warm during the day. Without this, there would be no life, no light, no weather and no warmth.

a) The first part of this question asked students to give the *Toaripi* word or meaning for the sun. Eighty-two students (53.6%) gave the *Toaripi* word *sare* for sun. Two students (1.3%) mentioned *epé savora*, the spirit that looks after and guides the sun
while another 69 students (45.1%) did not give a response to the question. Table 8.32 shows the students’ responses across the four grades.

b) The second part of this question asked the students to describe the sun in their own words. Twenty-six students (17%) described and stated that the sun is the biggest star in the solar system. Another 11 students (7.2%) stated that the sun is a planet and part of the solar system. The majority of students (41.9%) (n=64) stated that the sun is round and is a source of light while another 52 students (33.9%) did not give a response to the question. Table 8.33 shows the students’ responses across the four grades.

Table 8.32 Percentages (and student numbers) of types of responses to the question: ‘Give the Toaripi word or meaning for sun.’

<table>
<thead>
<tr>
<th>Type of response</th>
<th>Grade levels</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>7</td>
</tr>
<tr>
<td>Sare (sun).</td>
<td>4.6 (7)</td>
</tr>
<tr>
<td>Epe savora, spirit that looks after and guides the sun.</td>
<td>0 (0)</td>
</tr>
<tr>
<td>Did not answer/don’t know.</td>
<td>5.2 (8)</td>
</tr>
</tbody>
</table>

Table 8.33 Percentages (and student numbers) of types of responses to the question: ‘Describe what the sun is in your own words.’

<table>
<thead>
<tr>
<th>Type of response</th>
<th>Grade levels</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>7</td>
</tr>
<tr>
<td>Biggest and hottest star in the solar system.</td>
<td>1.3 (2)</td>
</tr>
<tr>
<td>A planet and part of the solar system.</td>
<td>0 (0)</td>
</tr>
<tr>
<td>Is round and source of light.</td>
<td>3.3 (5)</td>
</tr>
<tr>
<td>Did not answer/don’t know.</td>
<td>5.2 (8)</td>
</tr>
</tbody>
</table>

Only two students interviewed (one Grade 9 and Grade 10) stated that the sun is a star to the earth and is the solar system. Sarea, a Grade 9 male student, explained that “the sun is our planet or star to earth, that rotates around the sun.”
c) The third part of this question asked students if the sun stays in one place and why. The majority of the students (42.8%) (n=63) mainly Grade 9s (26.5%) (n=39) said ‘yes’ and stated that the earth orbits the sun. Another 38 students (24.9%) said ‘no’ and stated that it is because the sun orbits, rises and sets in different directions while over one third of the students (31.9%) (n=52) did not give a response. Table 8.34 shows the students’ responses across the four grades.

All eight students (six Grade 9s and three Grade 10s) interviewed agreed that the sun stays in one place and the earth rotates or spins around the sun every 24 hours for 365 days. Eka, a male Grade 9 student, stated, “the sun stays in one place but the earth rotates around the sun.”

Table 8.34 Percentages (and student numbers) of types of responses to the question: ‘Does the sun stay in one place? ..... Why? ...........

<table>
<thead>
<tr>
<th>Type of response</th>
<th>Grade levels</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>7</td>
<td>8</td>
<td>9</td>
<td>10</td>
<td>Total</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes because earth orbits around sun.</td>
<td>2.6 (4)</td>
<td>4.6 (7)</td>
<td>25.5 (39)</td>
<td>8.5 (13)</td>
<td>41.2 (63)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No because sun orbits around earth and sets in different directions.</td>
<td>4.6 (7)</td>
<td>7.2 (11)</td>
<td>5.9 (9)</td>
<td>7.2 (11)</td>
<td>24.9 (38)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Did not answer/don’t know.</td>
<td>2.6 (4)</td>
<td>13.7 (21)</td>
<td>11.8 (18)</td>
<td>5.8 (9)</td>
<td>33.9 (52)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

d) The fourth part of the question asked students to explain in their own words what sunset and sunrise means. Over two thirds of the students (69.9%) (n=106) stated that sunset is when the sun goes down or sets in the west (night) and sunrise is when the sun comes up or rises in the east (day). Forty-seven students (30.7%) did not give a response to the question. Table 8.35 show the students’ responses across the four grades.
Table 8.35  Percentages (and student numbers) of types of responses to the question: ‘Explain in your own words what sunset and sunrise means.’

<table>
<thead>
<tr>
<th>Type of response</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sunset is when the sun goes down or sets in the west (night) and sunrise is</td>
<td>7.2</td>
<td>15.7</td>
<td>31.4</td>
<td>15.0</td>
<td>69.3</td>
</tr>
<tr>
<td>when the sun comes up or rises in the east (day).</td>
<td>(11)</td>
<td>(24)</td>
<td>(48)</td>
<td>(23)</td>
<td>(106)</td>
</tr>
<tr>
<td>Did not answer/don’t know.</td>
<td>2.6</td>
<td>9.8</td>
<td>11.8</td>
<td>6.5</td>
<td>30.7</td>
</tr>
<tr>
<td></td>
<td>(4 )</td>
<td>(15)</td>
<td>(18)</td>
<td>(10)</td>
<td>(47)</td>
</tr>
</tbody>
</table>

f) The last part of this question asked students if it was possible that an old person might have told them that the sun is looked after and guided by a spirit called *epe savora* and why. In response, six students (3.9%) gave a positive answer and stated that it is a legend and they have heard village people talking about it. Another 30 students (19.6%) gave a negative response and stated that they have never heard this story while the majority of students (76.4 %) (n=117) did not give a response. This is because they have not associated well with the village elders and do not wish to identify publicly with traditional knowledge as it might make them appear uneducated. Table 8.36 shows the students’ responses across the four grades.

Table 8.36  Percentages (and student numbers) of types of responses to the question: ‘An old person might have told you that the sun is looked after and guided by a spirit called *epe savora*. Is this possible? ...... Why? .......’

<table>
<thead>
<tr>
<th>Type of response</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes because it is a legend and people talk about it.</td>
<td>1.3</td>
<td>0.7</td>
<td>1.3</td>
<td>1.3</td>
<td>3.9</td>
</tr>
<tr>
<td></td>
<td>(2 )</td>
<td>(1 )</td>
<td>(2 )</td>
<td>(2 )</td>
<td>(6 )</td>
</tr>
<tr>
<td>No because never heard the story.</td>
<td>1.3</td>
<td>0.7</td>
<td>15.0</td>
<td>2.6</td>
<td>19.6</td>
</tr>
<tr>
<td></td>
<td>(2 )</td>
<td>(1 )</td>
<td>(23)</td>
<td>(4 )</td>
<td>(30)</td>
</tr>
<tr>
<td>Did not answer/don’t know.</td>
<td>7.2</td>
<td>24.8</td>
<td>26.8</td>
<td>17.6</td>
<td>76.4</td>
</tr>
<tr>
<td></td>
<td>(11)</td>
<td>(38)</td>
<td>(41)</td>
<td>(27)</td>
<td>(117)</td>
</tr>
</tbody>
</table>
8.4.0 Wind

Students were asked if they knew that the southeast and northwest winds are the two main winds that blow annually. These winds are strong and bring rain and sometimes it is unsafe to go out to sea and look for fish.

a) The first part of the question asked students to give the Toaripi words or meaning for the south-east and north-west winds. For the south-east wind, 34 students (22.2%) gave the Toaripi word mauta. Another 40 students (26.1%) gave other meanings such as ovora, kamakama, eau erere, miruru, pisahu mea, kentu, measiani. Over half of the students (51.6%) (n=79) did not give a response to the question. Table 8.37 shows students’ responses across the four grades.

<table>
<thead>
<tr>
<th>Type of response</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mauta</td>
<td>2.6 (4)</td>
<td>4.6 (7)</td>
<td>13.7 (21)</td>
<td>1.3 (2)</td>
<td>22.2 (34)</td>
</tr>
<tr>
<td>Ovora, kamakama,'eau erere, miruru, pisahu mea, kentu, measlesi</td>
<td>4.6 (7)</td>
<td>5.2 (8)</td>
<td>8.5 (13)</td>
<td>7.8 (12)</td>
<td>26.1 (40)</td>
</tr>
<tr>
<td>Did not answer/don’t know.</td>
<td>2.6 (4)</td>
<td>15.7 (24)</td>
<td>20.9 (32)</td>
<td>12.4 (19)</td>
<td>51.6 (79)</td>
</tr>
</tbody>
</table>

For the north-west wind, 24 students (15.8%) gave the Toaripi word ovora. Another 34 students (22%) gave other meanings such as mauta, miruru, eau erere, kamakama, lahara, mirikiri, kentu. Over two thirds of the students (60.9%) (n=95) did not give a response to the question. Table 8.38 shows the students’ responses across the four grades.
Table 8.38  Percentages (and student numbers) of types of responses to the question: ‘Give the Toaripi word or meaning for the north-west wind.’

<table>
<thead>
<tr>
<th>Type of response</th>
<th>Grade levels</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>7</td>
</tr>
<tr>
<td>Ovora.</td>
<td>1.3 (2)</td>
</tr>
<tr>
<td>Mautu, Miruru, eau, erere, kamakama, lahara, mirikiri, kentu.</td>
<td>3.3 (5)</td>
</tr>
<tr>
<td>Did not answer/don’t know.</td>
<td>5.2 (8)</td>
</tr>
</tbody>
</table>

b) The second part of the question asked students to describe what the wind is in their own words. Sixty-one students (39.9%) described it as fresh air or breeze from the mountains or sea, strong wind that blows strong when it is raining and it cannot be seen touched or smelt but can be felt. Another 23 students (15%) stated that the wind is the moving air, which happens when heated, it rises and the cool air moves into and takes the place of the hot air. In this way the air moves. Also they stated that wind is the uneven heating of the earth’s surface. Another two students (1.4%) stated that wind is the spirits form the past and also represents the calendar. The majority of the students (42.1%) (n=67) did not give a response to the question. Table 8.39 shows the students’ responses across the four grades.

Table 8.39  Percentages (and student numbers) of types of responses to the question: ‘In your own words describe what the wind is.’

<table>
<thead>
<tr>
<th>Type of response</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grade levels</td>
</tr>
<tr>
<td>7</td>
</tr>
<tr>
<td>Fresh air or breeze from the mountain or sea. It is the strong wind that blows strong when it is raining which we cannot see, touch and smell but can be felt.</td>
</tr>
<tr>
<td>Is moving air, which happens when heat rises and then the cool air moves into and takes the place of the hot air. In this way the air moves. It is also the uneven heating of the earth’s surface.</td>
</tr>
<tr>
<td>Spirits from the past and also represents the calendar.</td>
</tr>
<tr>
<td>Did not answer/don’t know.</td>
</tr>
</tbody>
</table>
Only two (one Grade 9 and 10) out of the nine students interviewed spoke about the wind as being the movements of air. Sarea, a Grade 9 male student, stated, "the wind is the movement of air in and around the world."

c) The third part of the question asked students about where they think the wind comes from. Forty-two students (27.5%) stated that it comes from any direction or four corners of the earth’s atmosphere by strong moving air. Another 16 students (10.5%) stated that the wind comes from the sea and oceans. Another six students (3.9%) stated that the wind is the result of uneven heating of the earth’s surface from a region of high pressure to low pressure like the poles (north and south poles). Over half of the students (58.1%) (n=89) did not give a response to the question. Table 8.40 shows the students’ responses across the four grades.

<table>
<thead>
<tr>
<th>Type of response</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Comes from any direction (four corners) of the earth’s atmosphere by strong moving air.</td>
<td>4.6 (7)</td>
<td>5.2 (8)</td>
<td>11.8 (18)</td>
<td>5.9 (9)</td>
<td>27.5 (42)</td>
</tr>
<tr>
<td>From the sea and oceans.</td>
<td>0 (0)</td>
<td>3.3 (5)</td>
<td>2.0 (3)</td>
<td>5.2 (8)</td>
<td>10.5 (16)</td>
</tr>
<tr>
<td>Uneven heating of the earth’s surface, from a region of high pressure to low pressure like the poles (north and south poles).</td>
<td>0 (0)</td>
<td>0 (0)</td>
<td>3.9 (6)</td>
<td>0 (0)</td>
<td>3.9 (6)</td>
</tr>
<tr>
<td>Did not answer/don’t know.</td>
<td>5.2 (8)</td>
<td>16.9 (26)</td>
<td>25.5 (39)</td>
<td>10.5 (16)</td>
<td>58.1 (89)</td>
</tr>
</tbody>
</table>

d) The final part of the question asked students about what causes the wind to blow. Thirteen students (8.5%) stated that the wind blows because of the heat of the sun, which heats the land and make the hot air to rise and when the hot air rises, the cold air replaces the hot air. In this way the air moves and causes the wind to blow from a place of high pressure to low pressure. Another seven students (4.6%) stated that the waves from the sea, the seasons and the sea breeze cause the wind to blow. Another 11 students (7.2%) stated that rain clouds, dust, thunderstorms and heavy rains cause
the wind to blow. Finally, the majority of the students (78.9%) (n=122) did not give a response to the question. Table 8.41 gives the student’s responses across the four grades.

Table 8.41 Percentages (and student numbers) of types of responses to the question: ‘What causes the wind to blow?’

<table>
<thead>
<tr>
<th>Type of response</th>
<th>Grade levels</th>
<th></th>
<th></th>
<th></th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>7</td>
<td>8</td>
<td>9</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>The wind blows because of the heat of the sun which heats the land and make the hot air rise and when the hot air rises, the cold air replaces the hot air. In this way the air moves and causes wind.</td>
<td>0.7 (1)</td>
<td>0 (0)</td>
<td>3.9 (6)</td>
<td>3.9 (6)</td>
<td>8.5 (13)</td>
</tr>
<tr>
<td>Waves from the sea, seasons and the sea breeze cause the wind to blow</td>
<td>0 (0)</td>
<td>0 (0)</td>
<td>3.9 (6)</td>
<td>0.7 (1)</td>
<td>4.6 (7)</td>
</tr>
<tr>
<td>Rain clouds, dust, thunderstorms and heavy rain cause the wind to blow</td>
<td>1.3 (2)</td>
<td>1.3 (2)</td>
<td>2.6 (4)</td>
<td>2.0 (3)</td>
<td>7.2 (11)</td>
</tr>
<tr>
<td>Did not answer/don’t know</td>
<td>7.8 (12)</td>
<td>24.2 (37)</td>
<td>32.7 (50)</td>
<td>15.0 (23)</td>
<td>79.7 (122)</td>
</tr>
</tbody>
</table>

8.4.1 Clouds

Students were asked if they sometimes observed, when they look up into the sky, black or white clouds blown across the sky by the wind.

a) The first part of the question asked students to give the Toaripi word or meaning for clouds. Over half of the students (56.8%) (n=88) gave the words mea-e (clouds) and mea uru (black clouds). Another eight students (5.3%) gave other words such as kauri (sky), aguagu, ururu, kaia, urem, kutum. Over one third of the students (38.1%) (n=57) did not give a response to the question. Table 8.42 gives the students’ responses across the four grades.
Table 8.42  Percentages (and student numbers) of types of responses to the question: ‘Give the Toaripi word or meaning for clouds.’

<table>
<thead>
<tr>
<th>Type of response</th>
<th>Grade levels</th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>7</td>
<td>8</td>
<td>9</td>
<td>10</td>
<td>Total</td>
</tr>
<tr>
<td>Mea-e/mea uru.</td>
<td>6.5 (10)</td>
<td>10.5 (16)</td>
<td>24.8 (38)</td>
<td>15.7 (24)</td>
<td>57.5 (88)</td>
</tr>
<tr>
<td>Kauri, agagu, ururu, kaia, urem, kutum.</td>
<td>0 (0)</td>
<td>2.6 (4)</td>
<td>0.7 (1)</td>
<td>2.0 (3)</td>
<td>5.3 (8)</td>
</tr>
<tr>
<td>Did not answer/don’t know.</td>
<td>3.3 (5)</td>
<td>12.4 (19)</td>
<td>17.6 (27)</td>
<td>3.9 (6)</td>
<td>37.2 (57)</td>
</tr>
</tbody>
</table>

b) The second part of the question asked the students to describe in their own words what clouds are. Twenty-seven students (17.8%) described clouds as ‘a mass of condensed water vapour which are really tiny droplets of water floating in the sky and falls as rain’. Another 45 students (29.4%) described clouds as ‘thick white or black substances like cotton wool of different shapes floating across the sky and sometimes gives us rain’. Another 13 students (8.5%) described clouds as ‘white things like smoke from fires which people burn that floats across the sky and falls as rain’. The majority of the students (44.3%) (n=68) did not give a response to the question. Table 8.43 gives the students’ responses across the four grades.

Table 8.43  Percentages (and student numbers) of types of responses to the question: ‘Describe in your own words what clouds are.’

<table>
<thead>
<tr>
<th>Type of response</th>
<th>Grade levels</th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>A mass of condensed water vapour which are really tiny droplets of water floating in the sky and falls as rain.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>7</td>
<td>8</td>
<td>9</td>
<td>10</td>
<td>Total</td>
</tr>
<tr>
<td></td>
<td>2.0 (3)</td>
<td>2.0 (3)</td>
<td>10.5 (16)</td>
<td>3.3 (5)</td>
<td>17.8 (27)</td>
</tr>
<tr>
<td>Are thick white or black substances like cotton wool of different shapes floating across the sky and sometimes gives us rain.</td>
<td>3.9 (6)</td>
<td>7.8 (12)</td>
<td>11.8 (18)</td>
<td>5.9 (9)</td>
<td>29.4 (45)</td>
</tr>
<tr>
<td>White things like smoke from fires which people burn that floats across the sky and falls as rain.</td>
<td>0 (0)</td>
<td>3.3 (5)</td>
<td>3.9 (6)</td>
<td>1.3 (2)</td>
<td>8.5 (13)</td>
</tr>
<tr>
<td>Did not answer/don’t know.</td>
<td>3.9 (6)</td>
<td>12.4 (19)</td>
<td>16.9 (26)</td>
<td>11.1 (17)</td>
<td>44.3 (68)</td>
</tr>
</tbody>
</table>
c) The last part of the question asked students about how clouds are formed. Forty-six students (30%) stated that ‘clouds are formed when water in seas, swamps etc evaporates by the heat of the sun (evaporation) and it formed into water vapour and it is pushed up by the air currents so this is where the condensation takes place. The water vapour is now turned into clouds (condensation). Another 14 students (9.2%) stated that clouds are formed ‘when wind blows them together. They form a large cotton wool type as dark black or white clouds which are really droplets of water.’ The come down as rain when it cannot hold its water.’ Another 15 students (9.9%) stated that clouds are formed ‘by smoke of a fire when it is rising and from bad air that is wasted on the earth by pollution.’ Over half of the students (50.9%) (n=78) did not give a response to the question. Table 8.44 gives the students’ responses across the four grades.

Seven students (five Grade 9s and two Grade 10s) interviewed stated that clouds are formed when water evaporates by the heat of the sun and it is formed into water vapour and it is pushed up by the air currents so this is where the condensation takes place. The water vapour is now turned into clouds. Lucy, a Grade 9 female student, explains “clouds are formed when the water evaporates by the heat of the sun and it is formed into water vapour and it is pushed by the air current so this is where the condensation takes place. The water vapour is now turned into clouds” and acknowledged that she had learnt this in her science lesson or from the textbook.
Table 8.44 Percentages (and student numbers) of types of responses to the question: ‘How are clouds formed?’

<table>
<thead>
<tr>
<th>Type of response</th>
<th>Grade levels</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>7</td>
</tr>
<tr>
<td>Formed when water in seas, swamps etc evaporates by the heat of the sun</td>
<td>2.0 (3)</td>
</tr>
<tr>
<td>(evaporation) and it is formed into water vapour and it is pushed up by the</td>
<td></td>
</tr>
<tr>
<td>air currents so this is where the condensation takes place. The water</td>
<td></td>
</tr>
<tr>
<td>vapour is now turned into clouds (condensation).</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1.3 (2)</td>
</tr>
<tr>
<td>Are formed when wind blows them together. They form a large cotton wool type</td>
<td></td>
</tr>
<tr>
<td>as dark back or white clouds, which are really droplets of water. They come</td>
<td></td>
</tr>
<tr>
<td>down as rain when it cannot hold its water.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>0.7 (1)</td>
</tr>
<tr>
<td>Formed by smoke of a fire when it is rising and from bad air that is wasted</td>
<td></td>
</tr>
<tr>
<td>on the earth by pollution.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>5.9 (9)</td>
</tr>
<tr>
<td>Did not answer/don’t know.</td>
<td></td>
</tr>
</tbody>
</table>

8.4.2 Drought

Students were asked if they knew that in some villages in the Gulf Province in 1997, the drought caused many problems. Food crops such as bananas, sweet potato and yam did not grow well. Fires were lit by mistake and burned most of the food gardens, betelnut trees and sago palms. The Provincial Government helped villages by giving them food during the drought.

a) The first part of the question asked students to give the Toaripi word or meaning for drought. Forty-one students (26.8%) gave the Toaripi word pisahu and mea arara. Another 26 students (17%) gave other meanings such as oti ma sa sarapai (water covers the place), ma taiva (high tide), posera (famine), sare hehea soa (time for hot sun), sare savori kofa lai ari karo (long time for sun no rain). Over half of the students (56.2%) (n=86) did not give a response to the question. Table 8.45 gives the types of students’ responses across the four grades.
Table 8.45  Percentages (and student numbers) of types of responses to the question: ‘Give the Toaripi meaning or word for drought.’

