Enacting the 3rd Cycle Science Education Curriculum in Timor-Leste

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A thesis submitted in fulfilment of the requirements for the degree of Doctor of Philosophy in Education, the University of Auckland, 2019

ABSTRACT

In 2010–11 Timor-Leste's Ministry of Education introduced a new curriculum model described as an "integrated curriculum" called *3rd Cycle Science Education Curriculum* for pre-secondary students (Grade 7 to Grade 9). An underpinning concept within the science curriculum was the goal of scientific literacy that provided a focus for the integration of the subject domains that were previously taught separately by specialist teachers. Adopting this curriculum was seen by Timorese educational officials and educators as a strategy to advance the development of this country and its young learners. It was also hoped that increasing the scientific literacy of Timorese society would enable them to respond to the challenges of integrating into the regional and global economy of the 21st century. In the context of Timor-Leste, this is a significant vision considering how it has just become independent and is doing its best to stand on its own as a modern nation. Hence the focus of this research was to investigate how this new curriculum has been enacted in Timor-Leste schools, drawing on the voices of the Ministry of Education, educationalists involved in professional development and teachers of this *3rd Cycle Science Education Curriculum.*

This study used an interpretivist qualitative approach that involved 45 3rd cycle science teachers from three municipalities in Timor-Leste: Dili, Baukau, and Likisa, three Ministry of Education officials, two educationalists, and three student teachers. Data were collected from multiple sources such as focus group discussions, individual interviews, and documentary analysis. Content and thematic analysis were used to analyse the data.

The overall findings of the study suggest that there were misalignments between the vision of the *3rd Cycle Science Education Curriculum* that had been developed by outsiders and how it was interpreted by both educational officials, educationalists and science educators. Consequently, this lack of understanding influenced this curriculum enactment for both educational officials and teachers alike. Fundamental to not realising scientific literacy was these teachers' reliance on a pedagogy that was behaviourist, with transmission of knowledge reinforced by in-service teacher professional development as well as the national assessment system. Even though these Timor-Leste teachers had a strong belief that they needed more resources and knowledge development to improve their pedagogical content knowing, these findings

showed that rather than giving priority to knowledge development they need to develop an understanding of constructivist learning linked to pedagogy. It is suggested that a constructivist pedagogy will provide teachers with the skills to progress towards integrated contextualised learning.

ACKNOWLEDGEMENTS

Being able to forge my way through this long PhD journey was almost impossible to fulfil without the generous support and companionship from the many people, families, and friends. Hence I would like to take this opportunity to express my immense gratitude to each one of them.

First and foremost, I would like to express my utmost gratitude to my supervisors; **Associate Professor Beverley France**, **Dr Ritesh Shah** and **Dr Sally Birdsall**. I am conscious that completing this PhD project was indeed challenging but I was so fortunate to be surrounded by all of you. Without your generosity and constant support, this thesis would have been impossible to complete. Hence, thank you for your invaluable support, timely advice, meticulous scrutiny, scholarly assistance, benevolence and patience, which have helped me to a very great extent to accomplish this study. Under your supervision, I have gained a lot of knowledge and skills concerning the academic life and career. I hope to spread in some way all that I have learnt from you all to my fellow teachers and students in Timor-Leste.

I realise that this study would not have been fulfilled without the financial support from the New Zealand Ministry Foreign Affairs and Trade (MFAT) through the New Zealand aid scholarship programme. For that I am forever grateful. I will make sure that, as the first PhD scholar in the independence period that is supported by the MFAT in Timor-Leste, I will pay this debt forward by committing the improvement of science education for the Timorese children - whatever it takes!

I would also like to thank the 3rd cycle science teachers from Municipality of Dili, Baukau, and Likisa who provided me with abundant information about their teaching experience and entrusted me to channel their voices, struggles and dedication to helping Timorese students learn. *Obrigada wa'in, hamutuk ita bele.* My thank you also goes to the Director General of Pre-school, Basic and Recurrent Education, Sr. Cidalio Leite, M.Ed, (the Municipality educational director of Dili, Baukau and Likisa) who facilitated me to access the school teachers. Your role really made a significant contribution for me to realise this study.

While undertaking this study, the decision to be away from home and loved ones was indeed another challenge, but I was so privileged to receive constant encouragement

from my husband Natalino de J.G.Soares. So thank you for your understanding, support and patience in looking after our little boy ‘Sergio’ while I am completing the study.

I would also like to acknowledge my PhD friends in the school of Curriculum and Pedagogy - Maria, Orlando, Farhat, Li, mas Faisal and mbak Nurul who shared their time, feelings of joy and sadness while we battled to accomplish our PhDs.

It has been a common belief that doing a PhD is indeed a challenging task and sometimes there is a temptation on one to quit the journey. However I was so blessed to be surrounded by generous people that kept motivating and fuelling me with a good spirit to accomplish this study. Hence, my heartfelt thanks goes to my friend Helda Mada and her husband maun Adelino for their constant support and help in taking care of my little boy Sergio. Lastly, but not least I would like to acknowledge my only sister Elizita and her husband, maun Luis, and also my lovely nieces and nephews; Sonia, Diana, Eligio, Lourdes, Angela and Aday, who always see me as a model of success and being educated.

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CHAPTER ONE

INTRODUCTION

The Tetum version

Tempu udan, plástiku, fo'er sira iha rai lolon, uma leet sira lori hotu ba tasi, tasi baku fila mai ba kolam sira-nia laran. Tamba ida ne'e mak ita agradese ba sira hotu ne'ebé mak ohin partisipa iha loron ida ne'e, desde oan sira iha eskola, funsionáru publiku sira,. . . Ita hakarak fatin moos, furak, tanba liga mós ho ita-nia saúde, ambiente sidade nian. Hau hanoin ita hahú halo esforsu para que sensibiliza sidadaun, husu sira-nia kontribusaun. Ha'u espera neineik ita sei iha kontribusaun di'ak (Ruak, Timor-Leste Prime Minister, 2019, as cited in Belo, 2019).

Translation

In the rainy time, plastics and trash from the slopes, amongst the houses will be dragged into the sea, and then the waves will bring it back to the city conduit. Therefore, we thank those that participated here today – students, the public service, . . . We want clean places, beauty, because it also relates to our health, our city environment. I thought we should start to sensitise citizens, ask for their contribution [in solving the country's problems with trash]. I hope gradually, we can all contribute to the solution of this problem (Taur Matan Ruak, Timor-Leste Prime Minister, 2019).