<table>
<thead>
<tr>
<th>Type of response</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pisahu/mea arara.</td>
<td>2.0 (3)</td>
<td>5.2 (8)</td>
<td>8.5 (13)</td>
<td>11.1 (17)</td>
<td>26.8 (41)</td>
</tr>
<tr>
<td>Oti ma sa sararpa, ma taiva,</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>‘posera, sare hehea soa, sare</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>savori kofa lai eria kao.</td>
<td>2.6 (4)</td>
<td>4.6 (7)</td>
<td>7.2 (11)</td>
<td>2.6 (4)</td>
<td>17.0 (26)</td>
</tr>
<tr>
<td>Did not answer/don’t know.</td>
<td>5.2 (8)</td>
<td>15.7 (24)</td>
<td>27.5 (42)</td>
<td>7.8 (12)</td>
<td>56.2 (86)</td>
</tr>
</tbody>
</table>

b) The second part of the question asked the students to describe in their own words what a drought is. Over two thirds of the students (60.1%) (n=92) stated that it is experienced when a long period of dry season causes the soil to become too hard for the crops or plants to grow. They also stated that drought is a long dry season with no rain and crops or living things die because of the hot sun. Another three students (2%) stated that a drought is a flood that floods all over the place because of the water and causes many problems. It also kills all the crops and spoil peoples’ lives. Over one third of the students (37%) (n=58) did not give a response to the question. Table 8.46 gives the types of students’ responses across the four grades.

Table 8.46  Percentages (and student numbers) of types of responses to the question: ‘Describe in your own words what a drought is.’

<table>
<thead>
<tr>
<th>Type of response</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Is experienced</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>when a long period of</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>dry season causes</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>soil to become</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>too hard for</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>crops or plants to</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>grow. It is also a</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>very long dry season</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>with no rain and</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>crops or living</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>things die</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>because of the hot</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>sun.</td>
<td>4.6 (7)</td>
<td>16.3 (25)</td>
<td>24.8 (38)</td>
<td>14.4 (22)</td>
<td>60.1 (92)</td>
</tr>
<tr>
<td>Is flood that</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>floods all over the</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>place because of</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>water and causes</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>many problems. It</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>also kills all the</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>crops and spoils</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>people’s lives.</td>
<td>0 (0)</td>
<td>0 (0)</td>
<td>1.3 (2)</td>
<td>0.7 (1)</td>
<td>2.0 (3)</td>
</tr>
<tr>
<td>Did not answer/don’t</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>know.</td>
<td>5.2 (8)</td>
<td>9.2 (14)</td>
<td>17.0 (26)</td>
<td>6.5 (10)</td>
<td>37.9 (58)</td>
</tr>
</tbody>
</table>
All nine students interviewed stated that a drought is a long, long dry season when there is no rain, the place is hot and plants won’t grow. There will be no water left in the lake or ground and no food because the soil will become hard. Green leaves will dry and the place will be dusty with food running out. Lucy, a Grade 9 female student, explained that “drought happens when the country or place has no water, no food and the ground or soil becomes very hard.”

c) The third part of the question asked students about what they think causes a drought. Over one third of the students (33.4%) (n=51) stated that it was the heat of the sun and when there is no rain for a longer period of time that causes a drought. Another seven students (4.6%) stated that a drought is caused by changing of the earth’s rotation, when the rivers are full and flood the place, is a natural disaster due to climatic change. Over two thirds of the students (60.6%) (n=95) did not give a response to the question. Table 8.47 gives the types of students’ responses across the four grades.

Table 8.47  Percentages (and student numbers) of types of responses to the question: ‘What do you think causes a drought?’

| Type of response                                                                 | Grade levels
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>7</td>
</tr>
<tr>
<td>Heat of the sun or when there is no rain for a longer period of time.</td>
<td>3.3 (5)</td>
</tr>
<tr>
<td>Cause by changing of the earth’s rotation, when the rivers are full and flood the place, is natural disaster due to climatic change.</td>
<td>0.7 (1)</td>
</tr>
<tr>
<td>Did not answer/don’t know.</td>
<td>5.9 (9)</td>
</tr>
</tbody>
</table>

Eight students (six Grade 9s and two Grade 10s) interviewed stated that a drought is caused when there is no rain with very hot sun shining all around the year. For example, Tom, a Grade 9 male student, stated that “the sun causes the drought and the food dies, plants dry up and die because there is no water, or rain.”
Table 8.48  Percentages (and student numbers) of types of responses to the question: Give examples of things that occur during a drought.

<table>
<thead>
<tr>
<th>Type of response</th>
<th>Grade 7</th>
<th>Grade 8</th>
<th>Grade 9</th>
<th>Grade 10</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>No water in ground, crops or food plants dying, ponds for fish dry up, streams and creeks dry up, bush on fire, animals die and water wells dry up.</td>
<td>2.6 (4)</td>
<td>15.7 (24)</td>
<td>22.2 (34)</td>
<td>13.1 (20)</td>
<td>53.6 (82)</td>
</tr>
<tr>
<td>River flooded, long period of dry season.</td>
<td>0 (0)</td>
<td>0 (0)</td>
<td>1.3 (2)</td>
<td>0 (0)</td>
<td>1.3 (2)</td>
</tr>
<tr>
<td>Did not answer/don’t know.</td>
<td>7.2 (11)</td>
<td>9.8 (15)</td>
<td>19.6 (30)</td>
<td>8.5 (13)</td>
<td>45.1 (69)</td>
</tr>
</tbody>
</table>

d) The final part of the question asked students to give examples of things that occur during a drought. Over half (55%) of the students gave examples such as no water in the ground, crops or food plants dying, ponds for fish dry up, streams and creeks dry up, bush on fire, animals die and water wells drying up. Another 1.3% of the students gave other examples of river flooding and long period of dry season. Another 43.6% of the students did not give a response to the question. Table 8.48 gives the types of students’ response across the four grades.

8.4  Conclusion

In this study, although the students in this sample have attended primary school in their villages and secondary school away from their villages and all speak the Toaripi language, there is a different range of meanings for each of the concepts asked in the first part of each of the questions. It is evident from the responses that the older students (Grades 9 and 10) tend to speak and understand the language more fluently than the younger ones (Grades 7 and 8). The older students were able to interpret the definitions of each of the concepts from the English meaning into Toaripi more fluently than the younger students. For example, on erosion, ten Grade 7s (6%) and eighteen grade 8s (11.7%) stated that they did not know or were not sure about the Toaripi meaning. This could be that either they did not know the meaning or they were unable to define the meaning in English first and interpret it later into Toaripi. Also it is likely that the younger students speak Toaripi fluently
but are unable to write it. Also they may not fully understand the concepts from the explanations given in formal science classes.

The study also revealed that student’s ideas and explanations about natural phenomena are strongly governed and controlled by their school science knowledge in the school setting. This is strongly evident in the types of responses given by students in the open-ended questionnaire. Moreover, most of the explanations of natural phenomena based on the elders’ personal experiences were mainly dominated by school science as indicated by the students which also resulted from their own experiences and interactions with their own natural environment.

The following examples illustrate and support the assertion that secondary school students’ understanding of natural phenomena is mainly dominated by their school science knowledge in the school setting. On erosion, 69 students (45%) when asked to describe erosion stated that erosion is “soil washed away by water, rain or flood”. On deposition, 66 students (43.2%) when asked to describe what deposition was stated that deposition “is the building up of soil carried down by a river, when eroded soil come to a certain place and settling down of materials caused by erosion and deposits at mouth of river”. On plant growth, when students were asked to describe plant growth in their own words, 96 students (62.8%) stated that “plants grow from seeds, roots, cuttings and shoots with the help of sunlight, water and nutrients from the soil”.

On rain, when students were asked where it comes from, 96 (62.8%) stated that “rain comes from clouds through the processes of evaporation, transpiration, condensation and precipitation (water cycle)”. On the sun, 63 students (41.2%) when asked if the sun stays in one place said “yes”, and stated the reason that “the earth orbits around the sun”. On clouds, when students were asked about how clouds are formed, 46 students (30%) stated that clouds are formed “when water in seas, swamps, etc evaporates by the heat of the sun (evaporation) and it is formed into water vapour and it is pushed up by the air currents so this is where the condensation takes place. The water vapour is now turned into clouds (condensation)”. On drought, when students were asked to describe what a drought is in their own words,
92 students (60.1%) stated that it is "experienced when a long period of dry season causes the soil to become hard for the crops or plants to grow". They also stated that a drought is "a long dry season with no rain and crops or living things die because of the hot sun".

However in this study also, many chose explanations of the same phenomena about spirits, spells and magic that came from the village, in the family or home. It seems that the explanations given by students when referring to spirits, spells and magic did agree with those given by the village elders. This is because students stated that they have heard of these explanations at home, in the family and in the village. Furthermore, parents of these students may know of these stories from the elders and so are able to pass them on to their children. The following examples illustrate and support the various explanations given by secondary school students on natural phenomena that have been dominated and based on spirits, spells and magic. On erosion, where students were asked about an old person telling them that someone in their village can make the sand move to another part of the beach. This person may cast magic spells or use seseva to move the sand. Then students were asked if they thought this could happen and give a reason as to why. Sixty-three stated "yes" and gave the reason that "this person may be angry with someone for stealing his things or the old person's relatives may be involved in a fight so he takes revenge. Also some people do not respect these elders or they may be jealous". On rain, students were asked if anyone in their villages can either bring or stop rain and explain how, 84 students said "yes" and stated "magician" (seseva karu) and they bring rain "by saying magic spells and singing a traditional song". Seventy-two students (47.1%) said "yes" and stated "magicians or sorcerers" who can stop rain "by saying magic spells (seseva).

A few responses and explanations were referred to church which is because most students come from families where the Christian religion is strong and practised everyday. For example, on rain, students were asked if anyone in their village can bring or stop rain and explain how. Twenty-one students (13.7%) said "no" in answer to who can bring rain and stated "God, as God created everything on earth and will bring rain to them through his blessings". Nineteen students (12.4%) said
“no” in answer to who can stop rain and stated “God, as God brings rain and stops it”. On rainbows, students were asked if it was a good idea to make or stop a rainbow and give a reason why, 33 students (21.5%) said “no” and stated, “God created it”.

The results of this study also show that correct and causal explanations of natural phenomena tend to increase with age as shown in the tables across the different grade levels.

8.5 Summary

During the analysis of the data collected from the questionnaires, most school-aged students chose scientific explanations of natural phenomena in terms of what they had learned in school or from their own personal experiences. This can be seen from the way they perceive, interpret and explain their own natural environment and surroundings. This is also because they have lived closely within their natural environment and so are able to give explanations within and from their own perspective and perception which complements with those of science. However, many chose explanations of the same phenomena about spirits, spells and magic that came from the village, in the family and home. This study was unable to identify students’ traditional beliefs in their science classroom setting because of their dominance over the science knowledge gained while attending school.

This study revealed that students’ ideas about natural phenomena are strongly governed and controlled by their school science knowledge in the school setting. It is likely that their explanations based on their own traditional knowledge cannot be identified in a school setting but that this may be identified by detailed interviews or questionnaires in the students’ local language and be given to students in their villages (as opposed to school). A previously discussed, students may hold traditional beliefs about natural phenomena but may not be prepared to acknowledge these in a school setting.
CHAPTER 9

SCIENCE TEACHERS' AND CURRICULUM OFFICERS' VIEW ON TRADITIONAL KNOWLEDGE IN THE SCIENCE CURRICULA

9.0 Overview of Chapter

The theme of this chapter is to present and describe the views of two male science teachers and two female curriculum officers on the inclusion of traditional knowledge in the science curricula. It is in response to Research Question 5: 'What views do science teachers and curriculum officers have on the use of traditional knowledge in the science curriculum?' Transcripts of the interviews with the science teachers and curriculum officers are presented in full in Appendix 9.

9.1 Science Teachers' Views on Traditional Knowledge in the Curriculum

Following the data collection from the students' questionnaires, two male science teachers, Mr Ivalaooa and Mr Paimuru, were interviewed by the researcher at Malalaua Provincial High School about their views on the inclusion of traditional knowledge in the curriculum. Both teachers felt that traditional knowledge was important and acknowledged that wherever possible, they bring it into their teaching. For example, the researcher observed Mr Ivalaooa, who was teaching a Grade 9 class on the topic of bones in the body, use some aspects of traditional knowledge to identify, explain and memorise the different types of bones in the body to the students.

When interviewed by the researcher about teaching the various science units, especially bringing traditional knowledge into it, Mr Paimuru stated:

As much as possible, I try to bring in things on traditional knowledge that the students know, especially in naming plants. I try to bring it into my classroom situation in a Grade 7 unit on earth and science, the earth, moon, and stars, especially their names in the various languages.
Mr Paimuru also stated:

There are things that people do that relate to science one way or another. One that comes into my mind is making lime by our people, which is a scientific idea. I mean it's a scientific concept and I teach that in a topic or unit on chemical changes, changing from one form of material into a used product.

Similarly, Mr Ivalaoa spoke about making lime:

Yes, in chemistry where some traditional ideas are used, for example, in lime making which is calcium oxide. Students should know this particular technique used in villages as I have seen it.

Mr Ivalaoa also stated:

In agriculture, we collect plants, identify the plants and those that are forest related, especially weeds to see whether they are toxic to medicinal practices. We collect and identify them and I even ask students to identify their views of these plants.

During the interviews, the researcher highlighted the problem of students coming to school and learning formal science, which to his understanding is the only scientific knowledge that students know. Students do not perceive that their traditional knowledge is also important while learning formal science. In reply to this, Mr Paimuru stated, "I think this is a big problem and we have to get the students to see that what they know compared to what their parents know is important and that is science." Furthermore, the researcher enquired about the knowledge that students are supposed to learn either from their parents or grandparents but they do not seem to do that. If students ask their parents then probably, their parents will share the knowledge and they will know these things and will share them with other students.
Mr Ivalaaoa stated:

The problem is somewhere in the village where parents themselves are not educating their children on the traditional aspects. So when they come in at Grade 7, I asked them about the naming of the stars. The syllabus uses the stars in theory and when you relate that to your language, the names of the stars are interrelated. Names like morning star or evening star. But actually these are planets but the students do not realise that and they identify them as normal stars. When you try to ask students to identify them in their languages, most of them do not seem to know.

Similarly, Mr Paimuru stated, “it is interesting that I asked this to the Toaripi speaking students and they do not seem to know.”

The researcher also asked the teachers whether the school should play an important role in promoting the idea of the importance of traditional knowledge within the communities in the different villages. Mr Ivalaaoa acknowledged:

I think they should be acquainted with their traditional knowledge about the environment and should be aware and when told, they should relate this to whatever they learn in schools, especially in the other subjects. So it is important that they should know. I think in years to come, sooner or later, like in the different languages we speak, they will disappear.

Similarly, Mr Paimuru stated:

Parents should be strongly involved in the school community. They should know that they have something there that the students may not know that should be taught to their children as well. They are just as important in this whole puzzle of educating their children.

The researcher spoke to some students and one said that in agriculture, the old people used to grow plants in a way that they do not follow nowadays. When asked by the researcher why, the student stated that probably the young people feel that the olden
days are gone and it is not useful anymore. The researcher thought it was still useful and stated that the new ways can be good but it is good to adapt some of the good things from the old ways and incorporate into the new ones. The researcher asked the two teachers how they felt about relating more to the traditional aspects of life. Mr Paimuru stated, “yes, that’s what I’m trying to bring in by getting the parents to be more involved in their children’s learning and they are just as important in the aspects of learning.” Similarly, Mr Ivalaoa explained:

Students should be equipped with their own knowledge and relate to it easily like the Japanese as everything they learn is taught in Japanese. At least they should know because they are born with it, the harmony, traditions, customs and other things. For sure, these things are fading away fast.

The researcher commented that this also was because the old people were dying away. In response, Mr Ivalaoa stated “I remember a missionary who wrote the *Toaripi* Bible, when he lodged it, he told the community in Port Moresby to teach their children their own language otherwise they will lose it. This is what is happening now.” Again the researcher agreed and stated that this was happening because students do not speak their languages well and do not understand them. This was happening in the cities; fortunately, in the villages, students do speak and maintain their own languages. Mr Ivalaoa also commented:

I have a book on African traditional medicinal plants and Africans seem to practice it, especially on healing boils, which are caused by bacteria. The traditional African way I learnt from the book was to mix lime with the very tip of a paw paw leaf. Squeeze it and put it on your boil and it comes out.

The researcher acknowledged that this was interesting. Furthermore, Mr Ivalaoa explained, “I told the people and they have been using it and it is very effective. There are lots of traditional things which are now fading away because the older people in the village are dying away and the young people are not interested.”
To overcome this, the researcher stated that the best thing was to involve parents by allowing them to visit the school, for example, during open days or cultural events and share traditional knowledge with the students. Such activities will eventually strengthen the relationships between the schools and the different village communities. The researcher also realised that students were doing individual science projects, especially in Grade 9, where they have to select villages and conduct surveys or research into the types of problems in the village. In that way, the villagers can see that the school community is interested in them and in turn the villagers may be able to share their knowledge with the school. Mr Paimuru acknowledged, "Yes, an example of a project that can be easily done is that of lime making. Using different types of shells that are around to see which ones can give the better lime. I mean the quantity or increase the quality." The researcher also suggested research on betelnut and Mr Paimuru explained:

Yes, that’s the other thing too, the betelnuts we have. We have different betelnuts and there are not so many varieties there. Do we know them? Do the students know them? Do the people in the villages know them? But these are things at home, things we do. We are trying to look for what we have been doing in terms of science now. The other thing we can also look at is that there are different types of mustards used and which is the most suitable.

From the views expressed during the interviews with the two science teachers, Mr Ivalaoa and Mr Paimuru, on the inclusion of traditional knowledge in the curriculum, it is evident that both teachers tend to bring some aspects of traditional knowledge into their teaching of topics such as the bones of the body, lime making and identifying different types of plants. This also depends on which part of the country the teachers come from because certain traditional knowledge used to explain science concepts differs from province to province. Because Mr Ivalaoa is from the Gulf Province and speaks Toaripi, he was able to relate and explain ideas meaningfully to students for whom Toaripi is their first language.
9.2 Curriculum Officers’ Views on Traditional Knowledge in the Curriculum

During the data collection, two female Papua New Guinean curriculum officers, Mrs Aiih and Mrs Hotsia were interviewed by the researcher about their views on the inclusion of traditional knowledge into the reformed curriculum. Both officers strongly agreed on its inclusion and stated that they have being involved with the traditional aspect of learning and knowledge in their teaching and have included it in the writing of curriculum materials as well. With well over 700 different languages and very diverse cultures in PNG, students in a typical classroom vary from province to province in their backgrounds and knowledge. For example, in writing curriculum materials on the environment, it is important to include something that is common to all provinces and leave other examples to the provinces because examples of traditional knowledge relating to particular concepts vary from province to province. Because of these two officers’ experiences in developing curriculum materials, they strongly agreed with the idea of including various aspects of traditional knowledge into the science curriculum. The researcher expressed the opinion that for teachers, traditional knowledge is important and interesting because it can bring the students to a stage where they realise that it is their own knowledge that they should be learning in the classrooms. As educators, we should be looking at this and relate the curriculum content back to the village, to their parents and grandparents.

Teaching in urban centres like Port Moresby is quite difficult because when teachers teach science and relate it to traditional knowledge, they find that there are students from different provinces with their own traditional knowledge. For example, when teachers teach about lime making, the other students will refer back to their province and use their own idea in making lime. When the researcher asked both officers’ views about including traditional knowledge in the science curriculum, Mrs Aiih acknowledged that:

Places like Port Moresby and any other towns seem to get students from different cultural backgrounds. I think it should be interesting because in science, they should get the concept right, say lime making, which in some
areas use corals and in some areas use shells. So I mean it is still the same process and should not be any different.

On using other aspects of traditional knowledge in writing science curriculum materials, Mrs Aihi stated:

Again, they might talk about when it is the best time to go hunting or fishing and again traditionally, they say, when the moon is at a certain position. That is the best time to go fishing and this is traditional knowledge but students do not realise that. There is a whole lot of knowledge that has not been written because for us, Papua New Guineans, our tradition has always been oral.”

Similarly, Mrs Hotsia stated:

I think the main thing about science is that, for example, traditional medicine is science in itself. The making of traditional medicine involves some kind of scientific process. From that we can relate to, for example, what sort of things we can learn and people know how to make it traditionally. They do not think this is science in itself but I think the most important thing is to be aware that science has been part of our tradition. It is just that we have never thought about it that way.

The researcher again asked if there was any other issue that both officers would like to share about including traditional knowledge in the science curriculum, an area that has not really been looked into seriously. Again, Mrs Aihi stated:

What I can share is not so much on traditional knowledge but what we are doing at the moment. Lately, we have been working on a transitional syllabus for Grades 9 and 10. In one of the school terms, we are hoping that students will do project work of their own choice. The teacher is just a facilitator but he or she will guide them in whatever they do, supervise them in doing a survey on the kind of diet they have in the village. What is the main meal? Maybe they will be planting and harvesting food crops, or making a fish pond, or making a model of some fishing gear or a car or solar
panels or housing model. So these are examples of projects that they will be working on. It may also include some chemical analysis of some of their traditional medicines or they could do a survey on it."

Mrs Aihi concluded that this was another new initiative that they were trialing since 1998 and 1999. The researcher acknowledged and commented that these projects would allow the students to become little scientists, which means they have to do interviews and this is a technique used in collecting data. They will learn how to conduct interviews, write out questionnaires and travel out to the villages if they are in the rural areas to talk to the people. The researcher acknowledged that it was a good way to promote science in the village to make people realise that there still exists a gap between the school and the community. So this exposure is good, especially for the students in the rural areas to go out and visit the villages. For example, while at Malalaau High School in the Gulf Province, the researcher observed that the relationship between the school and the community was poor. He did not know why but probably there were some problems that Mrs Aihi acknowledged as contributing to the poor relationship:

The thing is to change the attitudes of the parents. Education now is not to get white-collar jobs but to survive so what the students need to learn and understand that they can use that information and knowledge to live better lives in their homes in the future. The survey that they do on their diet may find something interesting and they could use that data to help the community to develop a healthy diet for them. For example, they might find out a lot of people die if they eat a lot of carbohydrates food but not enough protein. So that data could be of help to tell those people that we need to eat more protein in our diet but hopefully this are the kind of things that they need to help the community.

From the views expressed during the interviews with the two curriculum educators, Mrs Aihi and Mrs Hotsia, on the inclusion of traditional knowledge in the science curriculum, it is evident that both officers have used some aspects of traditional knowledge in their writing of curriculum materials. The initiative taken for students to do individual projects is worthwhile because such an activity can identify the most
appropriate ones which can be compiled and published as resource learning materials for other teachers

9.3 Summary

In response to Research Question 5: 'What views do science teachers and curriculum officers have on the inclusion of traditional knowledge in the science curriculum', and according to the views of two male science teachers and two female curriculum, each stated that there was a need to bring this knowledge into the various topics from elementary to upper secondary. In this way, students have a better understanding of the various science concepts that are taught and how this relates to traditional knowledge. Ironically, traditional knowledge held by the various tribes in PNG is an area that needs to be researched further and in depth. The conclusions, implementations and limitations of this study are presented and described in Chapter 10.
CHAPTER 10

CONCLUSIONS, IMPLICATIONS AND RECOMMENDATIONS

10.0 Introduction

This chapter presents the overall finding of this study by describing the various ideas and explanations about natural phenomena from typical village elders from a typical rural village ad from typical secondary school students in a typical boarding high school in the Gulf province of PNG. It also describes typical traditional science beliefs which typical secondary school students' hold onto while attending formal science lessons as well as the sources and types of explanations about natural phenomena. Science teachers' and curriculum officers' views on the inclusion of traditional knowledge into the PNG science curriculum also is presented. The findings of the study are described in response tot eh research questions. The educational significance of the finings of the study for educational practice is discussed, followed by the limitations and recommendations for future research.

The research questions underlying this study which relate to village elders and secondary school students in the Gulf Province of PNG, are as follows:

1. What traditional beliefs or stories do village elders hold in explaining natural phenomena?
2. What traditional science beliefs do secondary school students hold?
3. What are the sources of explanations that secondary school students give for natural phenomena?
4. What types of explanations do secondary school students give for natural phenomena?
5. What views do science teachers and curriculum officers have on the use of traditional knowledge in the science curriculum?

In providing answers to the research questions, the cultures and worldviews of the village elders, students, science teachers and curriculum officers were observed. The
type of cultural background and worldviews they possess determines how they construct the ideas, beliefs and explanations that they hold in explaining and understanding natural phenomena.

This study identified the traditional knowledge which village elders possess about natural phenomena and described the sources and types of explanations that secondary school students give for natural phenomena in a rural secondary school in PNG. The study is important as it investigated the various ideas and beliefs that students possess and bring to the science classrooms from their diverse cultural backgrounds. Because PNG is a culturally diverse country where students attending science classes come from very diverse cultural backgrounds, teaching and learning can be problematic in schools. The research questions provided the basis from which these conclusions were written. This chapter describes the overall findings of this study by describing the various ideas and explanations about natural phenomena from typical PNG village elders from a typical rural village and from typical PNG secondary school students in a typical rural boarding high school. It also describes typical traditional science beliefs which typical PNG students' hold onto while attending formal science lessons. Of interest also were the views of teachers and curriculum officers on the place of traditional knowledge in the science curriculum.

This study combined a range of data sources and research methods to increase confidence in the findings. Data sources included interviews with village elders in the elder's language, student interviews and questionnaires. All research instruments used in this study were written for English as Second Language (ESL) speakers.

### 10.1 Village Elders' Ideas About Natural Phenomena

In this study and in response to Research Question 1: ‘What traditional beliefs or stories do village elders hold in explaining natural phenomena?’, the recorded interviews with the eight village elders’ in Toaripi were transcribed and translated into English (see Chapter 5). Using phenomenological analysis (Moustakas, 1994), the elders' beliefs and explanations were classified into four categories namely,
'spirits, magic spells and sorcery'; 'Christianity'; 'personal experience'; and modern science'.

10.1.1 Spirits, magic spells and sorcery

Some village elders still hold on strongly to their traditional beliefs involving spirits, magic spells and sorcery, which can be seen from the way they perceive, interpret and explain their natural environment and surroundings. These village elders treat nature with respect and acknowledge that nature can provide all the necessities for their well-being. They see their task as that of managing the interaction with nature effectively so as to derive maximum benefit. Most of these beliefs exist today, although modern development and changes have taken place in PNG. For example, among the Toaripi of the Gulf Province, there is still a belief, held by many people, that the sun is looked after by a mythical or tribal ancestor called 'Epe Savora'. 'Epe Savora' is also a title given to the Savorip clan, one of the Elema tribes and is also the traditional name for ivuta (iguana) that is unafraid of the sun's heat as it is common in the village to see an iguana asleep on a tree during the day. It does not leave and continues to sleep on the tree till dawn. Traditionally, this spirit also represented sequences or periods of time such as at sunrise, it enabled the village people to get up early and go to their gardens and at sunset allowed them to come back to their villages, as it was getting dark. These periods of time especially at daylight allowed people to carry out various activities such as gardening, fishing, harvesting and building new homes and canoes to survive.

There is the belief that the moon is also looked after by a young spirit woman called 'Lau Lumori'. PNG ancestors referred the moon to young women (lau lumori or lau lukerepu) belonging to the different sub-clans (elavoapeape) (literally mouth of the men's house) whose bodies were clean and shiny like the full moon. These women were praised and admired, as one would not see any dirt on their skin. The names of these sub-clans are Ai Lavi Koi Lavi. The moon also represented sequences or periods of time as well. The sequences or different phases of the moon signified a particular months in the preparation of mortuary feasts called maea aro (literally body covered with charcoal) or mai hiake (a small meal at the time of the dead)
especially in respect of the dead. Normally it took between three to twelve moons (months) to prepare fully for a feast traditionally. The moon also represented fertility and harvest plus initiation ceremonies during traditional times. The moon also helped women to calculate roughly the month they were due to conceive children and enabled them to determine the child’s different stages of growth. It also helped women to plan the time accurately of when she was going to bear her next child.

Because they have lived closely within their natural environments they are able to give explanations of natural phenomena from their own personal perspective and perception which complement with those of science. However, these ideas cannot be identified easily as it could be the result of the science that they had learnt at school during their early years.

Traditional beliefs such as the sun is looked after by a spirit (‘Epe Savora’) and the moon is also looked after by a spirit (‘Lau Lumori’), magic spells (‘seseva’) are used to move the sand on the beach near the village or sorcery (‘maeasiri’) (pointing the bone) is used to kill people still exist today in modern PNG. Among the ‘Toaripi’ of the Gulf Province, an eponymous tribal ancestor called ‘Epe Savora’ looked after the sun. This spirit represented the sequences or periods of time. For example, at sunrise, it enabled the village people to get up early and go to their gardens and at sunset allowed them to come back to their villages, as it was getting dark. These periods of time especially at daylight allowed people to carry out various activities such as gardening, fishing, harvesting and building new homes and canoes to survive. The moon is also looked after by a young spirit woman called ‘Lau Lumori’ and represented sequences or periods of time as well. The sequences or different phases of the moon signified a particular months in the preparation of feasts especially for the dead. Normally it took about 6 to 12 moons (months) to prepare fully for a feast traditionally. The moon also represented fertility and harvest plus initiation ceremonies during traditional times. The moon also helped women to calculate roughly the month they were due to conceive children and enabled them to determine the child’s different stages of growth. It also helped women to plan the time accurately of when she was going to bear her next child.
10.1.2 Christianity

In the study, village elders gave numerous and interesting explanations from a religious position, which is mainly based on their active involvement with the village church, an influence strongly associated with the teaching by the early missionaries. Several village elders have roles such as deacons, pastors in the church today. The education that these elders received from the village mission schools may explain their responses, for example, on plant growth, that ‘God created the plants and trees in this world; on red sunset and sunrise, that, ‘the sun represents the Father (God) as God is powerful; on moon, that ‘the moon represents the Son (Jesus Christ) as a plan and gets its light from the sun (God); on rainbow, that ‘God created the rainbow as a sign to Noah and his family after the Great Flood in the Bible that there will be no more floods’.

10.1.3 Personal experience and modern science

During the analysis of the interviews with the village elders, similarities were found amongst explanations of the ‘personal experience’ category and that of modern science (see Chapter 5). These village elders have lived closely and interacted with their natural environment over time and so are able to make this statements and explanations, the source of which, unfortunately, cannot be identified easily as it could be the result of the limited science knowledge they had learnt at school. The following examples illustrate and support the similarities between the two categories.

- On ‘erosion and deposition’, a typical example was ‘inland rivers and creeks are blocked due to the felling of trees for food gardens. As a result, the water cannot assist in the deposition of sand downstream and on to the beach. This also makes the river get shallow’. This explanations is derived from personal experience over time and based on a once fast flowing river called the ‘Meporo’ river which the village elders as youngsters like the researcher’s parents used to paddle up and down on their way to the gardens and to make sago. Due to the continuous erosion and deposition over time, which were experienced by these elders and the felling of trees for new food and sago
gardens, these actions did not allow the river to flow freely on order for the soil to be washed down to the beach. At present, the river has become shallow and overgrown with water weeds and as a result village people now walk back and forth to their food gardens or to make sago.

- On 'drought', a typical explanation was 'the hot sun causes it, is a very long dry season, causes high tide and big waves, no rain for many months, soil is dry because of no water from the rain and people go hungry because of food shortage'. This explanation is based on personal experience over time and was encountered during one of the worst droughts in 1997 around October and November at the same time these interviews with the village elders were conducted. They have also experienced similar situations and so are able to relate to their past experiences of events that occur around this time. According to the elders, this long dry seasons causes high tides and big waves along the coast at this time of the year and it is unsafe to go out fishing and canoeing. The elders also know that food is scarce at this time so they prepare well in advance in case they run out of food. The scarcity of water also makes them dig wells near their houses where they have access to clean water for drinking, cooking and washing. Almost all the houses in the village have ground water wells.

- On 'plant growth' and on 'burning', typical responses, respectively, were 'the water from the rain helps plants to grow, seeds blown by wind causes plant growth in new areas, and mature trees produce seeds which fall to the ground and grow again' and 'burning the forests helps food crops like banana, corn and sweet potato to grow better and burning the bush produces ash and this fertilises the soil'. This explanation is based on village elders' experience when they make new gardens in the forest by clearing a forest area full of trees and leaving it to dry and then later on burn it. Then they dig, weed and clean the ground and prepare it for planting. They believe that the ash from the burn materials fertilises the soil and this can be seen from the food crops they plant and if it is plentiful, then there is a good harvest. They can also tell that when
an area is cleared, it promotes new plant growth and this sometimes is evident during the rainy season which starts around November to April each year.

- On ‘red sunrise and sunset’, a typical explanation was ‘smoke from fires creates the redness in the sky, observations on the sun indicates that the sun’s path is different due to the tilt of the earth from January to June and from July to December and the sun stays in one place but the earth revolves around it’. This explanation is based on personal experience and modern science. During the 1997 drought, the elders were able to state that the smoke produced by the fire that burnt their sago plots created the haze in the sky, which formed the red sunrise and sunset. It was also during this time that there was a large forest fire that burnt a big portion of trees, sago and betel nut palms and food gardens’. Furthermore, their everyday careful observations of the sun state that the sun follows different paths as it sets over the horizon in the west. At most times in this area, one would find beautiful and spectacular sunsets almost every day of the year as it sets over the horizon. This experience can be emotional and create a yearning for the spirit world.

- On the ‘moon’, a typical explanation was ‘the sun’s rays fall on the moon and makes it shine and the moon controls tides, weather patterns and seasons’, is based on personal experience and modern science. From the village elders’ experience, they know that the moon controls tides so if there is a full moon, sometimes it is low tide in the night and high tide in the morning or visa-versa. They also can tell that the moon controls seasons such as the start and end of the wet and dry seasons. The different phases of the moon also signify the time when various species of fish as plentiful and in season.

- On ‘rain’ and ‘clouds’, typical explanations are, respectively, ‘the sun heats the water and it changes into steam, which rises into the air, moves around and form clouds. As the heavy clouds approach mountains, it falls down as rain again. Rain is brought by the wind, which brings black clouds’ and ‘black clouds are formed when water evaporates and changes into steam when he sun heats it. It rises into cool air and forms clouds’. These explanations are from
personal experience, when they have seen the steam rising into the air and changing into clouds and modern science.

10.2 Secondary School Students’ Science Beliefs

This study investigated the various science beliefs held by secondary school students while attending formal science classes and is in response to Research Question 2: ‘What traditional science beliefs do secondary school students hold?’ The responses from the first questionnaire on ‘Traditional Science Beliefs’ (see Appendix 4.1) were analysed to form four categories namely: ‘consequences involving humans’; ‘certain events are life-threatening; ‘consequences of nature’; and ‘events involving spirits’. Approximately 50% of the students held beliefs on 19 out of the 40 traditional belief statements. Of the four categories identified, more than 50% of the students held traditional beliefs in three items of ‘consequences involving humans’, five items involving ‘certain events are life-threatening’, six items involving ‘consequences of nature’ and three items for ‘events involving spirits’ (see Chapter 6 for detailed discussions).

10.2.1 Consequences involving humans

An example of an item in this category was, Drinking lots of juice from a young coconut can cure diarrhoea’ (Item 2) (66.7% of the students agree or strongly agree). Another example is, ‘If you point at a rainbow, you will get a mokora poi or a lump will grow under your arm pit’ (Item 20) (53.2% of the students agree or strongly agree).

10.2.2 Certain events are life-threatening

An example of an item in this category was, ‘If one sees a ghost in the night, that means someone will die’ (Item 35) (65.7% of the students agree or strongly agree). Another example is, ‘If you step over urine, you will get a swelling in the groin or kapo fare’ (Item 39) (58.9% of the students agree or strongly agree).
10.2.3 Consequences involving nature

An example of an item in this category was, ‘The evening star ‘Oa Miri-Mirou’ represents a planet called Venus’ (Item 21) (52.2% agree or strongly agree). Traditionally, Oa Miri-Mirou was the mythical tribal ancestor of the Melaripi clan of the Elema people. It is termed miri (beach) because of the coastal location. Another example is, ‘The chirping of a bird tells of visitors drawing near’ Item 28) (54.5% of the students agree or strongly agree).

10.2.4 Events involving spirits

An example of an item in this category was, ‘The sun is looked after by the mythical or tribal ancestor called epe savora (Item 34) (50.6% agree or strongly agree). During traditional times, epe savora was a honorific title given to one of the clans called Savoripi clan of the Elema people. Tribal ancestors used to say that epe savora represented the time when the sun rises in the morning and shines throughout the whole day till it went down. This meant that villagers worked during the time when the sun was hot it went down. Epe savora is also the traditional term for ivuta or iguana which does not get scared of the sun’s heat.

10.2.5 Undecided responses

The study also found that a high percentage of students were undecided about holding or not holding traditional beliefs among the four categories. For instance, students were undecided on four items for ‘consequences involving humans’, three items involving ‘certain events are life-threatening’, three items for ‘consequences involving nature’ and four items for ‘events involving spirits’. These students were most likely reluctant to show that they strongly believed in these beliefs as they may have thought that others would view them to be uneducated if they still held these beliefs. The following gives an example of an item in each of the categories.

An example of an item in the category on ‘consequences involving humans’ was ‘Eating the eyes of fish will make you see better in the night’ (Item 1) (47.5% of
students were undecided). In the category 'certain events are life-threatening', 'If men swim downstream of women, they will lose their strength' (Item 40) (46.8% of the students were undecided). In the category 'consequences involving nature', 'If the navel string (umbilical cord) is planted under a coconut tree, the tree will bear many fruits' (Item 10) (50.6% of the students were undecided). In the category on 'events involving spirits', 'A full moon is referred to as lau lumori, the young spirit woman who looks after the moon' (Item 33 (32.1% o the students were undecided).

Secondary school students still hold onto traditional beliefs, which they have heard them from their parents or grandparents at home or in the village. These beliefs, which could be magic spells (seseva) or chants and sorcery (maeasiri) (pointing the bone), have been used by tribal ancestors long ago and passed on from the older generation to the younger generation for centuries. Those who hold onto these beliefs contend that magic spells or chants are cast on betelnut or coconut trees to stop people from stealing them. Spells are also cast on the beach to move the sand onto another part of the beach as a revenge of the death of a daughter or even arguments with village people. It is also possible that students who were undecided about holding or not holding traditional beliefs did not fully understand the belief statements that were written in English so were unable to decide which ones they strongly believed in. A relatively low percentage of students disagreed and strongly disagreed with some of the statements which may be because they think they are for older people and not for the younger generation to hold onto in this modern world.

The students involved in this study came from different villages where they have spent most of their lives, including the community school. The beliefs they strongly hold onto have originated from their social interactions with their grandparents and parents, their peers and the games they play in the villages. This study shows that although the students spent most of their secondary school education away from their villages, many still admit to holding these beliefs strongly while attending formal science classes. If the students, after formal science learning, still continue to hold such traditional beliefs, then it is likely that the elders (with a large percentage being illiterate) in the village communities are able to convince students of the importance and lasting value of these traditional beliefs.
10.3 Secondary School Students’ Sources of Explanations About Natural Phenomena

This study, in response to Research Question 3: ‘What are the sources of explanations that secondary school students give for natural phenomena?’, examined students’ responses within the context of Students Questionnaire 1: Sources of Explanations (see Appendix 4.2). Secondary school students’ responses to the 11 questions were categorised in terms of the sources where they obtained their ideas or explanations: 1) the home, in the village or family; 2) school; 3) church; or 4) that they have never heard of these explanations being used.

The explanations given by these 185 students were dependent on context, primarily referring to spirits, spells and magic, and religion in providing the sources of explanations of natural phenomena in the home, family and village, and scientific explanations from school or from their own personal experiences in their interactions with their natural environment. The sources of explanations given by students when referring to spirits, spells and magic do agree with those given by the village elders and were heard at home, in the family and in the village. Furthermore, parents of these students may know of these stories from the elders, their grandparents and parents and so are able to pass them onto their children. Most of the sources of the explanations of natural phenomena resulted from their own experiences and interactions with their natural environment and were related to school science learned at school. The few explanations that were heard in the church came from families where the Christian religion is still strong and practised everyday.