1.1 The Issue of Teaching Scientific Literacy

The Prime Minister's statement reflects Timor-Leste's recent environmental situation and signals to all citizens that he expects will take part to gradually solve the trash problems in the country. In this introduction chapter, the identification of this trash problem provides a relevant and important context to explore and illustrate the educational challenge of developing citizens with an awareness and understanding of scientific literacy. Scientific literacy is the overall goal for the *3rd Cycle Science Education Curriculum* and the hope is that future citizens will be able to recognise and understand the science that is underneath this problem and be able to provide some solutions (Ministry of Education, 2010a & 2010b).

Timor-Leste has a problem with waste plastic. Bottles and plastic bags are everywhere. When I go to the beach, I see plastic bags and bottles on the sand and in the water. When I walk to my sister's house in Dili, I see plastic all along the road (see Figure 1.1) and when I arrive there is plastic everywhere in the common areas between their houses. When I go to the traditional market, I see plastic on the ground and all around. Consequently, in the rainy seasons, this litter will be dragged into the sea and the sea waves send it back to the city's conduits (Ruak, as cited in Belo, 2019).

Figure 1.1. Plastic trash in TasiTolu – Dili. Retrieved from https://neonmetin.info/buletin/2018/06/20/lixu-namkari-iha-fatin-istoriku-tasi-tolu/)

I know that water is sold in plastic bottles and in Timor-Leste, water in plastic bottles is one of the people's main purchases as there is no clean drinking-water from water taps or public drinking fountains. In fact, people are dependent on these single use plastic bottles, which are then normally thrown away after being used. They do not see how plastic in the water can affect the marine biodiversity and harm land that they utilise to grow their food. The worst thing is that some people burn these tons of plastic that are found in the areas of garbage. They do not know that the fumes given off are dangerous to their health and community when they stay close to it.

Recently, there were two concerns that the Timor-Leste government released to appeal its citizens to participate and act to solve the environmental issues. First, the environmental decree law which calls on Timorese society and the public service to clean the city every Friday. Second is that the government is calling on society to stop the action of using a plastic bag because of its adverse effect on the environment,

specifically, the impact on soil or land and sea. This is important because the majority (70%) of Timorese families still rely on soil and farming as primary sources for livelihood (La'o Hamutuk, 2018). Recently, the Timor-Leste Secretary of State for Environment, Deometrio do Amaral de Carvalho, with support from various NGOs and international agencies called for Timorese society to "go for green" and say no to plastic bags to fulfil the government call for "zero plastic policy" (Viera, 2019) They encouraged consumers to use environmentally friendly bags (such as palm baskets – see Figure 1.2) for grocery shopping. The action was a way to make society aware of the worldwide concern about the global challenge of dealing with ocean plastic pollution (Our, Ocean Conference, 2018) where the Timor-Leste delegation took part in this conference suggested that Timor-Leste citizens should be taking part in this global challenge.

Calling society to clean up the city's trash, which includes plastic bags, and becoming aware of why it is important to stop using them is an example of a context that would show people why the goal of scientific literacy is important and relevant in Timor-Leste society.

Figure 1.2. Timor-Leste Prime Minister carried a Timorese Palm Basket to harvest crops in Soibada subdistrict, Manatuto district. Retrieved from http://www.radioliberdadedili.com/notisia/ 1158-80-povu-tl-agrikultor-maibe-mall-nutrisaun

The problem of plastic pollution is just one example of why teaching science for scientific literacy is an essential goal in this society. Even though they do not produce plastic they use such goods that pollute this agriculturally based society in which most

of the population live in villages where they cultivate the land for food. Hence, to encourage students to be aware of the impact of these goods on themselves and the environment is vital.

But my experience is that teachers find it difficult to translate this goal of scientific literacy into the classroom when they are enacting the curriculum. I wanted to find out why this happens. Even though there are examples in the new curriculum that promote this scientific literacy focus – for example when investigating public water quality in the Grade 7 student textbook (Ministry of Education [MoE], n.d., p. 95), such an educational goal is not as important as to find a water source, rather than whether it is safe. Another context that is provided in the curriculum textbook is the issue of packed food that is sold in the school area. The curriculum asks teachers to identify the ingredients on the food packages in the Grade 7 student textbook (MoE, n.d., p.24). However, teachers may not realise that the focus of this activity is not just to identify the chemical ingredients present in the food but also whether these ingredients are healthy, let alone if they continue provide the trash.

I realised that teaching for scientific literacy is an important goal, but many teachers found it a challenge and did not understand why it was being promoted. They preferred to go back to the old way of teaching science, ways that they been educated and informed in. I wanted to find out why the new Timor-Leste curriculum focus on scientific literacy was a problem for teachers. I hoped that this research finding might help provide some insights.

The rest of this chapter provides an overview of my reasons for carrying out this study. This educational narrative is organised so that the reader can understand how my family life and values that influenced my educational journey and my goal to explore the pedagogy required for an enactment of the *3rd Cycle Science Education Curriculum* to develop scientific literacy in Timor-Leste.

Section 1.2 describes the values of life that I received and learned from my uneducated and traditional agriculture employed family. In Section 1.3, I tell the story through my eyes as a young child enduring the Indonesian invasion and how this occupation of the country has affected my education. Section 1.4 describes the Indonesian education system, particularly teaching and learning of science subjects that I experienced during

my secondary science education. Section 1.5 describes my educational experience at undergraduate level in Java Indonesia. Section 1.6 describes the learning experiences and school conditions that I encountered in Indonesia that eventually cultivated my vocation to be a teacher educator in Timor-Leste. Section 1.7 shows my evolution from being a teacher to a science teacher educator when I was called to take part in developing the education sector by preparing science educators for the new independent county. Section 1.8 tells about the issues I heard from Timorese science teachers when they were asked to teach the new junior secondary science curriculum or *3rd Cycle Science Education Curriculum* and how challenging it was to switch their teaching pedagogy from being a specialised teacher to a general science teacher. Section 1.9 provides an overview of the organisation of the thesis.