10.3.1 Students’ explanations heard in the home, in the village or family

In this study, many students have heard explanations of the same phenomena about spirits, spells and magic that came from the village, family or home. A small number had no explanations because they have never heard the ideas or explanations being expressed. The following examples illustrate and support the various sources of explanations given by secondary school students on natural phenomena that have been dominated and based on spirits, spells and magic. On clouds, students (44.4%)
have heard the following explanation at home, in the family and village. ‘A cloud is
the soft hair of a spirit woman called lau lumori who guides and looks after the
moon. Her soft hair is the cloud in the night that casts a shadow on the moon’. On
rain, students (81.4%) have heard the explanation: ‘People cast and use spells to
bring rain. As the spells are cast, the wind becomes strong. During the rainy season,
a fish called salivera appear living in a big rock. As the rain water rises and covers
the rock, the fish swim out, down the river and into the open sea’. On erosion and
deposition, students (76.5%) have heard the explanation: ‘People cast spells or
seseva and utter magic words to move sand on the beach in my village. As the sea
water hits the sand, it makes the sand walk and move along the beach. The sand
settles in the requested place and builds up’. On the moon, students (55.6%) have
heard the explanation: ‘In the past, some people believe that a young spirit woman
called lau lumori guides and looks after the moon. Her soft hair is the cloud in the
night sky that casts a shadow on the moon’. On the sun, students (50.5%) have heard
the explanation: ‘The sun is looked after by an ancestral spirit called Epe Savora’.
Epe Savora is the tribal ancestor of the Savoripi clan. It is also the title of honour for
menfolk of the clan. Epe Savora helps direct the sun from sunrise to sunset.

10.3.2 Students’ explanations heard in school

The following examples illustrate and support the various sources of explanations
identified by secondary school students on natural phenomena that they have heard
in school science as well as their own experiences and interactions with their natural
environment. On the formation of clouds, students (90.4%) have heard the
explanation: ‘In the forest, water on the ground dries up and disappears as the hot
sun heats it. It changes into steam and rises into the air. As it rises, it cools in the
cool air in the sky. Then it becomes clouds’. On how rain comes, students (82.4%)
have heard the explanation: ‘The sun heat the water and changes into steam. The
steam rises into the cool air, moves around and forms clouds. The wind blows the
clouds into the mountains. As they get closer to the mountains, they become heavy
and fall down as rain. The rain water flows into rivers and down to the sea. The
whole cycles starts over again’. On thunder and lightning, students (52.1%) have
heard the explanation: ‘Lightning and thunder are both formed when dark rainy
clouds move past one another at a fast rate. As they heat up the air, this forms thunder and lightning. The sound of thunder and lightning is like a drum being cracked, hit and rolled across the sky'. On rainbow, students (60.8%) of the students chose the explanation: 'A rainbow is a colourful sign that appears during and after rainstorms. The rainbow appears when the sun's light rays hit the steam (water vapour) from the rain in the air'.

On erosion and deposition, students (32.5%) have heard and learnt the following explanation at school or from their own personal experiences: 'The changes in the winds direction and tides cause the sand on the beach in my village to be eroded. The two processes helps built up the sand on the beach in my village'. On the moon, students (61.8%) have heard the explanation: 'My own observations of the moon tells me that it is a natural body in space. It has no light of its own. When the moon shines, it is really the reflecting light from the sun. The bright light on the moon is created by the sun's rays that fall on the moon'. For the sun, students (68.5%) have heard and learnt the following explanation at school and from their own experiences: 'My everyday observations tell me that the sun follows different paths. This is due to the tilt of the earth from January to June and from July to December. Therefore the sun stays in one place. Our earth revolves around the sun'. On plant growth, students (67.2%) have heard the explanation: 'Some seedlings are dispersed by animal with the help of water, wind and animal. The seedlings grow into large trees when there is enough water and good fertile soil'.

On drought, students (35.5%) have heard the following explanation: 'A continuous period of little or no rain means there is a drought. When this happens the demand for water is greater than the amount available. In areas where drought is short-lived, there is loss of food crops and the use of water is restricted'. On burning, students (31.4%) have heard this explanation that they have learnt at school of from their own personal experience: 'In the past, village people cleared and burnt the forest to let more light in. Burning the bush materials as a result produces ash, which fertilises the soil. Food crops grow well as the soil is fertile and contains water from the rain'. Finally on wind, students (56.3%) have heard the explanation: 'Moving air masses
are set in motion by the uneven heating of the earth’s surface. When the wind is strong, it brings many black clouds and heavy rain’.

Most of the sources of explanations identified by secondary school students in this category are based on school science knowledge and their personal experience. These explanations may have developed over time and students are able to relate them to their experiences of living within their natural environment.

10.3.3 Students’ explanations heard in the church

The following examples illustrate and support the various sources of explanations identified by secondary school students on natural phenomena that they have heard in church and which have been influenced by religion and their attendance at church services either at school or in the village. On clouds, students (77.7%) have heard the following explanations: ‘God created the earth and everything in it. God created clouds so that the rain gives water to plants and animals. The water also cools the hot ground’. On rain, students (69.8%) have heard the explanation: ‘God created clouds in order to bring rain to earth. It only rains when God wants it to rain. He causes it to rain so that plants and animals can survive. The water also helps to cool off the hot ground’. On lightning and thunder, students (64.2%) have heard the explanation: ‘Lightning and thunder are both great wonders of the world created by God. These two things are signs to scare people. They are signs to show people the great power of God’. On rainbow, students (73.9%) have heard the explanation: ‘A rainbow is a colourful sign created by God. It is God’s promise to the people on earth that there will never be another Great Flood again’.

For erosion and deposition, students (41.1%) have heard the explanation: ‘The sand on the beach in my village gets eroded and deposited somewhere all the time. This is a punishment from God because the people do not worship God. If people worship God, then the sand will build up again on the beach’. On the sun, students (38.7%) have heard the explanation: “Some Christian people believe that the sun represents the Father (God) or Jehovah Valara. The sun is hot which makes God also the Supreme Being. The moon represents the Son (Jesus Christ) or Atute. The stars
represent the Holy Spirit or *Safa Arahoha Lareva*. On the sun again, students (58.9%) have heard the explanation: ‘The sun was created by God in the beginning. The sun is hot and gives light and warmth to all plants and animals on earth. We depend on the sun because sunset means we can rest till morning. When the sun rises again, we wake up and go off to our daily work’.

On plant growth, students (64.7%) have heard the explanation: ‘Some Christian people believe that when God created the earth, he also created plants and trees. Plants grow because God cares for them. God provides the sun to help plants grow’. On drought, students (56%) have heard the explanation: ‘Some people believe a drought is a sign and punishment from God. This is because most people have turned against God and are doing evil and wicked things. A drought is also a sign that we are nearing the year 2000’. On wind, students (53.8%) have heard the explanation: ‘Large masses of air are created and formed by God or Jehova Ualare. This strong wind sometimes blow people’s houses down and destroy food gardens. This is to punish wicked people because of their sinful activities of Earth’.

10.4 Secondary School Students’ Types of Explanations About Natural Phenomena

The study investigated the types of students’ notions natural phenomena and is in response to Research Question 4: ‘What types of explanations do secondary school students give for natural phenomena?’ Responses were solicited from open-ended questions in *Student Questionnaire 2: Types of Explanations Used* (see Appendix 4.3). The following examples are illustrative of the explanations students have learnt from science lessons or from their own personal experiences of interacting with their natural environment over time.

- When they were asked to describe erosion in their own words, about a typical response from students (73.8%) was ‘erosion is soil washed away by water, rain or flood’.
- When asked to describe what deposition was, typical response from students (40.9%) was ‘deposition is the building up of soil carried down by a river’.
• On the sun, a typical response the students (42.8%) gave when asked if the sun stays in one place was 'yes' and the reason they gave was that 'the earth orbits around the sun'.

• When they were asked to describe plant growth in their own words, a typical response given by students (66.7%) was 'plants grow from seeds, roots, cuttings and shoots with the help of sunlight, water and nutrients from the soil'.

• When they were asked where rain comes from, a typical response students (63.5%) gave was 'rain comes from clouds through the processes of evaporation, transpiration, condensation and precipitation (water cycle)'.

• On how clouds are formed, a typical response students (31.8%) gave was 'when water in seas, swamps, lakes and rivers evaporates by the heat of the sun (evaporation) and it is formed into water vapour and it is pushed up by the air currents so this is where the condensation takes place. The water vapour is now turned into clouds (condensation)'.

• When they were asked to describe what a drought was in their own words, a typical response students (60.7%) gave was 'a drought is experienced when a long period of dry season causes the soil to become hard for the crops or plants to grow. It is a long dry season with no rain and crops or living things die because of the hot sun'.

The following examples illustrate and acknowledge students’ explanations that relate to spirits, magic spells and sorcery.

• On erosion, a typical response that students (41.1%) (n=63) gave when asked if an old person can make the sand move to another part of the beach by saying magic spells was as follows: 'Yes, as this person may be angry with the village people for stealing his/her sago, betelnuts or coconuts. This person’s relatives may be involved in a fight or village people have no respect for this person and because of jealousy'.

• When asked if an old person in their village can use magic spells to deposit the sand on another part of the beach in their village, a typical response given by students (18.2%) (n=28) was that 'The person may be angry with people for
collecting shellfish or fishing in the river. All the village people know this person has magic spells to do it. This person has the spirit of magic spells. This person is a powerful magician’.

- On explaining if anyone can bring rain, a typical response students (54.9%) (n=84) gave was that, ‘Magician (seseva karu) can bring rain by saying magic spells and singing a traditional song’.

- On thunder, a typical response when asked if there was any way in stopping thunder, students (18.3%) (n=28) said, ‘By using magic spells (sesevay).’

- When they were asked if there was any way in stopping lightning, a typical response by students (11.8%) (n=18) was ‘By using magic spells (seseva).’

- When they were asked if a young spirit woman looks after and guides the moon, a typical response students (9.9%) (n=15) gave was that, ‘Their ancestors might have told them the stories (papa fari) and have heard village people say lau lumori when they see the moon coming up’.

- When they were asked if the sun is looked after by a spirit called Epe Savora, a typical response students (3.9%) (n=6) gave was, ‘Because it is a legend and people talk about it’.

The following examples illustrate and acknowledge students’ explanations that relate to Christianity.

- When they were asked if anyone in their village could bring rain, a typical response students (13.7%) (n=21) gave was, ‘God created everything on Earth and will bring rain to them through his blessings’.

- When they were asked if anyone in their village can stop the rain, who and how, a typical response students (12.4%) (n=19) gave was, ‘God brings rain and stops it’.

- When they were asked if anyone could stop thunder, a typical response students (2.6%) (n=4) was, ‘Only God can stop it’.

- When asked to describe what a rainbow was, a typical response from students (16.3%) (n=25) was that it is ‘created by God and a promise that there will be no more flood’.

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10.5 Science Teachers’ and Curriculum Officers’ Views on Traditional Knowledge in the Science Curriculum

In this study, interviews with two male science teachers and two female curriculum officers sought their views on the inclusion of traditional knowledge in the science curricula. All stated that there was a need to bring traditional knowledge into the topics from elementary to upper secondary so that students’ understanding of the various science concepts becomes more meaningful. Both science teachers bring some aspects of traditional knowledge into their teaching of topics such as the bones of the body, lime making and identifying different types of plants. However, the inclusion of these topics also depends on which part of PNG the teachers come from because certain traditional knowledge used to explain science concepts differs from province to province. One teacher, Mr Ivalaoa, come from the Gulf Province and speaks Toaripi, and was able to relate and explain ideas meaningfully to students from whom Toaripi is their first language. Both curriculum officers, Mrs Aihi and Mrs Hotsia, have adapted and used some aspects of traditional knowledge in their writing of curriculum materials, students doing individual projects, for example, on using traditional knowledge in building houses making a fish pond, improving diet in the villages, growing and harvesting food crops. This knowledge may enable students to develop an interest in using their traditional knowledge to understand science concepts meaningfully.

10.6 Summary

Research Question 1: What traditional beliefs or stories do village elders hold in explaining natural phenomena?

Village elders’ explanations about natural phenomena were categorised as being attributed to spirits, magic spells and sorcery, Christianity, personal experience, and modern science. The explanations that relate to spirits, magic spells and sorcery have been passed on from the older generation through spoken word. Most of these beliefs are strongly held by older members of the tribe who also have invaluable knowledge on folklore and the different structures of the clans in the villages.
Traditional beliefs are those where the sun and the moon are looked after by spirits; magic spells (seseva) are used to move the sand on the beach near the village, or sorcery (maeasiri) (pointing the bone) is used to kill people as a revenge tactic. Another traditional belief (George, 1991) still strong among PNG tribes is that of a powerful spirit called Patip/Yangela who created the universe and everything in it. Each component of the universe is associated with its own spirit, like the spirit of the garden, spirit of the animal, spirit of weather and spirit of the forest. The spirit of lightning is considered to be an angry spirit and this makes the people fearful of it. This is why people tend to stay indoors during thunderstorms.

The explanations related to religion are most likely the result of the early influence by the missionaries in converting PNG people by teaching them to read the Bible and write in their own languages. Several of these elders in the study may have received their education by attending mission schools. The explanations related to personal experiences in the result of the elder’s time honoured interpretations and their interactions with their natural environment which complements with those of modern science.

*Research Question 2: What traditional science beliefs do secondary students hold?*

Secondary school students’ traditional science beliefs were categorised into four groups namely: ‘consequences involving humans’, ‘certain events are life-threatening’ ‘consequences involving nature’, and ‘events involving spirits’. Approximately 50% of the students held beliefs on 19 out of 40 belief statements in the *Traditional Science Beliefs* questionnaire. Students hold onto traditional beliefs because they may have heard them from their parents or grandparents at home or the games they play with their peers in the village. The study also found that a high percentage of students were undecided about holding or not holding traditional beliefs among the four categories. Students appeared to be reluctant to show that they strongly believed in these beliefs because others would interpret them as uneducated if they still held onto these beliefs. A relatively low percentage of students disagreed and strongly disagreed with their belief statements. This study was unable to identify the students’ traditional beliefs in their science classroom setting because these
beliefs were dominated by the science knowledge gained while attending and learning formal school science.

*Research Question 3: What are the sources of explanations that secondary school students give for natural phenomena?*

Most secondary school students' sources of explanations given in response to *Student Questionnaire 1: Sources of Explanations* were categorised as being dependent on context in terms of where they obtained their ideas or explanations from, whether they were from the home, in the village or family, school, church, or they have never heard of these explanations being used. Many students identified sources of explanations of the same phenomena about spirits, magic spells and sorcery that they had heard from the village, family or home and these explanations did agree with those given by the village elders. Furthermore, parents of these students may know of these beliefs from their grandparents and so are able to pass them on to their children. Students have heard explanations that are influenced by religion and their attendance at church services either at school or in the village. Most students identified sources of explanations from school science as well as their own experiences and interactions with their natural environment. A small number had no sources of explanations because they have never heard the ideas or explanations being expressed.

*Research Question 4: What types of explanations do secondary students give for natural phenomena?*

For *Student Questionnaire 2: Types of Explanations Used*, most secondary school students gave types of explanations on natural phenomena that were mainly dominated by scientific explanations of natural phenomena in terms of what they had learnt at school or from their own personal experiences and interactions with their natural environment. Students provided explanations about the natural environment and surroundings because they have lived closely within their natural environment and are able to give explanations from within their own perceptions that complement those of science. However, many students gave explanations of the same phenomena
about spirits, magic spells and sorcery that came from the village, in the family and in the home.

**Research Question 5:** What views to science teachers and curriculum officers have on the use of traditional knowledge in the science curriculum?

The interviews with the two teachers and the two curriculum officers indicated that they considered it important to include traditional knowledge in the science classroom and to let students know that traditional science is part of the tradition of PNG people. The curriculum officers also stated that there was a need for a new curriculum project that includes traditional knowledge in the science curriculum.

**10.7 Educational Significance**

Secondary school students still hold onto their traditional beliefs strongly. This presents a dilemma in whether or not the students really do hold other traditional beliefs that are strongly held by the village elders because it may be that in science classrooms, these traditional beliefs exist in parallel but are dominated by school science knowledge. This study and similar ones conducted in many other developing countries (e.g., Baker & Taylor, 1995; Cobern & Aikenhead, 1998; George, 1991; Waldrip & Taylor, 1999a; 1999b) again raises the dilemma of whether or not the school science curricula is serving the needs of students when their school learned knowledge is in conflict with that learned in the village, home or church or from their village elders and parents or grandparents. However, it may be that in school science classrooms, this traditional knowledge exists in parallel but is dominated by school science knowledge. It is likely that students' explanations based on their own traditional knowledge cannot be identified in a school setting but that this may be identified by interviews or questionnaires in the students' local language in their villages (as opposed to school). In addition, so as not to diminish the value of this traditional knowledge, science education programs are needed that are able to consider and harmonise traditional knowledge with school science. Jegede and Fraser (1989) suggest that curriculum and instruction of learners of science in non-Western societies begin with and reflect the world-views they already possess. Millar and
Driver (1987) concluded that the challenge for science education is to find contexts which relevant to students’ interests and concerns, and which can offer strategies an framework for developing their understanding of scientific concepts and the cultural contribution to science.

10.8 Limitations

The study has limitations that restricted making generalisations of the findings in describing the various ideas and explanations about natural phenomena from typical village elders from a typical rural village and from typical secondary school students in a typical rural boarding high school in PNG. Chapter 1 discussed four limitations. The first limitation was the single location and setting of the Gulf Province of PNG; the second limitation was because only village elders from one particular Toaripi speaking village were interviewed. The third limitation was because the data came from only one school with two classes each of Grades 9 and 10 and three classes each of Grades 7 and 8 in PNG; the fourth limitation related to instruments used in the study designed for English as Second Language (ESL) speakers.

The fifth limitation was the time selected for the actual gathering of data, a factor that may have affected the collection and analysis of data. Term three is the third quarter of the academic year and by this time students interest in participation in non-assessable activities declines because they have examinations to worry about, assignments and projects and psychologically, the thought of losing their close friends or relatives in Grade 10. The Grade 10s had only one week to sit for their School Certificate Examinations.

The sixth limitation was the allocated time to conduct extensive interviews with the students on traditional beliefs in the local language (Toaripi) using the same items on the questionnaire in their respective villages. It was evident in the study that the findings present a dilemma in whether or not the students really do hold other traditional beliefs that are strongly held by the village elders because it may be that in science classrooms, these beliefs exist in parallel but are dominated by school science knowledge.
The seventh limitation was that this study only attempted to identify the explanations on natural phenomena given by male village elders. It would be appropriate to interview female village elders using the same questions in the interview in a further study but this poses cultural issues for this male researcher.

10.9 Recommendations for Further Research

The recommendations are presented under the basic framework of the research questions. Recommendations 1 to 4 are related to the use of traditional knowledge from a cultural perspective in assisting teachers and curriculum developers in developing strategies and materials that will enhance an improve the relevance of secondary school student's science learning. Recommendation 5 relates to teacher education programs that will improve science teaching and learning, while Recommendation 6 relates to informal education in the community.

Recommendation 1

*Interview and record village elders in the different provinces who possess valuable knowledge on natural phenomena.*

The first research question, sought to identify the traditional knowledge of natural phenomena held by respected village elders from the Gulf province who speak *Toaripi*. The village elders possess interesting and extensive knowledge in explaining natural phenomena that were categorised as being based on spirits, magic spells and sorcery, personal experience, Christianity, and modern science. The explanations were from their personal experiences of living in harmony and interacting with the natural environment that complemented explanations of modern science.

Recommendation 2

*Conduct more research to identify and analyse the various traditional beliefs and ideas held by school students of all ages from the various cultural groups in PNG.*

The second research question, which sought to identify secondary school students' traditional science beliefs, shows that about half of these traditional science beliefs
were strongly held by the students, while most of the others beliefs were held by a small number of students. The students involved in this study came from different villages where they have spent time growing up (including community school). The beliefs to which they strongly held may have originated from social interactions with their grandparents, parents, uncles and aunts in the villages, their peers and the games they play. It is also evident from this study that although the students spent most of their secondary school education away from their villages, may still hold these beliefs strongly and bring them to science classes. However, these beliefs or ideas about their natural world do not conform to the modern science they learn in school science. Earlier research studies have not fully examined the concurrent existence of students’ traditional science beliefs but have shown that scientific explanations of the physical world are learned in school science chiefly for passing of school examinations.

**Recommendation 3**

*Encourage school students to carry out projects to interview their village elders to identify traditional knowledge and compile this information into learning materials like a natural history book.*

The third research question, which sought to identify the sources of explanations school students gave in explaining and understanding natural phenomena, showed these explanations were dependent on context when referring to spirits, magic spells and sorcery, and religion in providing explanations of natural phenomena in the home, family and village. Scientific explanations were identified from school or from their own experiences within their natural environment. Many explanations that students have heard when referring to spirits, magic spells and sorcery agreed with those given by the village elders; students stated that they have heard these explanations at home, in the family and village.
Recommendation 4

*Interview secondary school students in their local languages in their villages (as opposed to school) to identify whether or not they offer explanations of natural phenomena based on traditional knowledge.*

The fourth research question sought, by means of open-ended questions, to identify the types of explanations used by secondary school students in describing natural phenomena. Students’ ideas and explanations about natural phenomena appeared to be dominated by their school science knowledge in the school setting.

Recommendation 5

*Develop teaching/learning strategies that enable teachers to link Western science with traditional knowledge so that learning traditional knowledge and Western science can be enhanced and harmonised. In this way students could be accepting of both traditional knowledge and Western science.*

The fifth research question sought, by means of interviews with science teachers and curriculum officers, to identify how traditional knowledge can be used in developing teaching strategies and materials that will enhance and improve students’ science learning. Both science teachers stated that wherever possible, they bring traditional knowledge into their teaching, relating it back to the students’ village backgrounds. They believed that whatever ideas students bring with them to the classrooms must be listened to and valued by the teachers. Similarly, both curriculum officers stated that they have been involved with the traditional aspects of learning and knowledge in their teaching and have included it into writing of curriculum materials. However, the issue here is that the country has over 800 different languages and a diverse culture so what is common should be included and the other examples left to the provinces as examples because the curriculum will vary from province to province.

Both curriculum officers also stated that they bring in the traditional knowledge aspects of learning, especially in the writing of curriculum materials where they emphasise to teachers to explain more about traditional ideas and knowledge that relate to science. However, the officers claimed teachers often think that science is a
Western concept and foreign to them but they do not realise that, for example, projects that students do on lime-making is both traditional knowledge and modern science. They also stated that teachers have difficulty teaching students from different cultural backgrounds to their own and there is a lot of traditional knowledge that has not been written because for most Papua New Guineans the tradition has been oral.

Recommendation 6

Engage local communities in non-formal education and adult literacy programs so that traditional knowledge can be better valued.

The study has identified various traditional knowledge and beliefs possessed by village elders on natural phenomena in their communities that are still valued because the elders (with a large percentage being illiterate) in village communities still have power and control over these beliefs. There is a need for non-formal education and adult literacy programs to be devised based on locally produced contextually relevant science-based materials with appropriate instructional strategies that will empower the illiterate population to view and harmonise science learning which is still directly related to their local culture.

The interviews conducted with the science teachers showed that community participation on the students’ learning is non-existence. There is a need for sharing responsibility in education between the parents, teachers, pastors, family, community and other groups to achieve a fully educated society. In the provision of an appropriate curriculum, it is important to involve the community in education and include their role in developing community, vernacular or tok ples initiatives, early childhood and cultural education, and improve the quality and administration capacity of teachers, school administrators, district and provincial education administrators.

There is also a need to improve and promote community participation in the curriculum process and identify appropriate stakeholders to fully participate in the curriculum process. There is also a need for infrastructure to be put in place so that it will allow school teachers, parents, other members of the community, and curriculum
developers to ask their questions in the same forum and identify mutually accepted alternatives for the development of relevant curricula and schools that are connected to social and economic reality. Finally, there is a need to evolve science teaching in such a way so that it is both sensitive to the intellectual needs of the students and is culturally sympathetic to the students' cultural background.
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APPENDIX 3.1

The Gulf Province, Its Language and People,
Traditions and Sub-cultures

Physical features

The province has a land area of about 34,500 square kilometres with a population of 80,000 (1990 est.) on the south coast of the country. The provincial capital is Kerema, situated about 230 kilometres south-west of Port Moresby. The province spans over 1000 kilometres of the Gulf of Papua with its hinterland of stunning diversity. One-half of the province is made up of coastal plains predominantly covered with waterways, swamps and vast mangrove forests. The other half contains rugged timbered mountain ranges with the highest peak (Armit Range) at about 2775 metres (Datec, 1996). The province has some of PNG’s heaviest rainfall and its rivers and widespread swamps make it difficult for communication and transportation. The coastline is dominated by channels of water that wind through the sandy deltas from the Fly River in the Western Province to Point Cupola near Kerema. The built up of soil on the delta is due to the erosion and deposition by the Turama, Kikori, Purari and Vailala rivers with the Purari and Kikori being PNG’s third and fourth biggest rivers. Other major rivers of the province are the Tauri and Lakekamu found east of Kerema which pass through a broad swampy basin. The muddy waters of these rivers prevent the growth of coral along the coast (Rannells, 1990). The tidal flats along most of the coast are covered with mangrove forests, nipa palm growing in the mixed salt-fresh water swamps and sago palms in the fresh water areas. Much of the province is covered by lowland rainforests where the dominant trees are taun and terminalia. Secondary-growth forests are found in the heavily-populated areas of northern Kaintiba district and the coast between the Purari river and Kerema. The swamp and savannah of the Tauri-Lakekamu basin are dominated by paperback trees and grasses (Rannells, 1990).
History

Scientific evidence states that people used rock shelters in the Kikori-Kairi area 3000 years ago (Rannells, 1990). They used stone tools made from raw materials which they gathered from Tapini, Central, upper Kikori and Sirebi rivers. In more recent times, the coastal people traded cowrie and pearl shells for stone axes and adzes of the Highlands people. They also traded sago and logs in exchange for clay pots and shells of the Motuans of the Central Province during the famous Hiri Trade Expeditions. The early European settlement began in 1884 with the arrival of the missionaries from the London Missionary Society (LMS). In 1906, the district station at Kerema was opened by the Australians. In 1910, a short-lived gold rush occurred in the upper Lake Kamu while many Gulf men worked as labourers and carriers during the Second World War. During the war, they built a 144 kilometres road from Bulldog in the old Lake Kamu country to Wau in the Morobe Province. This is the closest the country has come to having a trans-island road after it was used briefly. The people of the Gulf started migrating out after the war to Port Moresby and other cities for work. The district of Gulf was formed in 1951 and a census in 1980 showed that more than 20.3 percent of those born in Gulf lived outside the province (Rannells, 1990).

In the past, the province was famous for its masks, dancing boards, drums and curved figures which all originally served special ceremonial and spiritual roles. Well into the last century, unique traditional rituals were always being performed by the local village people, specifically in constructing long houses. Sadly, with the arrival of the missionaries, most of the remaining long houses were destroyed by the people themselves in the years leading up to World War 2 and their traditions no longer sustained till now (Datec, 1996).

Districts

The province consists of six districts namely Baimuru with a population of 7109 who speak the Purari and Pawaia languages; Ilhu with a population of 9739 who speak the Oroko and Keuru languages; Kaintiba with a population of 14 654 who speak the Hamtai and Kaintiba languages; Kerema with a population of 7891 who speak
Uaripi; Kikori with a population of 9430 who speak the north-eastern Kiwai, Kerewo, Podope and Porome languages; and Malalaua with a population of 19,878 who speak the Toaripi and Hamtai Pmasa'a languages (Rannells, 1990). The Malalaua district consists of four census divisions, namely Kovio, Kaipi, Toaripi and Moripi.

Economy

The province is one of the least developed in the country as the coastal plain is not easily accessible by road with other provinces. Most of the coastal people survive through fishing, growing copra and food crops and making artefacts for sale to tourists. The main exports are timber, prawns and copra. To promote development, the Gulf and Southern Highlands Provinces have formed a joint venture to construct a new highway linking the two provinces which has started already (Kasia, 1997). The Gulf Provincial Government also aims to develop a multi-million kina port facility to compete with Lae in the Morobe Province which will divert shipping business to the province. The operation of a port will be a healthy business to bring in more capital and revenue to the province and people. The proposed development is also ideal because of the increased logging and fishing activity in the province. There is also more mining and petroleum exploration sites in the neighbouring Southern Highlands and Western Provinces which are potentially beneficial to the province (Post Courier, 1997b). There has been recent discovery of oil and gas reserves found which will boost the local economy and infrastructure in the future.

Further development will be enhanced with the construction of the new trans-highway, currently funded by the Japanese Government, linking Port Moresby and Kerema which was opened in May, 2000 by Sir Mekere Morauta, Prime Minister of PNG (Kone, 2000). The development of this trans-island highway has opened opportunities in the eastern part of the province. As a result, oil palm projects have been proposed in Baimuru and Ihu districts and with still a large oil and natural gas deposits being discovered, the province’s economic outlook will improve if this resources are developed. The private sector employment in the province is provided through timber and sawmilling where logging of timber is centred around Vailala and
Turama river areas. On the Lakekamu river, gold mining has resumed with other industries such as prawn fishery near Kerema and barramundi fishery at Baimuru. The Provincial Government operates about five prawn trawlers and generates income through its exports. A major income earner for the villagers is the selling of crocodile skin but they also produce copra and spices along the coast, rubber near Kerema and robusta coffee inland. There is a vast potential for hydro-electric power production from the Purari and Kikori rivers in the future (Rannells, 1980). Yet it is ironic and interesting that the province still maintains a largely subsistence based economy. The largely swampy hinterland has some of the same problems bothering the wet, unarable neighbouring Western Province.

Gulf’s prominent leaders

There are three members in the National Parliament who represent the province and its people. Since PNG’s independence on 16 September 1975, the province has produced many prominent politicians like Sir Albert Maori Kiki (deceased), former Prime Minister, Bill Skate and current Prime Minister, Sir Mekere Morauta and Chris Haiveta who have being classified as the ‘movers and shakers’ of the country’s politics. Other prominent leaders were Sir Tore Lokoloko and Sir Vincent Eri (deceased) who were former governor generals to Queen Elizabeth II of Great Britain.

Traditional languages

The province has 24 languages from which two-thirds of the people speak languages of the Eleman family namely Toaripi, Orokolo, Keuru, Uaripi, Opao and Tate. These people live along the eastern coast and inland Malalaua district. Hamtau, the other common language, has its roots in the Highlands. Hiri Motu is the province’s second main language. In the province as a whole, the Eleman family is also dominant in the rural census divisions of Kerema and Ihu districts but not in the Baimuru, Kikori and Kaintiba districts (Rannells, 1990). Toaripi is spoken by the Elema people numbering about 80,000 (1990 est.), and live in the coastal region of the Gulf of Papua, from Cape Possession to the Avei mouth of the Purari river, a distance of some 190
kilometres. The villagers live in a number of large villages around the mouth of the Tauri and Lakekamu rivers.

Coastal people live in big villages with houses well above the ground on poles and their main staple foods are sago, fish and coconuts. Many villagers grow taro, sweet potatoes and bananas with sweet potatoes being the main food of the province’s mountain people. In delta and swampy areas with little garden land, people live on crabs and shellfish. Mounds of land left by the burrowing of crabs are used for small gardens. The coastal people make masks by covering basketry with painted bark cloths of bush or sea spirits faces. Most coastal people also curve ancestor boards with simple outlines of human figures. The departure of men looking for work has left the province with PNG’s lowest median age and one of its highest percentages of females (Rannells, 1990).

People

Morauta (1984) states that the ancestors of all the coastal Toaripi villages in the Toaripi and Moripi census divisions are said to have lived inland and moved to the mouth of the Lakekamu river where they occupied two big villages, Mirihaea and Uritai at the end of the nineteenth century. The move to the coast is said to have been both because of the fish found there and the fights with the inland Moveave villagers (Morauta, 1984). In 1881, Reverend James Chalmers, a missionary from the London Missionary Society (LMS) was the first European to visit Uritai and Mirihaea when travelling along the coast. In 1884, a mission station was set up which was manned by a South Seas Mission worker, Taolaki, who was murdered by the people of Moveave in 1887. Morauta (1984) states an account by Ryan who attributes the dispersal of populations from Uritai (to Kukipi, and later to Popo and Lalapipi) and from Mirihaea (to Lelefuru, Hamuhamu, and Isapeape) to washaways and the pressure of an increasing population on resources near the original villages (p. 12).

Brown (1968) reports that the Elemu were divided into two major groups. They consisted of the western and eastern inhabitants according to whether they live to the west or east of Kerema which is the centre of administration. Amongst the western Elemu, Oroko is used as the literary language while the eastern use Toaripi.
Amongst the eastern *Elema*, there are two other closely related dialects spoken, *Kaipi*, found in the villages from *Koaru* to *Silo* whose dialect is called *Milareipi* and *Sepoe*. The *Sepoe* are a small *Elema* sub-tribe who live in villages towards Cape Possession. Of the 80,000 eastern *Elema*, most of them nowadays speak *Toaripi*. Owing to it being used for literary purposes, *Toaripi* is well known to people who speak the other two dialects, which to date have nothing published in them. Neither have they ever being used in broadcasting from Radio Kerema, only *Toaripi* and *Orokolo* being the media used for local broadcasts.

The missions have also been prominent in the field of education although their role has declined today. Early schools were taught and used texts in *Toaripi* and the result was that the entire senior generation in all *Toaripi* villages as well as those in their early 40s were literate in their own language. They were able to read *Toaripi* texts and hymns at church services, write minutes of church and other meetings and write letters of request for gifts to absent relatives (Morauta, 1984). Those who went to school in the 1960s learned only *English* in government schools and as a result, many are practically illiterate in reading and writing in *Toaripi*. Most of the primary schools today in the *Toaripi* villages are managed by the Gulf Provincial Education Office and use *English* as the medium of instruction.

*Traditional leadership*

Morauta (1984) asserts that traditional leadership in *Toaripi* society lay partly in the hands of the office-bearers in the men’s houses and rested on the influence achieved by men of outstanding character who may or may not have been office bearers. Since the late 1970s, although the men’s houses have disappeared with their office-holders, able men still have a respected voice in village affairs, at public meetings or being asked to adjudicate in disputes. Morauta (1984) states that the main determinant of political influence in *Toaripi* society in the late 1970s was an individual’s skill in public affairs, usually associated with the occupation of some official position.

Until 1919, there was a flourishing men’s cult based on men’s houses, initiation and ceremonies. These ceremonies were dramatic events in the life of a community which
intensified and focussed on emotional, artistic, social and productive life. Morauta (1984) describes these ceremonies were common right through the Elema cultural area. There were men’s houses and initiations at one of the Toaripi villages of Kukipi in its early days. The last boys who went through the initiation were those born from 1900 to 1904. Brown (1968) records the Toaripi system of named age-sets which permitted accurate dating of births. These boys were in pepa tao and peni tao, ‘paper’ and ‘pen’ age sets.

The cargo cult known as the Vailala Madness in 1919, swept through the coastal ‘Elema’ and villagers completely discarded their traditional ritual effects, ceremonies and cult. Although the traditional men’s cult has disappeared, other elements in the traditional system of beliefs are still strong. The Toaripi are constantly alert to dangers of sorcery and know a great deal about divining and healing techniques. As in the past, they were greatly concerned with their recent dead, with how they died by communicating with them in dreams. They continued to sleep on the graves of their recent dead in order to learn from their ghosts how and why they died.

*The land system*

The Toaripi term karikara, meaning ‘village’ connotes a place of settlement. As a social group, karikara meant the people who lived in the men’s houses and the surrounding women’s houses but today that form of social group is extinct (Morauta, 1984). To understand more on the nature of the village, the Toaripi system of land tenure will be discussed. Traditionally, the Toaripi economy was based mainly on sago and fish. Land tenure was important for sago, coconuts, small gardens and house sites. Sago and coconut were planted and disposed by the people who planted them. Much of the Toaripi territory was and is under water and saline swamp which is unsuitable for growing sago. There are only small patches of sandy land suitable for coconuts, gardens and house sites.

Morauta (1984) describes that rights in the land are determined within a framework of overlapping and unrestricted cognatic descent groups with sets of kin descended by any type of link from not a very remote ancestor. Cognatic descent establishes
one's right to try to move in on a piece of land for gardening or a house site. This was only possible through interpersonal goodwill which ensured that one can. A Toaripi has in a sense land everywhere and land nowhere but has an option on a large number of plots and this can be through any of his four grandparents; however, he has an undisputed and inalienable right to a very few. With respect to each of the plots of land he currently uses, he shares his right with a different set of people. The Toaripi has a lot of options with respect to land but he also has to make many difficult choices. It is impossible to maintain active relationships of mutual support with a wide range of kin.

This system of land tenure permits the Toaripi to lose completely their claims on land. If they neither use land, coconuts or sago on which they have a theoretical claim by descent nor have active relationships with others who do, their rights lapse. This happened traditionally when people exercised one set of rights in the area and let others lapse. However, it has taken on a new significance today when a Toaripi moves out of the area to the cities. If they neither use land, sago, coconuts (because they are away) nor maintain good relationships with those who do (because they are not poor and have relatives in the villages), they have access to land practically (Morauta, 1984).

Morauta (1984) reports that during traditional times, there were two corporate groups which consisted of the localised patrilineal subclan or elavoape ' (plural elavoapeape literally 'mouth of the men's house') and the age-set or heato. Throughout the Elema villages, there were nonlocalized patrilineal clans who shared common myths and totems. The members of clan who lived in a particular village formed in traditional times a corporate group occupying an elavo or 'a single men's house'. These subclans or elavoapeape shared rituals, ceremonies, feasts and performed certain specialised functions within the village as a whole. In Lelefi village for example, the first migrants settled the first village and called it Iki Miri and due to continuous erosion of the land, they resettled again on another piece of land and called the new village Iau Miri. There was again another resettlement of which the current village named Lelefi literally 'island of egrets' still maintains its name today. There are altogether 12 main elavoapeape in Lelefi village and the main ones are Mika Firu,
Lavare, Uaralaro, Povora Firu, Ori Lavi, The contemporary functions of the ‘elavoapeape’ as corporate groups were different from and slight in comparison with traditional times. Sometimes at feasts, the main elavoapeape are the basis for food distribution, although on many occasions they are not.

As in the Central Province, the United Church has incorporated traditional corporate groups into its activities such as fund-raising and church duties. The large annual donation of circuit funds raised was organised along the lines of the main elavoapeape. Each of the main elavoapeape had to contribute one third of the figure set for the village as a whole, despite the large discrepancies in numbers. In the late 1980s, fund-raising for the new church building at Lelefru was organised competitively along the lines of the main elavoapeape. At the opening in 1992, eachelavoapeape built an open-sided men’s house to accommodate visitors and also tried to out do the others in its gifts of religious accessories like plastic flowers, bowls and dishes of cooked food to the church. Each of the elavoapeape also shared its flamboyant display of these things outside the church which were later given away to the visitors.

Traditionally, the age set or heato was important for marriage, funerals, work parties and recreation. These age sets were groups of men who were initiated into the men’s cult at the same time. Nowadays, however, it does not have these functions and the identification of age sets by new names stopped in the 1940s. The insignificance of corporate descent groups in Toaripi society is associated with a strong focus in kinship behaviour on the nuclear family (Morauta, 1984). Responsibility for the care of the young falls mainly on their parents and sometimes on these children’s older married siblings. The converse of this is that parents expect their children to assist them once they are old. The children see the care of the old as repayment for the pain of childbirth and the struggle to raise children and provide for them. Both the care of the children and of the aged are acts of love and compassion (meaforoe) to the Toaripi. During an individual’s life time, their position changes in the parent-child relationship. Since women often bear children over a long span of years, some children may be married adults while others are still small. In such situations, the
older siblings may support and provide for the younger ones which is also clearly another form of assistance to their parents.

*Marriage and feasts*

Nowadays, marriages are organised by the couple concerned which has replaced the traditional system of arranged marriage by the 1940s (finishing mainly with persons born in 1907 to 1910, *auri tao* and *si uke tao*). Marriage is marked by little ceremony, but sometime in the few years after the marriage and perhaps after one or two children, a brideprice is paid. The *Toaripi* system requires that a return gift is made by the bride’s parents equivalent in value to between one third and half of the bride price paid by the groom and his relatives. The size of the bride price is determined by the donors and reflects on the prestige within the community (Hasu & Morauta, 1981). Today, the majority of the bride price is contributed by the groom and perhaps a little from his parent and relatives, while the receipt of the brideprice and the collection of the return payment is similarly concentrated among the bride’s kin. Normally, brideprice payments are in cash with some armshells and food, including bulk imported food (rice, flour, sugar) and perhaps some pigs. Some food is cooked and distributed at the time that the brideprice is handed over. It is also during this time that the bride is finally farewelld by her parents and relatives normally with household gifts and kitchen utensils as a mark that she is in fact a woman and ready to join her husband’s relatives and clan.