1.2 My Family Life and Values

I was born in a small village in subdistrict of Kelikai, district of Baukau. I am from a traditional agricultural family. According to my family story, in the past Timorese households lived on their own land that was inherited through generations. A family that had many family members usually cultivated a large area of land to grow their crops, while a family with fewer members to cultivate the land had a smaller area. This happens because in Timor-Leste people are able to go and clear land to farm when they want to. So, with a larger family, they can afford to work on a large area because there are more family members to work and they will have reclaimed more land. Once a family member is married, they can stay with their family, but when children are born there will be more family members and this land may not enough to feed this expanded family and the chance to improve the family wealth will be less. Consequently, there may be a need to clear more land or find another way of feeding their family. My father had the same experience when he married my mother. Initially we lived in a place close to Mount Matebian and they were looking for new land to start a new life. But this changed after 2 years when Indonesia invaded the country on 7th December 1975.

My personal interest with natural science emerged from my family life, as they were farmers, and from my father's work as a metal artist. My family relied on nature for farming. For example, they relied on roosters crowing and shadows to notice the time. They knew when they should start their day farming by the crow of the rooster – for

example by how many times the rooster crowed. I recall the way my family made appointments to visit their work mates or relatives by telling the position of the sun. The terms that they used to describe the time were early morning, morning, when the sun rises a bit, noon, after noon, late afternoon, and night or late at night. With these terms, they could ensure their appointment time to meet up or visit relatives.

This tradition was strong habit for me. I remembered that at secondary school my friends still relied on me to tell them the time if they did not have a watch. One day, one of our nuns (from the convent where I stayed and was financially supported by when at school) was curious about this ability and she asked me to tell her the time on that day and moment. After I observed the shadow of the house, I told her the time, she then compared my guess with the watch on her wrist. She then told the friends in my boarding house that my guess had been right. Through my family's agricultural background, I am familiar with nature and its phenomena since my early childhood. This was an aspect which cultivated my interest with natural science rather than other areas for study.

As the daughter of a metal artist, I had observed how my father melted, casted and finished his metal work before marketing it for people to use as part of a woman's dowry. He was able to use waste metal to make the Timorese sword or *Surik*. The *Surik* is used to symbolise a woman's dowry that may be presented to the family to appease their ancestor's sorrow that may have occurred in the past from disease or accident. Unfortunately, as a woman, we were not allowed to learn those skills, as it was associated with a man's work. But in my childhood, I was involved with the collection of the ingredients to make the metal bright and to collect the wood for melting the metal. I was always fascinated by this physical process. However, I was never aware that his work relied on knowledge of materials such as metals until I did my undergraduate physics class in Java, Indonesia – and by that time he had passed away. This is when I learned that things or materials in nature could change their form and shape by external forces or the adding of new materials.

1.3 Life Under Indonesian Invasion

I was only 2 years old when Indonesia invaded Timor-Leste on December 7, 1975. We were bombarded by the Indonesian military planes and terrestrial infantry. We hid in

the Matebian caves for almost three years. People who were able to save their lives were those who are able to move or walk, but aged people just stayed in their house until they died either from famine or were killed by the bombs.

According to my parent's stories we were only able to eat when the military did not launch the bombs. For example, in the night time adults had a chance to find food and prepare a meal for the family members but if the warplanes kept bombarding us for several days then we were not able to eat when the bombs were actively thrown. This situation caused many Timorese to suffer from starvation and lose their lives from famine and war. During this time of turmoil, many people lost their beloved family members. I lost my beloved uncle who was the only son in the family that went to school during Portuguese time.

Although the situation was at its worst, and people were starving and naked, the spirit to liberate themselves from the illiteracy cycle continued to flare up. In the hidden caves, when there was not bombing, Portuguese-educated people brought together school-age children to teach them to read and write. According to Cabral and Martin-Jones (2008), António Carvarinho, one of Timor-Leste's independence movement fighters, and a member of Central Committee of Fretilin (CCF), taught Timorese people to write the Tetum alphabet and then others taught them Portuguese.

I was too young to join the learning groups, but my parents recounted that the non-formal group-study existed. During that time, some Timorese children who were educated in these non-formal groups ran out of appropriate learning equipment, such as notebooks and pencils or pens, but their passion for being educated kept flaming. For writing tools, they utilised palm tree skins as notebooks and charcoal as pens for writing.

This situation formed my parents' views about life and education. Even though my parents and most of their extended family never got an education, there were two family members – one from my father's side and one from my mother's family – who went to school. These family members changed their views of education – that educated people live better than uneducated. Unfortunately, the Indonesian invasion took both of these uncles away from us.

Following the decline of war tension, we moved to the city, to seek medical assistance to recover from epidemic diseases that we caught when staying in refugee camps. We lived in the city and we could not access land to farm but, fortunately, my father's metal skills saved our lives from starvation. My father produced the *Surik* and then bartered them to gain money or other forms of merchandise. After my father sold or exchanged his *Surik* with some goods and commodities, my mother sold these commodities back in the market. Frequently, they asked us, my sister and me, to help them to sell them.

One day before my mother let us sell the merchandise at the market; she had introduced us to various types of the currency that were used at that time. Though illiterate, my parents recognised the amount of money from the colour or figures that were printed on the money. But I understood the differences in money from a different point of view. While my mother was introducing to me the differences between the currencies, I responded to her that, "sure I know it now, but I can differentiate the money from the digit but not the colour of it." My father was surprised, and he encouraged me to believe that I might be right. His reasoning was that the colour and the figures printed on it would change in one day, but if you ensure the amount of the money from the digit, then you know how much it is worth. Helping my parents to sell the merchandise was a way that equipped me with arithmetic skills which later brought me to explore in the physics area. I found that physics was easy to learn.

1.4 My Educational Experiences

My experience of being educated in the Timor-Leste education system focused my interest in exploring and researching science education in my country.

I was educated under the Indonesian regime. However, most of our primary school teachers were Timorese who had been trained by the Portuguese. At this time, the central government launched a programme to increase the schools' and students' enrolment numbers, but they were short of teachers. It was intended to educate school-age children in order to expand the influence of the Indonesian way of life on Timorese. They believed that school-age students could influence older people who were mostly illiterate.

Most of these teachers had only completed primary school that was not higher than Grade 7 or junior high. These teachers continued their education at schools just above this level at the same time as they were teaching us. Because there were few teachers some of the Indonesian military volunteered to teach at schools.

The primary education system at that time was organised to develop students' literacy skills that enabled them to understand Indonesian indoctrination of Pancasila that would prepare the young generation of Timorese to become good Indonesian citizens. For the first 3 years (Grades 1–3), the learning content emphasised reading and writing and memorising the content of Pancasila. Following that, from Grades 4 to 6, our education was focused on us being good citizens by memorising all of the constitution preamble and its meaning in real life.

I can still remember the content of Indonesian history and the preamble about the Indonesian constitution. For instance, it is deeply rooted in my memories of childhood how we had to practise the Indonesian preamble constitution and history during the school year, from primary up to pre-secondary school. Every day before any class activities we had to gather in the school compound, sing the Indonesian anthem, "Indonesia Raya," and the students had to take turns in reading the preamble of Indonesia constitution version 1945, part of which is:

> That indeed independence is the right of all nations and therefore, the occupation of the world must be abolished because it is not in accordance with humanity and justice.… and by realising a social justice for all the people of Indonesia.

Also, after school we had to sing the anthem again while pulling down the Indonesian flag. Apart from that, we were also obliged to learn the content of Indonesian history and their struggle against Dutch and Japanese. From this learning experience, I believe that we were able to remember because of this practice every day. We were indoctrinated.

If I reflect on my primary education journey, I remember we were introduced to science lessons in primary school. Unfortunately, I do not remember any of the content that I learned at that time. But I must have learned the lessons because I was able to answer most of the national exam questions and I got a good mark at that time.

However, for science, information was memorised for examination purposes and our learned information went away immediately after the exam. I remember that teachers dominated the learning process. We did not interact with our teachers and there was a huge gap between the teachers and us – the learners. We, the students, just followed whatever teachers directed us to do such as memorising the content of each subject. I found it strange that they kept explaining the meaning of the content that related to Indonesia, such as Indonesian preamble constitution and the Pancasila, but not about the science subjects that we needed to understand in life.

As a consequence of this education practice we, as Timorese students, did not develop other ways of learning and understanding, especially our reasoning skills. Indonesian education practices caused Timorese pupils to be influenced with the thought pattern that says, that the teacher is always right and is the source of knowledge. Hence, students hardly gained the chance to question the teachers in a classroom. This resulted in successful students being those who accepted the given content and memorised it for exams so that they could get high grades. I witness that, even now, these practices continue in the current education system and it needs help to be solved.

In fact, I was good at math in school and was able to memorise all subjects diligently. I found going to school was easy and enjoyable. It was unusual that my family encouraged me and my sister to go to school as at that time education for girls was not thought important. Also, school provided a place to play, for example traditional games, balls and swing, before and after school time. At home, there was no space to play and we had to work.

Even though I enjoyed school, I remember that my teachers ruled the class with an iron hand. They carried a stick during lessons. For example, in the reading sessions, our teacher read the lessons loudly and all of the students had to repeat the sounds after them. If they found someone did not open their mouth the teacher would beat them with the stick. This corporal punishment reflected the Portuguese education system rather than that practised by Indonesians.

1.5 Dominance and Priority Given to Science Education in Secondary Schools

The Indonesian education system has bred a long-lasting concept of hierarchy among students. Systems were established to honour certain groups while devaluing others. At this time (Indonesian time 1975-1999), the education system highlighted science students who were regarded as higher than those studying social sciences and languages. It seems to me that science teaching and learning diverged from its natural path where learning about the phenomena of nature is part of human life when understanding about human existence. I believe that learning about science can generate a curiosity to discover more about our surroundings. Nevertheless, in the Indonesian period, science was articulated as a subject that dealt with complex concepts and mathematical formulations. Science education was designed for outstanding students, whom, it was assumed, would follow career paths to work in such areas as outer space programmes.

Science students were considered an exclusive group and were regarded as people who stayed away from real life and solely carried out laboratory experiments. Students who enrolled in science classes for example biology and physics were labelled as "groups which inherit Habibie's brain". B.J. Habibie is a brilliant Indonesian aircraft engineer and politician who was president of Indonesia (1998–1999) and is a leader in the Indonesian technology and economic fields (Amir, 2007). He was also the Indonesian politician who granted Timor-Leste the option to become independent. It is important to note that he allowed this option for Timor-Leste people to choose freedom from Indonesia which empowered people to fight for independence and caused the Indonesian invasion.

I was identified as an excellent student and was given permission to delve into the physics discipline. I got good marks in physics because I had a good memory and I could solve the mathematical problems that illustrated the concepts. Physics classes were dominated by Indonesian students because they had more resources and had extra tutorials to pass the entrance exams. The content and contexts were about Indonesian themes and contexts – for example forces were illustrated by cars, trains and airplanes. Even if we complained that we did not know about this unfamiliar content or context we were told that you need to learn this in order to be successful in physics. A bright

future was promised. We knew that we were at school to pursue the lesson content just for examination purposes and to get a high mark. As a result, education at the secondary level caused students to aim for high marks without understanding the underlying concepts and their relevance for their life.

The examination system promoted memorisation and the common form of assessment was multiple choice and problem solving. As I did not have a clear understanding of the goals for science education at that time, I merely became efficient in memorising the content that we were required to know. For example, in the multiple-choice exam we were asked to identify the best definition – "what is force" – and then we were asked to choose the best answer from the mathematical solutions provided.

Even though Timor-Leste is independent, and the education system is developed for Timorese children, these pedagogical values still persist as the goal for students is to get high marks in science. It seems that learning by memorisation and doing mathematical problems seems to be the way for success. Teachers still hold on to this way of teaching and they find it difficult to use Timorese contexts to develop students' understanding. I wanted to find out what the issues were that stopped teachers teaching science about their world so that students could understand it.

1.6 My Undergraduate Experience

When Timor-Leste education integrated with Indonesia the enrolment numbers of students increased dramatically (Nicolai, 2004) but many adults remained illiterate and continued working in traditional agriculture for their survival. I was in the same situation. My father continued trading his *Surik* to support us, but he could not afford to send me to a university. Fortunately, I was successful in my exams and I got a scholarship from the regional government (Timor-Leste province) to do a physics course in a university in the Java island, Indonesia. In terms of school infrastructures, school facilities, and teaching and learning environment, I found, Java provinces had a better education system than the one that we had in Timor-Leste.

My major subject was physics and I also learned basic chemistry and biology. My vocation to be a teacher emerged in the time I did my undergraduate study. The reason was not that in Indonesia teaching was considered a privileged profession, but because I found the way we are being introduced to science was so different from my previous

educational experiences. In another words I was inspired by the way my science lecturer introduced us to science knowledge and how it could be applied. It was very different from how we had been taught. In this university in Java, the lecturer provided clear guidance and a syllabus subject outline. Experiments were provided alongside the science topics. At this time, I found reasons for how and why theories and laws of science existed.