Another major responsibility of kin is the mortuary feast called *maea aro*, literally ‘body covered with charcoal’, between three and twelve months after the death itself. In traditional times, there was a series of feasts after a death of which only *maea aro* and *mai hiake*, ‘a small meal’ at the time of the death remained. *Maea aro* feast can be a large or small and includes imported food as well as locally grown food like sago, banana and sweet potatoes. The size of the feast is closely related to the reputation and inclination of the giver than the status of the dead person. For example, large feasts can be made for even small children when parents or grandparents have the inclination or resources especially with help from their relatives. The food for the feast is usually distributed by one main organiser (father,
husband or brother of the dead person) with contributions from others such as close kin relatives.

Two other types of feasts today are, firstly the feast for people who have helped with a particular piece of work, the biggest of these being associated with the work of carpenters in building and construction houses of permanent materials. Secondly, feasts are made to mark the end of disputes when people agree to ‘shake hands’, set aside their differences and live in peace (Morauta, 1984). It may even happen between family members and such differences can take place between fathers and sons or between brothers.

*The Semese festival*

In times preceding the coming of the first Europeans, the Elema people showed an artistic eminence in their pictorial art and drama as evinced by the *Semese* festival or *Hevehe*, its *Orokolo* name (Kiki, 1963). For example, Mack (1994) made the following account of the *Elema* tribe living west of Orokolo Bay in the Gulf of Papua who performed two ceremonial cycle The first was dedicated to the bush spirits called Kovave while the other to the sea spirits called Hevehe. Hevehe was a cycle of ceremonies during which dangerous female sea spirits called Ma-Hevehe were believed to have visited the village periodically, bringing to the single men’s house (elavo), various materials for the constructions of the masks. Hevehe masks represented the spirit’s daughter who presented themselves to the assembled crowd at the climax of the cycle of ceremonies.

The first major ceremony of the Hevehe Karawa initiated young men into the secret of the spirits (Mack, 1994). The Hevehe ceremony can be interpreted and seen through the initiate’s eyes as a process of disillusionment. As boys, they discovered the masks not to be the spirit’s daughter but men disguised and later as young adults, they learnt that the greater noise the spirit made when they came from the sea was men pretending to be spirits. The process of initiation was a means of advancement which brought the acquisition of knowledge with its power. For it was the older men who knew how to make masks, orchestrate the ceremonial cycle and to whom the
largest share of the repeated presentations and the exchanges of food and valuable were given. The ceremony reinforced the privileged position of the older men on whose knowledge it depended for its success (Mack, 1994). The Semese Festival has long been discarded and with it, the disappearance of the traditional art since the late 1930s.

Sub-clans

Traditionally, the Gulf people were organised into totemic clans that had no heredity chiefs with the older men possessing the power and influence. Rich ceremonial life was centred on large men's houses and expressed in prolonged dramatic rituals for which a great number of ceremonial objects including masks were created. Ceremonies consisted of a series of activities and a full cycle could take many years to complete. The purpose of the ceremonies varied among different groups and was based on the promotion of garden fertility, initiation of boys and girls into adult sex life, strengthening of the participants and prevention of sickness or initiation into various cults.

The Elemas are divided into upwards of ten patrilineal dispersed clans, each with its associated mythology from which are derived the ualare, the eponymous ancestors and the linked totems of the clans. The meaning of ualare in its origin is a mythical ancestor of the clan in which the linked totems of the clan were also called ualare. The clan mythology was concerned with the doings of the ualare to whom were ascribed the origin of various plants and animals. There are upwards of ten of the dispersed clans, each with its ualare. Brown (1968, p. ii) reported a fair amount of the clans which are mainly arbitrary. The various clan names, variants and the clan ancestors are shown in Table 1.
Table 1: Ten patrilineal dispersed clans of the *Elema* people (Brown, 1968; p. ii)

<table>
<thead>
<tr>
<th>Clan Name</th>
<th>Variants</th>
<th>Clan ancestor</th>
<th>Variants</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Auipi (Auma)</td>
<td>Veveapoe Heaea</td>
<td>Oa Evoa</td>
<td>Kari Marupi</td>
</tr>
<tr>
<td>2. Kaipi (Purari Miri)</td>
<td>Pukari Heaea</td>
<td>Meavea Kivovia</td>
<td>Oa Kaiva</td>
</tr>
<tr>
<td>3. Laipi (Nabo)</td>
<td>Lavipi, Misaea</td>
<td>Oa Marai</td>
<td>Mavaro Mirou Serei</td>
</tr>
<tr>
<td>4. Lavai ipi (Maiu, Baiu)</td>
<td>Opelolo</td>
<td>Oa Lavai</td>
<td></td>
</tr>
<tr>
<td>5. Leikipi</td>
<td></td>
<td>Oa Erevu</td>
<td>Maiv</td>
</tr>
<tr>
<td>6. Luipi (Vailala)</td>
<td></td>
<td>Oa luvu</td>
<td></td>
</tr>
<tr>
<td>7. Meloripi (Ahea, Hurava)</td>
<td>Oripi, Misaiapi</td>
<td>Toivita</td>
<td>Melare</td>
</tr>
<tr>
<td>8. Savoripi (Kaia)</td>
<td></td>
<td>Oa Epe Savora</td>
<td></td>
</tr>
<tr>
<td>9. Sove Heaea</td>
<td></td>
<td>Oa Sove</td>
<td></td>
</tr>
<tr>
<td>10. Uriipi (Kauri)</td>
<td>Kaurilavi</td>
<td>Oa Molala</td>
<td>Oa Harai</td>
</tr>
<tr>
<td></td>
<td>Horalavi</td>
<td></td>
<td>Oa Kave</td>
</tr>
</tbody>
</table>

As seen in Table 1, only a few of the variants are given. It is misleading to translate these names for they are best understood as being derived, not from localities but from the *ualarë*. The totems are not classified by the people and the word *ualarë* has being used indifferently for the totems or the eponymous ancestors. The totems have therefore no practical significance nowadays and sadly, many a young person lacks knowledge of them. Some acquaintance with the clans and the *ualarë* are however required if certain forms of traditional speech behaviour are to be understood. These consist of honorific titles, various exclamations (*isuta*), special names for parts of the body and intimate possessions (Brown, 1968).

According to Brown (1968), the *Elema* have an extensive oral literature known as *papa lama*. This includes the mythology which is concerned with the doings of the *ualarë*, the eponymous ancestors and the totems of the various clans. There are also folk stories such as those that tell of encounters with bush spirits while others tell how various creeks, hills and parts of the beach have received their present names. For example, the researcher's village called *Lelefūr* was named after a bird called an egret because it used be an island full of them out in the sea. This is also not the original name of the village because there were two previous resettlements which was due to the erosion of the coastline and this two earlier villages were called *Iki Miri* and *Iau Miri*.
APPENDIX 3.2

Results Of The Current Education Reforms

Advantages of the reforms

Orere (1998) asserts that the current reforms in education are working because they are being implemented. Elementary schools are now formal schools and have become part of the national education system. However, their success depends on how much support and responsibility the community gives to make them work effectively. Under the reform, elementary teachers complete three years of course work and do on the job training. They teach the children initial literacy, basic mathematics concepts, cultural studies and community life in the child’s language. Further research (Rei, 1999a) strongly supports the use of vernacular languages in elementary schools because there are academic achievement benefits for the students from being bilingual.

Furthermore, Yombom (1999) asserts that enrolment under the reform process has increased at each level of education since 1995. He states that when the reforms were fully implemented between 1997 and 1999, the number of students at the elementary level grew from 25,633 to 130,191. In primary schools, enrolments grew from 548,256 to 603,885 and in secondary schools from 72,419 to 79,601. The number of female students also increased by 46.8 percent at the elementary level which implies that a larger number of girls will have the chance to complete grade 12. There was also significant progress in upper secondary education. Since the introduction of the reforms in 1992, there are now some 22 secondary schools in the country. Unfortunately, only Gulf, East Sepik, and Central provinces are yet to acquire these schools. According to an education survey, students in the reformed schools did better in examinations than those in ordinary schools (Yombom, 1999). For example, students at Malala Secondary School in the Madang Province came top and had higher grades when compared to those students in national high schools in 1997 and 1998.
Contrarily, Rei (2000) highlights some of the problems that occurred after the education reforms were introduced. For example, there is a lack of space as provision for land became a major concern in the NCD where elementary schools which were introduced in 1993 lacked space to expand, especially when both the elementary and primary schools share the same site. Another concern was that of standards which diminished because students at the primary schools performed better in the Grade 8 examinations compared to those educated through the traditional high school system. Furthermore, Rei (2000) states that there is a shortage of well trained qualified teachers to teach grades 7 and 8 due to the expansion. There was also a concern in the upper primary and upper secondary levels and a rapid expansion for the secondary sector in the number of places available to Grades 11 and 12. Fortunately, all high schools have now phased out the Grades 7 and 8 from their establishments and doubled their enrolments in Grades 9 and 10. Five years of implementing the reforms at the primary and secondary levels in 1994, the NCD had made a significant progress in terms of access, equity and quality.

The new school system

Under the new education system, primary education begins from Grades 3 through to 8 while secondary education starts from Grades 9 to 12. A primary school that goes beyond Grades 6 to 9 is called a top-up primary school. Provincial high schools which expand to become a secondary school with Grades 11 and 12 are called a top-up (secondary) school. The change under the reformed system is that two grades from the old high school system have been moved back into primary education so that children have access to two more years of general education.

Orere (1998) claims that the effective implementation of the national education plan will raise the general education level of the population. The strategies developed to implement the education reforms aim to increase access and participation for geographically isolated groups and others who have difficulty getting education. For example, it allows more girls with less opportunity to go to school than boys. According to Orere (1998), there is an increase in percentage of enrolments for girls at the elementary and primary (grades 7 and 8) levels. This has being attributed to the
schools being assessable and closer to home which is an advantage in educating girls because the more educated they are, the more healthier their children will be.

The education reform was designed purposely to support decentralisation and increase community ownership, participation, involvement and support in educating PNG children. The aim of the education reform is to provide nine years of basic education for every Papua New Guinean child at 7 years of age, starting with elementary prep and continuing on to the end of grade 8. Elementary schools therefore cater for values and strongly supports the cultural and linguistic diversity of PNG’s children.

The education reforms were developed by Papua New Guinean professionals with support from other professionals experienced in the country’s education system. A number of significant milestones which date back more than 10 years include the Matane Report in 1985, the Jomtien Declaration of Education for All in 1990, the National Education Reform Task Force in 1992 and the National Education Plan for 1996. For example, the Matane Report published a philosophy of education which is seen as the birth of the education reforms, especially in the curriculum area. As expressed in the National Constitution, the national goals of education recognises the importance of integral human development, equality and participation, national sovereignty and self reliance, natural resources and PNG ways.
<table>
<thead>
<tr>
<th>Context</th>
<th>Language</th>
<th>Mathematics</th>
<th>Resource Development</th>
<th>Social Development</th>
<th>Spiritual Development</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Elementary</strong></td>
<td>In the context of their home, clan, community, classroom, school and church, students will:</td>
<td>speak, listen, read and write for effective practical communication, enjoyment, self expression and community and self development</td>
<td>develop competence in basic mathematical operations of counting, measuring and interpreting mathematical information.</td>
<td>maintain their personal health through knowledge and practice of a healthy lifestyle and promote health in their community.</td>
<td>participate responsibly in personal, family and community national and international affairs.</td>
</tr>
<tr>
<td><strong>Primary</strong></td>
<td>In the context of their community, province, nation and other countries and overseas agencies, students will:</td>
<td>develop an understanding of the patterns and relationships in mathematics</td>
<td>perform a variety of practical resource development skills appropriate to their community and their personal futures such as gardening, household maintenance, book keeping etc.</td>
<td>understand the behaviour of people in relation to their physical environment resources and history.</td>
<td></td>
</tr>
<tr>
<td><strong>Secondary</strong></td>
<td>In the context of their community, province, nation and other international organisations, students will:</td>
<td>apply knowledge of the physical world around them to solve problems and make decisions in order to use their resources wisely.</td>
<td>perform a variety of cultural activities such as painting, dancing etc.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(Department of Education, 1997; p. 2)
APPENDIX 4.1

SCIENCE AND MATHEMATICS EDUCATION CENTRE

Traditional Science Beliefs Scale

Name: ..........................................................................................................................
Grade: ..........................................................................................................................
Birthday: ......................................................................................................................
Village: .......................................................................................................................  
Province: ................................................................................................................... 
Languages spoken: ....................................................................................................
Father’s employment: ............................................................................................... 
Mother’s employment: .............................................................................................. 

Instructions
1. Please read all the items carefully.
2. Circle the number that best reflects your belief.
3. Choose from the following:
   
   Strongly agree = 5; Agree = 4; Don’t know = 3; Disagree = 2; Strongly disagree = 1.

4. Remember there is no right or wrong answer.
5. Your answers are wanted for each item.
6. Your answers will not be shown to anyone.
<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Drinking a lot of juice of a fresh young coconut will cause diarrhea.</td>
</tr>
<tr>
<td>2.</td>
<td>Starving the eyes of fish will make you see better in the dark.</td>
</tr>
<tr>
<td>3.</td>
<td>A pregnant woman who eats a lot of watermelon would have an easy delivery.</td>
</tr>
<tr>
<td>4.</td>
<td>When one is young and plans toilets, they will not bear a lot of them.</td>
</tr>
<tr>
<td>5.</td>
<td>If there is a spell of very hot days, it means downward on the market and sell.</td>
</tr>
<tr>
<td>6.</td>
<td>You cover all matters during a storm or else you'll have won the market and sell.</td>
</tr>
<tr>
<td>7.</td>
<td>A mysterious woman who eats a lot of garlic would have an easy delivery.</td>
</tr>
<tr>
<td>8.</td>
<td>Being the name of a fish will make you see better in the dark.</td>
</tr>
<tr>
<td>9.</td>
<td>Sweeping at night in a village will bring the house.</td>
</tr>
<tr>
<td>10.</td>
<td>If the rear end (umbilical cord) is plunged under a coconut tree, the tree will bear many fruits.</td>
</tr>
<tr>
<td>11.</td>
<td>Do not eat bananas at night on the moon or in the moonlight but after you get out of your home.</td>
</tr>
<tr>
<td>12.</td>
<td>If you wake up in the morning with strong teeth, it means that you may become a king or queen.</td>
</tr>
<tr>
<td>13.</td>
<td>If you don't drink a spool of stew which is kept over the fire, a squirrel or bush spurt will appear.</td>
</tr>
<tr>
<td>14.</td>
<td>When a child is sitting in there, a woman should not attempt to walk across otherwise she will not be able to dry it.</td>
</tr>
<tr>
<td>15.</td>
<td>Cutting nails at night will cause disease.</td>
</tr>
<tr>
<td>16.</td>
<td>If you step on a stick of certain juice, you will get a disease.</td>
</tr>
<tr>
<td>17.</td>
<td>If you spill into your mouth will get a swollen neck.</td>
</tr>
<tr>
<td>18.</td>
<td>If you swallow when you will get a pox.</td>
</tr>
<tr>
<td>19.</td>
<td>If you bounce into the fire will die.</td>
</tr>
<tr>
<td>20.</td>
<td>If you pour into the wind, you will win.</td>
</tr>
<tr>
<td>21.</td>
<td>If you throw into the wind will get a solemn pack.</td>
</tr>
<tr>
<td>22.</td>
<td>The morning sun, the moon, represents a planet called Venus.</td>
</tr>
<tr>
<td>No.</td>
<td>Statement</td>
</tr>
<tr>
<td>-----</td>
<td>-----------</td>
</tr>
<tr>
<td>40.</td>
<td>If men swim downstream of women, they can lose their strength.</td>
</tr>
<tr>
<td>39.</td>
<td>If you step over water, you will get a shock in the groin or hips.</td>
</tr>
<tr>
<td>38.</td>
<td>The moon causes &quot;moonstruck&quot; or &quot;moonstruck&quot; in females.</td>
</tr>
<tr>
<td>37.</td>
<td>Having the head of a fish frequently will make you more intelligent.</td>
</tr>
<tr>
<td>36.</td>
<td>A meandering cat in the night means that someone will die.</td>
</tr>
<tr>
<td>35.</td>
<td>If you see a ghost or a cat in the night, someone will die.</td>
</tr>
<tr>
<td>34.</td>
<td>The sun is looked after by the sun or the sun will die.</td>
</tr>
<tr>
<td>33.</td>
<td>A full moon is also referred to as &quot;you'll drive,&quot; your spirit woman who looks after and guides their lover and good luck.</td>
</tr>
<tr>
<td>32.</td>
<td>To wash a new boat should be prepared and directed to the spirits of our ancestors to seek.</td>
</tr>
<tr>
<td>31.</td>
<td>If you eat the rice for a new look in exchange for your old one, it will give you a new one.</td>
</tr>
<tr>
<td>30.</td>
<td>A chicken on the sky means someone is going to die.</td>
</tr>
<tr>
<td>29.</td>
<td>Laidly people and those who ride underdeveloped crops.</td>
</tr>
<tr>
<td>28.</td>
<td>The dimpling of a particular body of positions drawing near.</td>
</tr>
<tr>
<td>27.</td>
<td>Drying fish fillets indicate rain comes.</td>
</tr>
<tr>
<td>26.</td>
<td>Chicken moving to roost means evening draws near.</td>
</tr>
<tr>
<td>25.</td>
<td>And chicken moving from low ground and down to higher ground means it is going to rain.</td>
</tr>
<tr>
<td>24.</td>
<td>Darkness without the dimpling of chicken means the sun is not and it is evening right.</td>
</tr>
<tr>
<td>23.</td>
<td>If you cast a spell of suggesting to move the sands on the beach, the sand will move to another part.</td>
</tr>
</tbody>
</table>
APPENDIX 4.2

STUDENT QUESTIONNAIRE 1: SOURCES OF EXPLANATIONS

Instructions:

1. This questionnaire is to find out how best you can use your ideas to describe eleven (11) occurring natural phenomena.

2. There are a variety of explanations used to describe each of these natural phenomena as given in this questionnaire. You may have heard some of these explanations used by different groups of people in the places given below. Or you may have never heard of them being used.
   1. Home/family/village  2. School  3. Church  4. I have not heard it used

3. Decide in which places you have heard these explanations being used.

4. Circle the number in the box provided (see example). You may have heard of these explanations being used in more than one place.

   1  2  3  4

QUESTION 1: CLOUDS

The following are examples of explanations about clouds. In which place have you heard these explanations being used?

1. Home/family/village  2. School  3. Church  4. I have not heard it used

A. In the forest, water on the ground dries up and disappears as the hot Sun heats it. It changes into steam and rises into the air. As it rises, it cools in the cool air in the sky. Then it forms clouds.

   1  2  3  4

B. The wind helps to form clouds. Strong winds make the water evaporate faster. Strong winds also bring plenty of black clouds in the sky. This means that heavy rain is going to fall.

   1  2  3  4

C. God created the Earth and everything on it. God created clouds so that the rain gives water to plants and animals. The water also cools of the hot ground.

   1  2  3  4

D. A cloud is the soft hair of a spirit woman called lau lumori who guides and looks after the Moon. Her soft hair is the cloud in the night sky that casts a shadow on the Moon.

   1  2  3  4
QUESTION 2: RAIN

The following are examples of explanations about rain. In which place have you heard these explanations being used?

1. Home/family/village  
2. School  
3. Church  
4. I have not heard it used

A. The Sun heats the water and changes it into steam. The steam rises into the cool air, moves around and forms clouds. The wind blows the clouds into the mountains. As they get closer to the mountains, they become heavy and fall down as rain. The rain water flows into rivers and down to the sea. The whole cycle starts all over again.

B. People cast and use spells to bring rain. As the spells are cast, the wind becomes strong and brings many black clouds. The rain falls to the ground with the help of the strong wind. During the rainy season, fish called salivera appear living in a big rock at the mouth of the river. As the rain water rises and covers the rock, the fish swims out, down the river and into the open sea.

C. The wind brings many black clouds in the sky. As the black clouds bump into one another, they create lightning and thunder. This causes the clouds to break up into pieces and fall as rain. The rain gives water to plants and animals.

D. God created clouds in order to bring rain to Earth. It only rains when God wants it to rain. He causes it to rain so that plants and animals can survive. The water also helps to cool off the hot ground.

QUESTION 3: LIGHTNING/THUNDER

The following are examples of explanations about lightning and thunder. In which place have you heard these explanations being used?

1. Home/family/village  
2. School  
3. Church  
4. I have not heard it used

A. People use and cast spells to make lightning and thunder. Good spirits gave these two wonders to people on Earth as a gift and blessing. People use it to destroy things when other people make them angry.

B. Two dark rain clouds quickly travelling in opposite direction bump into each other. As they bump, they heat the air up and make it hot. The air becomes so hot that it creates lightning and thunder.