We were also encouraged to take part in classroom discussions, raise questions and discuss our science experiments. Learning was organised and structured. These learning practices changed my views about the goal of science lessons. I was inspired and reflected that the training of Timor-Leste science teachers needed to be changed.

At this time, I had a chance to train as a science tutor and started to learn about learning theory and pedagogy. This was my first introduction to the various theories of learning, such as behaviourism, cognitivism, and constructivism. Even though I did not understand these learning theories in depth at least I gained new insight about how my previous teachers had trained us for success. One of the reasons was that they probably were passing on the content and skills that they learned from their previous teachers.

However, there was one impression that I found that was the same as when I was in Timor-Leste. Not many students were interested in studying science for teaching and during my enrolment time of 1993 in Java there were only five student teachers who were interested in choosing physics education. But we persisted in our goal to teach physics and I heard from my physics friends that all five of us became physics teachers. Even now, I realise that this was unusual because there are few people who study physics who are interested in education.

During that time, I was inspired by one of our lecturers. I was interested in the way she introduced us to the content to be learned. She always started her lessons with a question, – a question that was relevant to everyday life or at least things or events that were visible and relevant for students. This was the turning point of my view of physics and education.

I learned that if a teacher's explanation of science content was related to the student's life then students might engage to explore science concepts. I learned that the teacher needs to stimulate students to think and ignite their motivation to explore further. The

teacher does not need to feed every single of piece of curriculum information to students as they also have their own desires to gain that information.

I hoped that I would be able to teach in the same way when I returned to my own country.

1.7 My Evolution from a Teacher to a Teacher Educator

To reflect on this educational evolution – I was part of a new-born generation when Indonesia invaded the country and was ready to be part of country's educational development when Indonesia left the country.

I returned to Timor-Leste just after the country tried to rise again from its worst moment because of the Indonesian army's and militia's atrocity and brutalism. This view of history is because before the Indonesians left the country, the military and militia destroyed and burnt down all of the infrastructures that they had ever built and developed in Timor-Leste. Besides that, they also killed more than 1,000 people (CAVR, 2012).

I started my teaching career in early 2001. At that time, I found myself fortunate to be one of the few Timorese to have a physics education major in this newly independent country. The new Timor-Leste transition government declared a shortage of teaching staff and asked Timorese young people to be part of this development.

In 2001 I joined the university, and immediately headed the new physics education department – established for the first time in our country. Before this, in the Indonesian time, there was only a biology education department and no education focus for physics, chemistry and geology.

In the new department, teaching 50 trainee teachers, I found that I walked alone. As a fresh graduate, sometimes, I felt less confident to lead this small department of me and a volunteer teacher from California. However, there was no chance to avoid this role as everyone was required and called on to develop this new independent country. I prepared my trainee teachers based on my experience gained from the Indonesian university in Java. During this time, I applied these new ways of teaching I had seen and I started my lessons with a question. If not a question, I started my teaching topic with something that was relevant to their lives.

Besides teaching undergraduate physics education students, I also delivered training to physics teachers from schools all over the country. I noticed that this was the time that we began to open the teachers' horizons. For example, how scientists work when they realised that in the history of scientific knowledge development many explanations of the world were discarded because there was no scientific proof. We also shared with these teachers that we were not the primary source of students' information and knowledge. We showed them that teachers could co-operate and complement each other. It showed in the teachers' comments that they benefited from our help, but they were entrenched with old ways of learning and teaching. It seemed hard for them to change their teaching mind-set immediately. I learned that change takes time.

As well as the challenge of a lack of teachers and how they taught, the country was also challenged with language issues. In primary in the 1st grade, students were taught by Timorese teachers in the Portuguese language. These 1st grade students knew only the mother tongue and Tetum. After 1st grade, students were taught by Timorese teachers in Tetum, but their resources were written in Indonesian – most of the teachers being fluent in this language. This language problem meant that there was a lack of resources and no clear decision about the language of instruction. Even though the constitution had stated that the official languages were Tetum and Portuguese, this was not clear in education (Quinn, 2013).

The country's leaders and politicians were conscious that this new state of Timor-Leste needed to be developed by education, which is critical in preparing and developing its human capital. But the country was short of educational resources, and they had to welcome and borrow a foreign curriculum and an education blueprint to use in their country. This happened, and Timor-Leste used the Portuguese education system at this time. This situation occurred up to the development of the new *3rd Cycle Science Education Curriculum* which designed and authors by Pacheco, Morgado, Flores & Castro (2009) in Portugal and introduced to Timor Leste to use it. The next section will describe the issues of this establishment of a science curriculum that I experienced. In this section, I will describe my experiences that led to this research.

1.8 Teaching and Leading Professional Development for Scientific Literacy

Up till 2010, I was involved in teacher education that followed the Indonesian way. Anecdotally I would predict that teachers were trained in their specialised areas with most of their time spent on developing knowledge. I spent time with student teachers learning physics and, the rest of the time, we taught about the curricula and pedagogy for a minor part of the teacher education period. What time was left we studied other sciences and general knowledge. For instance, the physics student teacher would learn basic biology, chemistry, and environmental science.

It was important that UNTL (Universidade Nacional Timor Lorosa'e) provided the best teacher education to the country. I believed that I had a big moral responsibility to give the best service to the country through education. But I realised that when the Ministry of Education decided to alter the previous curriculum to make it more in line with global needs and the situation, it triggered arguments among teachers, teacher educators and policy makers. They believed that this curriculum was not the best way to educate and they did not believe in or did not know the meaning of scientific literacy. The new curriculum aimed to develop scientific literacy by teaching all of the subjects as general science. It seemed that most of the content that made up the new curricula were alien to them.

As a teacher for country educators in the only public university in the country, I have a big moral responsibility to give the best service to our country through the education sector. I expect that our student teachers would give back the knowledge and skills that they gained to schools and society, at least to meet the educational calls in their best way.

However, in 2010, when the government, through the Minister of Education, decided to alter the previous curriculum with a new curriculum that resonated with the current situation as well as global needs and situation, it triggered huge discussion and arguments between science teachers, teacher educators, and the policy makers.

These science teachers complained; they were not ready to implement these goals that led to a new curriculum that aimed to develop scientific literacy. However, the imposition of this curriculum continued with international trainers and local policy

makers and the requirement that local teacher trainers attend the short-term training sessions and then teach this information to local teachers. I accompanied my students to these teacher-teaching sessions where the schoolteachers and the internship teachers were always grumbling and complaining about the issue of teaching this curriculum.

It appeared to me that the policy makers thought that these teachers would be able to switch their way of teaching and learn more knowledge out of their specialisation automatically. They believed it would happen. I started to think – how can a specialised teacher change to a general science teacher? I wondered if the curriculum implementation was resulting in what the curriculum intended.

After hearing all of this discussion among teachers, teacher educators and policy makers, I decided to explore how the implementation of the curriculum was going. I applied to the government for a grant to study this problem. In 2013 I was awarded a New Zealand educational scholarship that allowed me to come to New Zealand to research the issue of curriculum integration of science subjects into general science with the goal of developing scientific literacy.

Before I came to Auckland, I had a chance to visit and observe the training directly at a workshop where around 60 teachers attended. The atmosphere was chaotic, teachers were not happy with the training process. Some teachers just wandered in and out of the classroom. I was curious to know what had happened. Why were teachers so disrespectful of this training?

I talked to some of the teachers. Some of them mentioned that their trainers were not qualified, and the national educational officers had sent them to deliver the training because they were relatives of the officers. Others commented that with this new policy, the quality of education has reversed and even worse than what they experienced before. They also asked – how come a polytechnic graduate delivers science to us when they did not study science properly?

They said to me “So, we are here to attend the workshop, because they provide us with a workshop daily incentive for food and transportation. But we are not here to learn science from trainers whose knowledge is lesser than us.”

I was curious to know further how these teachers implemented the new curricula in their own science classrooms. In 2017, after 5 years of implementation, I returned to

explore how teachers are enacting this new curriculum. Instead of just talking to teachers who had previously attended the workshop sessions, I involved more teachers and asked them how they had implemented the new curriculum in the classroom. I wanted to know whether the training workshop changed the situation. How do teachers cope the curriculum goal of scientific literacy? I wanted to investigate what aspects hindered science teachers to implement this new curriculum in the classrooms. How do they deal with their teaching? What actions have teachers taken to overcome the issues?

Before I describe this research, I must tell the reader that this research is only concerned with pre-secondary science curriculum (*3rd Cycle Science Education Curriculum*, version 2010) that was enacted from 2012 -2017 when the study was conducted.

To conclude this chapter, I state the aim of this thesis. It is to explore how Timor-Leste teachers enact this new curriculum with its vision of scientific literacy for all. While exploring teacher and teacher educators' views about this enactment it is important to identify the challenges they face and how teachers of Grades 7–9 have managed these challenges during this enactment of the *3rd Cycle Science Education Curriculum*.

1.9 Organisation of the Thesis

This thesis is organised as follows.

Chapter 1 – This chapter provides a brief story of my personal life, educational experiences, and teaching career, which highlights the country's science education situation that has formed my interest and research focus. It provides justification for the focus on researching teachers' views about the difficulties of enacting a curriculum that is focused on scientific literacy.

Chapter 2 – The chapter provides the literature review about the history of Timor-Leste education system. This includes the Portuguese education system, Indonesian education system, the country's education system under the United Nations administration for a transitional government and the Timor-Leste educational system in the independence era. The chapter also discusses the country's educationalist endeavour to shift its education system from a behaviourist teaching and learning approach to a social constructivist approach. The chapter also describes teaching and

learning science with the goal of developing for scientific literacy both in Timor-Leste and in a range of developing countries. The challenges of curriculum design for scientific literacy and professional development are discussed in terms of teacher belief. Pedagogical issues are discussed when teachers are required to teach science using relevant context as well as moving from a behaviourist view of learning to one where students are in control of their learning – that is using a constructivist pedagogy. The model of *pedagogical content knowing* (PCKg) by Cochran, DeRuiter, & King, 1993 as a framework for teaching is described. Additionally, the language challenges encountered in Timor-Leste are identified in the literature. Finally, this chapter restates the aim of this thesis and the research questions that have been identified from the literature.

Chapter 3 – presents the overall methodological framework of the research. It discusses why the interpretivist paradigm has chosen as an appropriate approach to interpret participants' perceptions in the study. The selection of participants is outlined, the participants introduced, along with the data collection and analysis methods. The strategies used to establish trustworthiness are discussed along with the ethical principles involved in this study.

Chapter 4 – reports on the curriculum philosophy and intentions as identified in the official documents and educational officials' interpretations of these official views. It provides data about how the Ministry of Education officials perceived the new curriculum vision and also interprets how teacher trainers should enact this spiral curriculum model. Ways in which information about the curriculum was developed and provided to teachers is reported as well as the ways in which the level and direction of professional development was provided by a UNESCO funded organisation.

Chapter 5 – Educational challenges identified by teacher participants are reported and discussed. In order to explain these difficulties, the differences in curriculum vision as identified in earlier curricula and the latest document are described and discussed. The challenges of professional development as well as language challenges when being required to teach in Portuguese to students whose language facility was in their mother tongue and Tatum are explored. Resource challenges encountered by teachers are identified together with the difficulties of a textbook developed in Portugal and written in Portuguese that reflected a colonial perspective not only in its use of context but

also its sophisticated view of constructivist pedagogy. Lastly the challenges of a national assessment system that imposes a behaviourist view of learning on teachers and teachers is identified.

Chapter 6 – This chapter identifies and reports on the efforts that teachers have taken to overcome the challenge of enacting this new curriculum, such as pedagogical strategies to overcome a lack of resources. Teachers' awareness that learning science concepts involves more active participation indicates developing a constructivist pedagogy. An emerging appreciation of how science knowledge is developed is discussed with examples. Finally, the influence of teachers' views of learning and their subsequent adoption of a corresponding pedagogy are identified through their discussion of the behaviourist, cognitivist and constructivist teaching approaches they used during this enactment of this curriculum.

Chapter 7 – This chapter discusses the research questions. That is how the vision of this integrated *3rd Cycle Science Education Curriculum* has been interpreted by Ministry of Education officials and educationalists and the challenges for teachers as well as the pedagogical strategies they have used during this enactment. The issue of teaching for scientific literacy is reflected on in terms of the input from Ministry officials and educationalists. A discussion of teacher belief about science education and learning that provide challenges to the implementation of this curriculum in Timor-Leste occurs. An analysis of teachers' science education pedagogy occurs with reference to the model of PCKg (Cochran, DeRuiter, & King, 1993) that provides commentary about these teachers' views of learning (behaviourist, cognitivist and constructivist) that is explained by a colonial educational legacy. The implications for teacher professional development are explored as are future directions for further research. Finally, the thesis finishes with a discussion of the limitations of this research and a concluding statement.