C. Lightning and thunder are both wonders of the world created by God. These two things are signs to scare people. They are also signs to show people the great power of God.
D. Lightning and thunder are formed when dark rain clouds move past one another at a fast rate. As they heat up the air, this forms thunder and lightning. The sound of lightning and thunder is like a big drum been cracked, hit and rolled across the sky.

QUESTION 4: RAINBOWS

The following are examples of explanations about a rainbow. In which place have you heard these explanations being used?

1. Home/family/village  2. School  3. Church  4. I have not heard it used

A. A rainbow is a colourful sign that appears after lightning and thunder have occurred. This also stops the rain from falling down.

B. A rainbow is a colourful sign created by God. It is God’s promise to the people on Earth that there will never be another Great Flood again.

C. A rainbow is a colourful sign that appears in the sky. It means that heavy rain is coming.

D. A rainbow is a colourful sign that appears during and after rainstorms. The rainbows appear when the Sun’s light rays hit the steam (water vapour) from the rain in the air.

QUESTION 5: EROSION/DEPOSITION

The following are examples of explanations about erosion and deposition. In which place have you heard these explanations being used?

1. Home/family/village  2. School  3. Church  4. I have not heard it used

A. People cast spells or seseva and utter magic words to move the sand on the beach in my village. As the sea water hits the sand, it makes the sand walk and move along the beach. The sand settles in the requested places and builds up.

B. The changes in the winds direction and tides causes the sand on the beach in my village to be eroded. This removes the sand and deposits it somewhere on the beach. These two processes helps to built up the sand on the beach in my village.

C. The sand on the beach in my village gets eroded and deposited somewhere all the time. This is a punishment from God because people do not worship God. If people worship God, then the sand will built up again on the beach.
D. The currents from the rivers near my village have become weak. This is because trees are cut which fall into the river. As they fall in, they block off the flow of the river. This stops the eroded sand being taken down to the open sea. Therefore it does not help build up the sand on the beach in my village.

QUESTION 6: MOON

The following are examples of explanations about the moon. In which place have you heard these explanations being used?

1. Home/family/village  2. School  3. Church  4. I have not heard it used

A. In the past, some people believe that a young spirit woman called lau-lumori guides and looks after the moon. Her soft hair is the cloud in the night sky that casts a shadow on the moon.

B. Some Christian people believe that the Sun represents the Father (God) or Jehovah Ualare. The Sun is hot as it rises which makes God also the supreme being. The moon represents the Son (Jesus Christ) or Tute. The Stars represent the Holy Spirit or Safu Arahoha Lareva.

C. My own observations of the moon tells me that it is a natural body in space. It has no light of its own. When the moon shines, it is really the reflecting light from the Sun. The bright light on the moon is created by Sun’s rays that falls on the moon.

D. Some people believe that the moon represents each month of the calendar year. It controls weather patterns and tides. We get rain when there is a new moon every month during the rainy season.

QUESTION 7: SUN

The following are examples of explanations about the sun. In which place have you heard these explanations being used?

1. Home/family/village  2. School  3. Church  4. I have not heard it used

A. My everyday observations tell me that the sun follows different paths. This is due to the tilt of the earth from January to June and from July to December. Therefore the sun stays in one place. Our earth revolves around the sun.

B. The sun is looked after by an ancestral spirit called epe savora. Epe savora is the tribal ancestor of the Savorepi clan. It is also the title of honour for menfolk of the clan. Epe savora helps and directs the Sun in its path from sunrise to sunset.
C. The sun was created by God in the beginning. The sun is hot and gives light and warmth to all plant and animals on earth. We depend on the sun because sunset means we can rest till morning. When the sun rises again, we wake up and go on with our daily work.

D. The sun is like a very hot fire burning in a furnace. The sun does not stay in one place but visits many places. When the sun sets, that means it has gone to another part of the world.

QUESTION 8: PLANT GROWTH

The following are examples of explanations about plant growth. In which place have you heard these explanations being used?

1. Home/family/village  2. School  3. Church  4. I have not heard it used

A. All plants grow because they take in water from the soil. The water gets into the soil after the rain has come down. When there is no water in the soil, the leaves of plants fall off and they die.

B. Some Christian people believe that when God created the Earth, he also created plants and trees. Plants grow because God cares for them. God provides the Sun to help plants grow.

C. Some seedlings are dispersed by and with the help of water, wind and animals. The seedlings grow into large trees when there is enough water and good fertile soil.

D. Plants grow from seeds from bird droppings in an area. They also grow from seeds which fall from big trees to the ground. They grow well in fertile soil with plenty of water.

QUESTION 9: DROUGHT

The following are examples of explanations about drought. In which place have you heard these explanations being used?

1. Home/family/village  2. School  3. Church  4. I have not heard it used

A. The start of the dry season from June to October each year means there is a drought. This is also the start of the strong winds, the Southeast winds and Southwest winds. During this time the seas are rough with high tides. People do not usually plant food crops in their garden around this time.

B. A continuous period of little or no rain means there is a drought. When this happens the demand for water is greater than the amount available. In areas where drought is short-lived, there is loss of food crops and the use of water is restricted.

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C. Some people believe a drought is a sign and punishment from God. This is because most people have turned against God and are doing evil and wicked things. A drought is also a sign that we are nearing the year 2000.

D. In the past, the drought means the start of the dry season or pisahu usually around May or June. At this time village people cut and burn forests and built new fences around their new gardens. The actual dry season with the severe heat from the Sun starts around August to October. It is usually very dry during this time of the year because there is no rain.

QUESTION 10: BURNING

The following are examples of explanations about burning. In which place have you heard these explanations being used?

1. Home/family/village        2. School        3. Church        4. I have not heard it used

A. Village people in the past cut forests and bush towards the end of the dry season. They cleared the bush to plant new gardens. As the bush dried, they burnt it. This made the ground bare so that they can dig the soil and plant their food crops. Burning helped because the ash from the burnt materials made the soil fertile. As a result food crops grew strong and healthy with water from the rain during the rainy season.

B. In the past people cleared and burnt the bush to clean their pathways. They also burnt the bush to chase harmful animals away. Burning also gets rid of rubbish and makes the place clean.

C. Burning occurs because village people have differences and arguments or because someone has been caught stealing. They light fires to destroy each other’s food gardens, betelnut trees and sago palms etc. As a result, other people’s garden and cash crops are destroyed in the burning process.

D. In the past, village people cleared and burned the forest to let more light in. Burning the bush materials as a result produces ash which fertilises the soil. Food crops grow well as the soil is fertile and contains water from the rain.

QUESTION 11: WIND

The following are examples of explanations describing wind. In which place have you heard these explanations being used?

1. Home/family/village        2. School        3. Church        4. I have not heard it used

A. Large masses of moving air set in motion by the even heating of the earth’s surface. When there is strong wind, there are plenty of clouds in the sky.
B. Large masses of strong moving air created and formed by God or Jehovah Ualare. The strong winds sometimes blow people's houses down and destroy food gardens. This is to punish wicked people because of their sinful activities on Earth.

1 2 3 4

C. Moving air masses set in motion by the uneven heating of the earth's surface. When the wind is strong, it brings many black clouds and heavy rains.

1 2 3 4

D. Moving air masses created and formed by spirits or mearoavaeka arahoha to the warm earth's surface. Sometimes strong winds bring many black clouds with heavy rain. The heavy rains can cause flooding and landslides.

1 2 3 4
APPENDIX 4.3

STUDENT QUESTIONNAIRE 2: TYPES OF EXPLAINATIONS USED

Instructions
1. Please answer all questions
2. Remember there is no right or wrong answers.
3. Your answers (opinions or thoughts) are wanted for each question.
4. Your answers will not be shown to anyone.

QUESTION 1: EROSION

In your science lessons you may have heard and used the word erosion to help explain various activities within your natural surrounding.

a) Give the Toaripi meaning or word for erosion.
b) Describe in your own words what erosion is.
c) Give an example of erosion in your village.
d) Where do most people in your village think erosion takes place?
e) How can you prevent erosion in your village?
f) An old village person might have told you that someone in your village can make the sand move on the beach to another place. This person may cast magic spells or use seseva to move the sand and place it on another part of the beach. Do you think this can happen? ..........Why?

QUESTION 2: DEPOSITION

In your science lessons, you may have heard and used the word deposition to help explain various activities in nature.

a) Give the Toaripi meaning or word for deposition.
b) Describe in your own words what deposition is.
c) Give an example of deposition in your village.
d) A young villager may have told you that he/she can cast magic spells or use seseva to move the sand and deposit it on another place of the beach in your village. Do you believe this person can do it?.................Why?

QUESTION 3: PLANT GROWTH

During your school holidays, you might have helped your parents to cut and clear the forest to make a place for a new garden. You helped them to plant new food crops like yams, taro, sweet potato and banana. You also notice new plants have started to grow in the place where you helped to clear all the trees and bush.

a) Give the Toaripi meaning for plant growth.
b) Describe in your own words how plants grow?
c) What makes plants grow?
d) What do most people in your village think how plants grow?
e) How can you make ‘plants grow’ better?
f) How did people in your village learn about how to make plants grow better?

QUESTION 4: RAIN

During the rainy season, you see rain falling down from the sky. This is a time when there is plenty of water to wash with and drink.

a) Give the *Toaripi* word or meaning for rain.
b) In your own words, explain how rain comes?
c) Where does rain come from?
d) What do most people in your village think rain comes from?
f) Can anyone in your village stop the rain? ..........Who? How?
g) Is it a good idea to make or stop the rain? .................Why?
h) What do people in your village people say what ‘rain’ is?

QUESTION 5: THUNDER

During rainy seasons, you might have heard a loud noise in the sky. In science lessons, you may have learnt about what this noise is already which we call thunder.

a) Give the *Toaripi* word or meaning for thunder.
b) In your own words explain what thunder is.
c) How does thunder come?
d) What do your village people say what thunder is?
e) Can thunder hurt you? .................How?
f) How can you keep yourself safe from thunder?
g) Is there any way of stopping thunder? ............How?

QUESTION 6: LIGHTNING

During the rainy season, a large bright spark sometimes appears in the sky followed by a big bang of thunder. In your science lessons, you might have learnt this already and you call it ‘lightning’.

a) Give the *Toaripi* word or meaning for lightning.
b) Describe in your own words what lightning is?
c) How does lightning come?
d) What do people in your village say what lightning is?
e) Can lightning hurt you? .............How?

f) How can you keep yourself safe from lightning? .............How?

g) Is there any way of stopping lightning? .............How?

QUESTION 7: RAINBOW

After a heavy rain sometimes, you might have seen the shape of a semi-circle appear with different colours in the sky. In your science lessons, you may have learnt this already and we call it a rainbow.

a) Give the Toaripi word or meaning for a rainbow.

b) Describe in your own words what a rainbow is.

c) Can anyone make or stop a rainbow? ...................Who? How?

d) Is it a good idea to make or stop a rainbow? .............Why?

e) How do people in your village learn and know what a rainbow is?

QUESTION 8: MOON

When there is a full moon in the sky, you find it easier to see your way around at night.

a) Give the Toaripi word or meaning for moon.

b) Describe in your own words what the moon is.

c) How do people in your village learn about the moon?

d) What makes the moon shine in the night?

e) An old village person may have told you that a young spirit woman called lau lumori looks after and guides the moon. Her soft hair is the cloud in the night sky that casts a shadow on the Moon. Is this possible? .............Why?

QUESTION 9: SUN

The sun appears to rise in the morning in the east and set in the evening in the west. The sun gives light and keeps us warm during the day. Without this, there would be no life, no light, no weather and no warmth.

a) Give the Toaripi word or meaning for sun.

b) In your own words, describe what the sun is.

c) How do people in your village learn about what the sun is?

d) Does the sun stay in one place? .........................Why?

e) Explain in your own words what sunset and sunrise means?

f) An old village person might have told you that the sun is looked after and guided by a spirit called epe savora. Is this possible? .................Why

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QUESTION 10: WIND

The south-east and the north-west winds are the two main winds that blow annually. These winds are strong and bring rain and sometimes it is unsafe to go out to sea and look for fish.

a) Give the Toaripi words or meanings for the:
   - South-east wind
   - North-west wind

b) In your own words describe what the wind is.

c) How do people in your village learn about what the wind is.

d) Where do you think the wind comes from?

e) What causes the wind to blow?

QUESTION 11: CLOUDS

When you look up into the sky you see sometimes see black or white clouds blown across the sky by the wind.

a) Give the Toaripi word or meaning for clouds.

b) Describe in your own words what clouds are.

c) How are clouds formed?

c) How do people in your village learn about what clouds are?

QUESTION 12: DROUGHT

In some villages in the Gulf Province last year (1997), the drought caused many problems. Food crops such as banana, sweet potato and yam did not grow well. Fires were lit by mistake and burned most of the food gardens, betelnut trees and sago palms. The Provincial Government helped villages by giving them food during the drought.

a) Give the Toaripi meaning or word for drought.

b) Describe in your own words what a drought is.

c) What do you think causes a drought?

d) Give examples of things that occur during a drought.

e) What do most people in your village think about what a drought is?

f) List a number of ways of how you can help ease the effects of a drought.
APPENDIX 4.4

Letter to Secretary, National Department of Education
The Secretary
PNG National Department of Education
PSA Haus
PO Box 446
Waigani
National Capital District
Papua New Guinea

22 September 1997

Dear Secretary,

SEEKING PERMISSION FOR MR SOIKAVA PAUKA TO UNDERTAKE RESEARCH IN SCIENCE TEACHING AND LEARNING IN PAPUA NEW GUINEA CLASSROOMS

I am writing on behalf of Mr Soikava Pauka who is undertaking a PhD at the Science and Mathematics Education Centre (SMEC), Curtin University of Technology. Soikava is currently on leave without pay from the Schools, Liaison and Administration Division of the Department of Education. As his immediate supervisor, I am seeking permission for him to undertake research work in science teaching and learning in PNG secondary school science classrooms. The title of his research is ‘The Effect of Traditional Knowledge on Science Teaching and Learning in Papua New Guinea Classrooms.’ Presently, Soikava’s research proposal is awaiting approval from the Graduate Studies Committee. A copy of his proposal is enclosed for your perusal and consideration.

Soikava would prefer to conduct his research at either Coronation (Kerema) or Malalaua Provincial High Schools in the Gulf Province. As he originates from Lelefiri village in the Gulf Province and speaks the Toaripi language of the Malalaua area, it is highly desirable for him to conduct the study in the local language amongst his own people. As this study is a pilot one and upon completion if successful, could be trialed in the other provinces throughout the country in the future. Soikava intends to collect his data next year.

Soikava has the full support to undertake this research work from the Acting Head of SMEC, Associate Professor John Malone, from myself as his supervisor, and from other faculty members at the SMEC with whom he is working.

We seek your permission and support for Soikava to return to Papua New Guinea next year to collect his data. All information collected will be analysed and kept electronically and confidential and participants will be allowed access to their own responses should they request it. A copy of the PhD thesis will be provided to your unit upon completion.

Yours sincerely,

Dr Bruce Waldrip
Lecturer
SMEC

Dr David Treagust
Professor of Science Education
SMEC

encl...
APPENDIX 4.5

Letter of Approval from PNG Secretary for Education
APPENDIX 4.5: Letter of approval from PNG Secretary for Education

Note: For copyright reasons, Appendix 4.5 (p. 321 of this thesis) has not been reproduced.

(Co-ordinator, ADT Project (Bibliographic Services), Curtin University of Technology, 20/08/03)
APPENDIX 5

Tabulated Responses From PNG Village Elders On Four Categories Explaining Natural Phenomena

Table 1: Responses from the village elders on erosion and deposition categorised by the type of explanation.

<table>
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<tbody>
<tr>
<td>1. Spells are cast. (Pou, Mai &amp; Tati.)</td>
<td>1. Blessings from God as peoples’ ways were honest when there was no erosion. (Mesea, Ivan &amp; Sevese)</td>
<td>1. Changes in tides and river currents. (Mora, Mai &amp; Sevese)</td>
<td>1. Changes in tides and river currents. (Mora, Mai &amp; Sevese)</td>
<td>1. Changes in tides and river currents. (Mora, Mai &amp; Sevese)</td>
</tr>
<tr>
<td>2. Spells are not cast. (Mora)</td>
<td>2. Punishment from God as they do not worship God. (Mai Mesea &amp; Ivan)</td>
<td>2. Caused by southeast and northwest winds. (Mora, Mesea, Mai, Tati &amp; Sevese)</td>
<td>2. Caused by southeast and northwest winds. (Mora, Mesea, Mai, Tati &amp; Sevese)</td>
<td>2. Caused by southeast and northwest winds. (Mora, Mesea, Mai, Tati &amp; Sevese.)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3. Occurs at mouth of rivers during heavy rainfall. (Mora, Mesea &amp; Sevese)</td>
<td>3. Occurs at mouth of rivers during heavy rainfall. (Mora, Mesea &amp; Sevese)</td>
<td>3. Occurs at mouth of rivers during heavy rainfall. (Mora, Mesea &amp; Sevese)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4. Long beach in the past but sand eroded till present. (Mai &amp; Sevese)</td>
<td>4. Currents from river is weak as river is blocked off by trees being cut. This stops the sand being eroded down to the open sea. (Mai Sevese)</td>
<td>4. Currents from river is weak as river is blocked off by trees being cut. This stops the sand being eroded down to the open sea. (Mai, Sari, Tati &amp; Sevese)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5. Beach will disappear and village will resettle again in five years from now. (Mesea &amp; Sari)</td>
<td>5. Strong river currents help take the sand down to the sea. (Pou, Mora, Sari, Tati &amp; Sevese)</td>
<td>5. Strong river currents help take the sand down to the sea. (Pou, Mora, Sari, Tati &amp; Sevese)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6. Currents from river is weak as river is blocked off by trees being cut. This stops the sand being eroded down to the open sea. (Mai, Sari, Tati &amp; Sevese)</td>
<td>6. Helps built the sand up on the beach. (Sari, Ivan, Tati &amp; Sevese)</td>
<td>6. Helps built the sand up on the beach. (Sari, Ivan, Tati &amp; Sevese)</td>
</tr>
</tbody>
</table>
Table 2: Responses from the village elders on drought categorised by the type of explanation.

<table>
<thead>
<tr>
<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td>1. Spells are cast to bring or stop rain. (Pou)</td>
<td>1. Blessings from God as a reminder. (Mora, Mai, Sari &amp; Mesea)</td>
<td>1. Hot shining sun causes it. (Mora, Mai &amp; Mesea)</td>
<td>1. Hot sun causes it. (Mora, Mai &amp; Mesea)</td>
<td></td>
</tr>
<tr>
<td>2. Punishment from God. (Mora, Mai, Ivan &amp; Sari)</td>
<td>2. Dry season occurs between July to November - long dry season. (Pou, Mora, Mai, Tati &amp; Sevese)</td>
<td>2. Very long dry season. (Pou, Mora, Mai, Tati &amp; Sevese)</td>
<td></td>
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</tr>
<tr>
<td>3. God controls and has the world in his hands. (Sari)</td>
<td>3. Causes high tides. (Mora)</td>
<td>3. Causes high tides. (Mora)</td>
<td></td>
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<tr>
<td></td>
<td>5. Same drought happened in the past. (Mora &amp; Tati)</td>
<td>5. No rain for many months. (Mora, Tati &amp; Sevese)</td>
<td>5. No rain for many months. (Mora, Tati &amp; Sevese)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>6. Dried creeks and river levels low. (Mora)</td>
<td>6. Dried creeks and rivers level low. (Mora)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>7. Burnt forests and very dry. (Mora)</td>
<td>7. Burnt forests and very dry. (Mora)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>8. Sign that year 2000 is close. (Ivan, Mesea &amp; Tati)</td>
<td>8. People go hungry because of food shortage. (Mesea)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>9. People go hungry because of food shortage. (Mesea)</td>
<td>9. Food crops die when planted. (Mai &amp; Mesea)</td>
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<tr>
<td></td>
<td>10. Food crops die when planted. (Mai &amp; Mesea)</td>
<td>10. Waters taste sour and moss growing in it. (Ivan)</td>
<td></td>
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</tr>
<tr>
<td></td>
<td>11. Water tastes sour and moss grows in it. (Ivan)</td>
<td>11. Leaves dropping off from trees indicate no water in the soil. (Mesea)</td>
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<tr>
<td></td>
<td>12. Black cloud form to bring rain but strong winds blow them away. (Tati &amp; Sevese)</td>
<td>12. Soil is dry because of no water from the rain. (Ivan)</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>13. Leaves dropping off from trees indicate no water in the soil. (Mesea)</td>
<td>13. Leaves dropping off from trees indicate no water in the soil. (Mesea)</td>
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</tbody>
</table>
Table 3: Responses from the village elders on plant growth categorised by the type of explanation.