CHAPTER 2. LITERATURE REVIEW:

A COLONIAL PAST AFFECTING PRESENT CURRICULUM ENACTMENT

2.1. The Problem

Timor-Leste emerged as a new sovereign state with the new millennium. In doing so, it has had to make a leap into a sophisticated world, where globalisation continues to break down boundaries between continents, regions, and countries. For Timor-Leste, it is as if we are standing at the crossroads of a world from the past, a world of today and a world of the future. The issues therefore lie in whether we step into this sophisticated world immediately, which would be difficult because we have no prior experience of this, or whether reverting to a previous era would be easier. However, we now live in the 21st century and so it appears that we have no choice but to change and develop quickly.

In mid-2011, Timor-Leste's Ministry of Education introduced a new curriculum model, described as an "integrated curriculum," for pre-secondary students from Grades 7 through to 9 (MoE, 2010a & MoE, 2010b). This curriculum has been promoted as a 21st-century model because it is holistic, contextually appropriate, and integrated (MoE, 2010a & MoE, 2010b). Within this focus on integration, the science curriculum has shifted its emphasis to developing students' scientific literacy, rather than content knowledge. Nevertheless, insufficient educational infrastructure and teacher capacity appears to be placing constraints on the enactment of this new curriculum. Science classrooms do not possess the equipment needed, there is a lack of qualified teachers in schools, and there has been no professional development for teachers about how to teach science in an integrated manner. Our (the researcher and two other colleagues') study on "Assessment of the state of science education in Timor-Leste" revealed that, "although integrated science teaching at a pre-secondary level is well-established and respected in many nations, most current science teachers in Timor are extremely suspicious of this new system, having absolutely no experience or education in learning or teaching integrated science" (Gabrielson, Soares, & Ximenes, 2011, p. 5).

The country's leaders have chosen Portuguese as the instructional language at schools, this has resulted in another problem for local educators to convey the significant intentions (da Costa Sarmento, 2013) of the sciences. The main educational problem therefore lies is that the country continues to adhere to a Portuguese educational framework that is hard for teachers to interpret and transform into a contextually appropriate curriculum for Timorese so that they are in tune with the essential core of the curriculum ideas.

Research in Timor-Leste, which covers the early part of the 21st century of curriculum reformation up to 2005, has found that successive curriculum reforms for basic education Grades 1 to 6 have not managed to alter pedagogical practices (Shah & Quinn, 2014).

A study conducted by Ninnes (2013) about the practices of the *3rd Cycle Science Education Curriculum*, designed by Pacheco et al., in 2009, provided a general report from Grades 1–9 in 2013 and found that most school teachers still deliver their lessons in the way they were taught, that is in separate subjects and by rote learning. Other scholars who examined teaching and learning practices in Timor-Leste classrooms also highlighted the same issues, noting that a rote-learning teaching approach had been embraced by most teachers (da Costa Cabral, 2015; Shah, 2013).

Some informal conversations with science teachers who had graduated from the physics department at UNTL revealed that even though the new curriculum required them to teach the science content jointly, in fact they were sharing this content among them, as they found this was an easier way for them to deliver the content. Timor-Leste's Education Management Information System (RDTL, 2015) database highlights this non-integrated view of teacher expertise, where teachers' demographics in many schools still categorise science teachers based on their specific subject expertise, such as physics or biology, but not by the overall integrated category of *natural physical science* as required by the curriculum reformation agenda. This creates a mismatch between the decisions taken by the Ministry of Education and the implementation of the curriculum at the individual school level. As a result, government schools are still reporting to the education department by subject. Furthermore, because teachers have been influenced by two successive colonial education systems that have entrenched a behaviourist approach within their pedagogy

this approach continues to influence how education is structured in schools in Timor-Leste (Shah, 2013).

It appears that there has been no research about why this approach has continued in both schools, in pre-service teacher training institutes and in-service teacher programmes. Consequently, there is a need to conduct research to find out more information about teachers' views and their training to enact this new curriculum.

2.2 Chapter Organisation

The following discussion sets out to explain how these colonial periods have affected the present education system, particularly the teacher training institutions and science education. Section 2.3 describes education when Portugal was in control of education and Section 2.4 discusses the effect of the Indonesian invasion on education. Section 2.5 then describes the ambitions of the country's post-independence education system in the transition period. In Section 2.6, Timor-Leste's education since independence is described; the reforms to science education and the science curriculum are presented in Section 2.7 to show how it reflects a shift in the underlying paradigm of learning. A behaviourist theory of learning has dominated science education throughout this colonisation of Timor-Leste, which is discussed in Section 2.8. However, the curriculum requires a different focus on learning that can be accommodated by a constructivist learning theory, which is discussed in Section 2.9. When constructivist learning is promoted, there is a need to change teachers' pedagogy and the changing role of teachers from knowledge givers to knowledge facilitators is discussed in Section 2.10. Section 2.11 discusses the challenges of teaching an integrated science curriculum. Section 2.12 explores the problem of language in a changing colonised country where different languages have been promoted and often enforced during different periods of Timor-Leste's colonisation. Section 2.13 documents the challenges of a lack of infrastructure and school facilities that create further problems for the delivery of effective education. Finally, in Section 2.14, the aims of this research are stated and the research questions are presented.

2.3. Education Under the Portuguese Period: A Colonising Agenda

This section describes the education system in Timor-Leste under the Portuguese.

The Portuguese education system was characterised as being an elite civilising force where content that promoted colonisation was learned through rote learning. During the Portuguese era, education in Timor-Leste was reserved for the children from noble families such as *liurai* (local kings), Portuguese officials, and Timorese who chose professions as priests or nuns, as well as those who taught the Catholic doctrines or the "catechists" (de Carvalho, 2007; Martins, 2010).

To better understand how the Portuguese developed the educational system in Timor-Leste, a study by Santos (2008) about the national exams in primary education (1948–1974) in Portugal provides a thread of understanding. Her study revealed that primary education was compulsory for those aged 7 to 12 and who were mentally and physically healthy. According to her, the goal of education for first cycle (Grades 1–4) was to enable students to read, write and count. Moreover, the emphasis was on the simpler facts of the living environment and on exercising moral and civic virtues that were based on love for Portugal.