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<tr>
<th></th>
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</thead>
<tbody>
<tr>
<td>1. None</td>
<td>1. Water from rain helps plants to grow quickly. (Pou)</td>
<td>1. God created plants and trees in this world (God's creation). (Mora)</td>
<td>1. Water from rain helps plants to grow. (Pou)</td>
<td>1. Water from rain helps plants to grow. (Pou)</td>
</tr>
<tr>
<td></td>
<td>2. Plants do not grow if there is no rain and no water in the soil. (Pou)</td>
<td></td>
<td>2. Plants do not grow if there is no rain and no water in the soil. (Pou)</td>
<td>2. Plants do not grow if there is no rain and no water in the soil. (Pou)</td>
</tr>
<tr>
<td></td>
<td>5. Mature trees produce seeds which fall to the ground and grow again. (Mesia)</td>
<td></td>
<td>5. Mature trees produce seeds which fall to the ground and grow again. (Mesia)</td>
<td>5. Mature trees produce seeds which fall to the ground and grow again. (Mesia)</td>
</tr>
<tr>
<td></td>
<td>6. Does not know how different varieties and types of trees come to grow in an area. (Mesia)</td>
<td></td>
<td>6. Does not know how different varieties and types of trees come to grow in an area. (Mesia)</td>
<td>6. Does not know how different varieties and types of trees come to grow in an area. (Mesia)</td>
</tr>
<tr>
<td></td>
<td>7. Leaves dropping off from trees indicate no water in the soil. (Mesia)</td>
<td></td>
<td>7. Leaves dropping off from trees indicate no water in the soil. (Mesia)</td>
<td>7. Leaves dropping off from trees indicate no water in the soil. (Mesia)</td>
</tr>
</tbody>
</table>
Table 4: Responses from the village elders on red sunrise and sunset categorised by the type of explanation.

<table>
<thead>
<tr>
<th>Categories of explanations</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Spirit called <em>epe savora</em> helps and directs the sun from sunrise to sunset. <a href="Pou"><em>Epe Savora</em> is the mythical tribal ancestor of the <em>Savoripin</em> clan; hence the honorific title for menfolk of the clan. It is the traditional term for <em>ivuta</em>, the iguana.</a></td>
</tr>
<tr>
<td>2. Punishment from God. (Mai &amp; Sari)</td>
</tr>
<tr>
<td>3. A promise from God that something is going to happen as in the Bible (Mai, Ivan &amp; Sari)</td>
</tr>
<tr>
<td>4. Represents the Father (God) as God is powerful. (Mai)</td>
</tr>
<tr>
<td>5. A blessing from God signifying different seasons. (Mora)</td>
</tr>
<tr>
<td>6. Sign that year 2000 is close. (Mesa)</td>
</tr>
<tr>
<td>7. Observations indicate the Sun’s path is different due to the tilt of the Earth from January to June and from July to December. (Mora)</td>
</tr>
<tr>
<td>8. Sun is very hot as the place feels hot. No cool air to make the place cooler. (Ivan &amp; Tati)</td>
</tr>
<tr>
<td>9. World’s natural fire and is very hot. (Mesa)</td>
</tr>
<tr>
<td>10. Sun gives light and heat to the world. (Sari, Ivan &amp; Tati)</td>
</tr>
</tbody>
</table>
### Table 5: Responses from the village elders on burning categorised by the type of explanation.

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<tr>
<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td>1. None</td>
<td>1. A punishment from God as people do not know God. (Sari)</td>
<td>1. Clearing forests for new garden sites by burning helps to plant food crops which grow well. (Pou, Mesea &amp; Mai)</td>
<td>1. Burning of forests helps food crops such as banana, sweet potato, etc grow well. (Mora, Mesea &amp; Mai)</td>
<td>2. Burning the bush produces ash and this fertilises the soil. (Mora &amp; Mesea)</td>
</tr>
<tr>
<td></td>
<td>2. A blessing from God to make people rethink that God is powerful. (Sari)</td>
<td>2. Differences, arguments and jealousy causes people to burn gardens and food crops or steal betelnuts. (Pou, Mora &amp; Ivan)</td>
<td></td>
<td>2. Burning the bush promotes ash and this fertilises the soil. (Mora &amp; Mesea)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3. Mischievous and careless people light fires and destroy food crops and sago palms. (Pou, Mesea, Mai &amp; Ivan)</td>
<td></td>
<td>3. Burning of forests helps food crops such as banana, sweet potato, etc grow well. (Mora, Mesea &amp; Mai)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4. Burning of forests helps food crops such as banana, sweet potato, etc grow well. (Mora, Mesea &amp; Mai)</td>
<td></td>
<td>4. Burning of forests helps food crops such as banana, sweet potato, etc grow well. (Mora, Mesea &amp; Mai)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5. Burning the bush produces ash and this fertilises the soil. (Mora &amp; Mesea)</td>
<td></td>
<td>5. Burning the bush produces ash and this fertilises the soil. (Mora &amp; Mesea)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>7. Burning destroys food gardens and people go hungry. (Sari)</td>
<td></td>
<td>7. Burning destroys food gardens and people go hungry. (Sari)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>8. Rapid burning takes place in areas where it is very dry and hot. (Titi &amp; Sevese)</td>
<td></td>
<td>8. Rapid burning takes place in areas where it is very dry and hot. (Titi &amp; Sevese)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>9. Burning helps to clear and create new pathways when bush is cut and dried. (Sevese)</td>
<td></td>
<td>9. Burning helps to clear and create new pathways when bush is cut and dried. (Sevese)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>10. Burning the bush kills poisonous snakes or wasps and other animals. (Sevese)</td>
<td></td>
<td>10. Burning the bush kills poisonous snakes or wasps and other animals. (Sevese)</td>
</tr>
</tbody>
</table>
Table 6: Responses from the village elders on the moon categorised by the type of explanation.

<table>
<thead>
<tr>
<th></th>
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</thead>
<tbody>
<tr>
<td>1. A spirit called <em>lau lumori</em>’s guides and looks after the Moon. The dark shadow caused by the clouds which blocks out the Sun’s rays represent the hair of this spirit. Womenfolk (young) are called <em>lau lumori</em>. (Pou)</td>
<td>1. Represents the Son (Jesus Christ). (Mai) 2. God created the Sun to give light during the day. With a little bit of the Sun’s light on the Moon gives light in the night. (Mesea &amp; Sevese) 3. Created by God as a plan. (Ivan &amp; Sari)</td>
<td>1. Sun’s rays fall on the Moon and makes it shine. (Sevese) 2. Only on moon lit nights make people see better in the dark. (Mesea) 3. Shining Moon in the night is cool (sun is very hot). (Mai) 4. Controls weather patterns and seasons (when new moon comes out, it brings rain). (Ivan) 5. Controls tides. (Ivan) 6. Moon represents each month of the calendar year. (Ivan) 7. Gives light to the world when it is dark in the night. (Sari &amp; Sevese)</td>
<td>1. Sun’s rays fall on the Moon and makes it shine. (Sevese)</td>
<td>2. Controls tides. (Ivan)</td>
</tr>
</tbody>
</table>
Table 7: Responses from the village elders on rain categorised by the type of explanation.

<table>
<thead>
<tr>
<th></th>
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<tbody>
<tr>
<td>1. Spells are cast to bring rain. (Pou)</td>
<td>1. God created rain as a plan to give water to plants and animals on Earth. (Ivan)</td>
<td>1. Rainy season starts from December to April. (Pou, Tati &amp; Sevese)</td>
<td>1. Sun heats the water and changes into steam. It rises into the air, moves around and forms clouds. As the heavy clouds approach the mountains, it falls down as rain again. Flows into rivers and down to the sea (water cycle). (Pou, Mora, Mai, Mesesa, Ivan, Tati, Sevese)</td>
</tr>
<tr>
<td>2. Appearance of a fish called salmon (‘salivera’) which live in a big rock at the mouth of the river. When the water covers the rock, the fish swim out and down the river. (Pou)</td>
<td>2. Sun heats the water and changes into steam. It rises into the air, moves around and forms clouds. As the heavy clouds approach the mountains, it falls down as rain again. Flows into rivers and down to the sea (water cycle). (Pou, Mora, Mai, Mesesa, Ivan, Tati, Sevese)</td>
<td>2. Black clouds bring rain. (Pou &amp; Sevese)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3. Black clouds bring rain. (Pou &amp; Sevese)</td>
<td>3. Rain gives water to all living things. (Ivan)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>4. Rain brings water which cools the Earth. (Ivan)</td>
<td>4. Rain falls where there are many trees. (Mesesa)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>5. Rain gives water to all living things. (Ivan)</td>
<td>5. Rain is brought by the winds which bring the black clouds. (Mai &amp; Tati)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>6. Rain falls where there are many trees. (Mesesa)</td>
<td>8. Rain falls when black clouds are hit by thunder and lightning. This break the clouds into pieces. (Sari)</td>
<td></td>
</tr>
</tbody>
</table>
Table 8: Responses from the village elders on thunder and lightning categorised by the type of explanation.

<table>
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<tr>
<th></th>
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</thead>
<tbody>
<tr>
<td>1. Spells are cast.</td>
<td>1. Created by God and</td>
<td>1. Sign of black clouds</td>
<td>1. The travelling</td>
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</tr>
<tr>
<td>[Lightning destroyed</td>
<td>wondrous during Noah’s</td>
<td>causes thunder and</td>
<td>speed of dark clouds</td>
<td></td>
</tr>
<tr>
<td>a line of trees from</td>
<td>time as in the Bible.</td>
<td>lightning. (Pou)</td>
<td>forms thunder and</td>
<td></td>
</tr>
<tr>
<td>the beach to the</td>
<td>(Mesa &amp; Sevese)</td>
<td></td>
<td>lightning. (Pou)</td>
<td></td>
</tr>
<tr>
<td>swampy mangroves</td>
<td>2. God created thunder</td>
<td>2. Rapid evaporation</td>
<td></td>
<td></td>
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<tr>
<td>only in one</td>
<td>and lightning to scare</td>
<td>and the speed of clouds</td>
<td></td>
<td></td>
</tr>
<tr>
<td>direction.] (Tati &amp;</td>
<td>people. (Mai)</td>
<td>causes lightning and</td>
<td></td>
<td></td>
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<td>Sevese)</td>
<td>3. Gift from God to</td>
<td>thunder. (Sari)</td>
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<td></td>
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<tr>
<td></td>
<td>destroy things. (Tati &amp;</td>
<td>3. Caused due to speed</td>
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<td></td>
<td>Sevese)</td>
<td>of dark rainy clouds.</td>
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<tr>
<td></td>
<td></td>
<td>(Pou)</td>
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<td>4. Formation of many</td>
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<td></td>
<td></td>
<td>dark clouds causes</td>
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<td></td>
<td>thunder and lightning</td>
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<td></td>
<td></td>
<td>and brings rain. (Pou,</td>
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<td></td>
<td></td>
<td>Mora &amp; Sari)</td>
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<td>5. The travelling speed</td>
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<td></td>
<td></td>
<td>of black clouds causes</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>thunder and lightning</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(Pou)</td>
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<td></td>
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<td></td>
<td></td>
<td>6. Thunder is like a</td>
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<td></td>
<td></td>
<td>big drum that has been</td>
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<tr>
<td></td>
<td></td>
<td>hit and rolled around</td>
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<td></td>
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<tr>
<td></td>
<td></td>
<td>the place in the sky.</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>(Ivan)</td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td>7. Destroyed a line of</td>
<td></td>
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<td></td>
<td></td>
<td>trees from the beach to</td>
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<td></td>
<td></td>
<td>the swampy mangroves in</td>
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<td></td>
<td>one direction (experienced</td>
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<td></td>
<td></td>
<td>this as a young boy when</td>
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<td></td>
<td></td>
<td>an old man cast a spell</td>
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<td></td>
<td></td>
<td>using lightning). (Tati)</td>
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</table>
Table 9: Responses from the village elders on rainbow categorised by the type of explanation.

<table>
<thead>
<tr>
<th></th>
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</thead>
<tbody>
<tr>
<td>1. None</td>
<td></td>
<td>1. Created by God. A sign to Noah and his family after the Great Flood - no more floods. (Pou, Mesea, Mai, Sari, Ivan &amp; Tati)</td>
<td>1. Sign signifying thunder and lightning and rain to stop. (Pou)</td>
<td>1. Formed when sun shines on the steam (water vapour) from the water. (Sevese)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2. Occurs after and during rainy seasons (Mora).</td>
<td>2. Occurs after and during rainy seasons (Mora).</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>3. Sign that heavy rain is coming. (Mora &amp; Ivan)</td>
<td>3. Sign that heavy rain is coming. (Mora &amp; Ivan)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>4. Sign that brings rain. Formed when sun shines on the steam (water vapour) from the water. (Sevese)</td>
<td>4. Sign that brings rain. Formed when sun shines on the steam (water vapour) from the water. (Sevese)</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>5. Has different colours. (Sari)</td>
<td>5. Has different colours. (Sari)</td>
<td></td>
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</tbody>
</table>
Table 10: Responses from the village elders on clouds categorised by the type of explanation.

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<thead>
<tr>
<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td>1. None.</td>
<td>1. God created it. (Masea)</td>
<td>1. Strong winds blow them here. (Pou)</td>
<td>1. Strong wind blows them here. (Pou)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2. Caused by evaporation of water. Changes and forms steam when Sun heats the water. Rises into cool air and forms clouds. (Masea &amp; Tati)</td>
<td>2. Caused by evaporation of water. Changes into steam when Sun heats the water. Rises into cool air and forms clouds. (Masea &amp; Tati)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>3. Plenty of cloud cover means wind is strong. (Pou)</td>
<td>3. Plenty of cloud cover means wind is strong. (Pou)</td>
<td></td>
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</tr>
<tr>
<td></td>
<td>4. Very hot Sun means there are many clouds in the sky. (Tati)</td>
<td>4. Very hot Sun means there are plenty of clouds in the sky. (Tati)</td>
<td></td>
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</tr>
<tr>
<td></td>
<td>5. Paddle of water when heated by the Sun dries and disappears. The vapour rises and is cooled by the cool air in the sky. This changes and forms black clouds and brings rain. (Tati)</td>
<td>5. Paddle of water in the forest when heated by the Sun dries and disappears. The vapour rises and is cooled by the cool air in the sky. This changes and forms black clouds. (Tati)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>6. Plenty of black clouds bring rain. (Tati)</td>
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APPENDIX 9: Sample interview

Note: For privacy reasons, pages 332-335 of Appendix 9 have not been reproduced.

(Co-ordinator, ADT Project (Bibliographic Services), Curtin University of Technology, 20/08/03)
Sample Interview with Ms Josephine Hotsia, Curriculum Officer with the Mathematics Department of the Curriculum Development Division

Soi: This next interview is between Josephine Hotsia and myself again. I used to work with Josephine when I worked in the Science Department at the College of Distance Education. Good morning Josephine. I’d like to thank you for having to make up this time to come to this interview. So your name is Josephine.

Jose: Hotsia.

Soi: And you are from which province.

Jose: North Solomons.

Soi: How old are you.

Jose: 40 years.

Soi: Could you give me the types of qualifications you have. You graduated from Goroka so you have a Diploma in Secondary Teaching.

Jose: I also have a Bachelor of Education majoring in Maths.

Soi: But I think you have an interest in Science and you’ve taught science.

Jose: Yes.

Soi: So how long was the program at the university.

Jose: Two and a half years. Five semesters.

Soi: So when you were at Goroka what subjects were you trained to teach.

Jose: I was trained in maths, science and commerce.

Soi: So where have you taught then. Which schools?

Jose: Asitavi, Marianville, Malala and CODE.

Soi: So the knowledge that you learnt at the Teacher’s College and the university, did you find them useful in your teaching.

Jose: Yes.

Soi: So how many years have you taught at Marianville?

Jose: Two years.

Soi: Asitavi.

Jose: One.

Soi: What was the other school.

Jose: Two years at Malala. It’s now a secondary school.

Soi: Which grades have you taught?
Jose: Grade 7 and 8 science in Malala.

Soi: So which grades have you taught best.

Jose: Grade 7 and 8.

Soi: Why do you think you find these grades interesting?

Jose: I guess because I have taught them continuously with more experience in the subject area.

Soi: So you’ve said you’ve taught grade 7 and 8. Now what units and topics have you found interesting to teach.

Jose: Especially environmental issues.

Soi: Why environmental issues?

Jose: Because it’s dealing with a subject that’s written as part of the environment, and talks about the environment and relationships. Related with you as a person.

Soi: Could you list the types of the various teaching strategies that you have used in your teaching. I mean one that I can think of is group work. During the lesson asking the student to do the practicals themselves so that they can be able to learn and find out what they are doing themselves.

Jose: Videos, questionnaires.

Soi: So how do you motivate your students to learn science meaningfully? How do you motivate them to learn science more meaningfully? One thing that I can think of is the use of metaphors. Like you trying to explain an electric current. One of the metaphor you can use is a water pump. Like we block the water and you let the water fall through a drain or a channel. That is a metaphor that you can use to explain the flow of electric current. So use of metaphors is one way to enhance the students learning. So all along you have been teaching especially in science, I’m going to ask you ways in which you have tried to blend your own traditional knowledge into the teaching of any of these topics. Now you’ve mentioned about the environment.

Jose: I’ve come to see the teaching of science as a subject itself.

Soi: So for example in your teaching, which topics or units have you found interesting. I know what you are saying has been there for quite a number of years and now we are coming to a stage where we are thinking that oh we should be blending our comments to say on the traditional knowledge aspect. In terms of science or any other subjects.

Jose: I think the main thing about science is that it’s already there and has been. For example to give you an example, traditional medicine. That’s science in itself. The making of traditional medicine involve some kind of scientific process. From that we can related that to for example by now what sort of thing we can learn. People know how to make traditionally. They don’t think that involves science. So you can now we can say that, that is science in itself but ..... I think the most important thing is that science has been part of our tradition. It’s just that it has never been thought about in that way.

Soi: That sounds like in other words it wasn’t given any importance and the role played in the school community.

Jose: They did not establish that traditional science was not taught. So
Soi: That's a very good point Josephine. Okay now I'm going to ask you about questions on your what you think your worldview because it's about worldview. What do you think of worldview, this word worldview.

Jose: Worldview about science.

Soi: Worldview about science. It could be about anything.

Jose: What was the question?

Soi: Well I mean looking at that word 'worldview', how do you view the world?

Jose: It's just what education to science or.

Soi: Well it could relate to anything in science.

Jose: Well worldview is what is the general pattern that we have. Think about certain issue generally. It's a general view or general understanding of also general knowledge about issues in science. I think for example if you have views relating to science facts that view ... As a world, common view ... I mean it's getting towards one worldview because can apply because scientific knowledge or skills that you have been learning .. can apply and add on some new knowledge.

Soi: Yes so that's what we should have been doing, the types of traditional knowledge and coming to a stage where we are seeing its value and seeing its importance.

Jose: ...I think science would have been very meaningful.

Soi: Meaningful yes. It would have been better and meaningful.

Jose: Our teachers, they were outsiders but they would have used our knowledge. They have been using our knowledge ...

Soi: Science as an outside subject yes. We seem to teach a lot of outside science rather than our own science and that is why we have problems with our own science. We should have been teaching more of our own science rather than the outside science. Now I know you work in the Maths Department. What is it's like working in the science department. What would you find or see the role of in that particular department. Its view and its expectation. One role for the science department is to write and produce suitable teaching materials especially in science for use in the schools especially for the teachers.

Jose: I think the view and the expectations is there now. The role of this place in science curriculum is to produce a course suitable for the students. The change in the rationale behind teaching science ...

Soi: How long have you been writing Josephine?

Jose: For science.

Soi: Yes. How long did you write?

Jose: From 1983 to 1985 ....basically for science alone so it's four years at CODE.

Soi: In maths, how long have you been writing?

Jose: Sorry I mean ..

Soi: Well to CODE and to here.
Jose: For CODE in Maths 1988 to 1992. Then I went off and I came back and joined these people in 1996.

Soi: Till now. But during that time, you've attended workshops and courses to help you improve in your writing. I mean the experience at CODE. So what types of materials have you written so far.

Jose: For CODE ...

Soi: For CODE you wrote a Grade 8 Science unit.

Jose: Yes ...

Soi: Growth and reproduction. Yes, that was one of the ones that you wrote. So you yourself as a writer what do you see your role as. You yourself as a writer.

Jose: To publish ....

Soi: Better material for the students or teachers which is more traditionally oriented ah towards Papua New Guinea rather then being imported from elsewhere.

Jose: Yes that's the whole purpose.

Soi: Well have you got anything else to say because I think we've come to the end of our interview now.

Jose: Good luck in your studies.

Soi: Thank you very much for your time Josephine. That was interesting talking to you. Thanks.