According to Soares (2011), there is no available documentation on the science content taught to Timorese under Portuguese colonisation. However, communication with a senior Timorese educational officer educated under the Portuguese colonial rule revealed that the science content generally covered plants, animals, types of transportations and the climate in Portugal and other colonies such as Angola, and Mozambique. In terms of teaching and learning, teachers were mainly from Portugal, or were educated by the Portuguese (my personal communication, 2015). To elaborate an example of a Portuguese context was a description of the kinds of transportation utilised in Portugal that contextualised an explanation of science concepts.

Other Timorese scholars noted that the education under Portuguese era was focused on students learning how to read, write and do simple arithmetic in the Portuguese language (Jeronimo, 2011). This meant that Timorese students who had been in teacher training classes carried on this simple education and assisted or taught students to read, write and be able to converse and express their colonisers' content in the Portuguese language. As a result, students were enrolled in this kind of education

system that was alien to their local context but made students become familiar with the Portuguese culture and content.

In summary, Portuguese education was established to "civilise" and indoctrinate Timorese children to be like them (Shah, 2013). In this period, science education was not a focus, and, when taught, the content was focused on reinforcing this civilising project. This focus on Portuguese content and language was imposed on the Timorese to make them literate in Portuguese content and negate their own Timorese context and relevance.

2.4. Education Under Indonesian Occupation

As a background to this commentary on education under the Indonesian period it is fruitful to explore Freire's views on education. Freire (2004) argued that education is for liberation. As such, he maintains that educational pedagogies must build upon the intention to address oppression and inequalities. In relation to this, Esteva and Prakash (2014) maintained that education must be able to introduce a radical change that offers possibilities for those in the margins to access quality education. These arguments are echoed in institutional agendas and policies such as the popular slogan, 'Education for All' (Slavin, 1996). Reflecting on this perspective as the purpose of education being to emancipate (Freire, 2004), it is important to consider this purpose when describing the history of education in Timor-Leste, especially when it attempts to explain how the science curriculum was developed, promoted, and sustained in Timor-Leste during the period of Indonesian power.

At the end of Portuguese occupation of the country, 1975, just as Timor-Leste thought it would have its freedom to establish the direction of the government on its own, the Indonesians occupied the country. Unlike the limited education available under the Portuguese colonisers, Indonesian education was open to everyone; however, it was also used to spread the occupying country's ideology. Under Indonesian power, Timor-Leste's education developed rapidly. For example, from 1975 to 1999, the numbers of schools and students increased considerably. A study conducted by Nicolai (2004) found:

> Primary school enrolment between 1975 and 1999 increased dramatically; from a starting-point of some 10,000 students to 165,000 students, junior

> secondary education enrolments grew from 315 to more than 32,000 students and senior secondary education grew from under 100 to between 15,000 and 19,000 students. (p. 46)

Furthermore, she also emphasised that another reason for this growth was an adoption of the global policy of "education for all" policy by the government of Indonesia. In Indonesia, every citizen has an equal right to be educated, as they see educated citizens as the main resource to develop the country's economy (Abbott, 2017). For Timor-Leste, there was an additional hidden educational intention; it was an attempt to 'Indonesianise' the Timorese children in order to mould Timorese people to be the same as other Indonesian citizens (Shah, 2012) in all provinces. In other words, the goal of education was to mould the Timorese in accordance with "*Pancasila*, an ideology based on a single Indonesian ideal of a shared history and set of values and beliefs" (Shah, 2013, p.63). Under this ideology, schoolchildren were taught two compulsory subjects for all levels. These subjects were Indonesian history and moral education, which was valued in Indonesian ethics and values – Pancasila (Abbott, 2017; Pedersen & Arneberg, 1999).

In case of the science subjects like physics and biology, these were taught at pre-secondary level and were introduced as two separate subjects. They were taught by different teachers and the subjects were not integrated. All of the teaching and learning was set in an Indonesian context that was evident in textbook covers and content as seen in Kanginan (2000). Kanginan is an Indonesian teacher who authors physics textbooks for the secondary and junior secondary level. These textbooks were also used by physics teachers to teach students in Timor-Leste classrooms, even though none of the textbooks mentioned Timorese content and context.

Science teachers were given scripted lesson plans, which included notes about the theory, definitions of terms and formulae, and model exercises to practise the formula. Kanginan (2000) provides an example - in junior secondary physics text books the science content started with units and measurements. Instead of practical work, where students could take measurements for themselves, the students learned those topics by heart without any practical experience. This resulted in the learning of physics which was merely playing around with numbers and their magnitude (Kanginan, 2000). When learning physics, students were asked to calculate the result after being given

the formula. The legacy from Indonesia was that science became a specialised and compartmentalised subject. Therefore, each science teacher only taught his or her own areas of specialisation (Gabrielson et al., 2011; Ninnes, 2013).

In examinations, students were expected to recall their lessons and write these as precisely as possible in their answers. If the students answered the examination questions slightly differently from what they had been taught, they lost marks. This was a reflection of Indonesia education system at that time, where the educational objectives and school evaluations were based in the cognitive domain by emphasising memorisation (Baunto, 2011). Freire (2000), in his *Pedagogy of the Oppressed,* strongly critiqued this form of teaching as a 'banking system' where students are merely being fed with information to become subjects and are not being taught to think critically.

This banking system pedagogy was perpetuated in the teacher training institutions; during the Indonesian period there were various types of pre-service teacher training. These ranged from a school for teacher education, a school for teachers of physical and sports education, a school for teachers of the Catholic religion, a school for elementary school teachers, and a school for pre-secondary school teachers (Jeronimo, 2011). Even though pre-service teacher training was available in the country for Timorese, these pre-service institution graduates were limited to teaching at a primary school level but not for the upper grade levels. During this time (1975–1999), the percentage of Timorese teachers in the teaching profession diminished. In primary schools, around 60% (that is 5172 teachers from 6672 total teachers) were Timorese. In junior secondary the numbers reduced to 40% (that is 65 from 1963 total teachers). And in secondary schools there were even less, with 12% (87 Timorese teachers out of 1059 total) teachers that taught on that time (Pedersen & Arneberg, 1999). There is little explanation from scholars to explain the fundamental reason for the Indonesian policy to limit Timorese from teaching higher-level students but it could be noted from the Bexley & Tchailoro article that it could be a means of preventing the spread of political independence ideas that were occurring among the Timorese youth who may have used schools to plan clandestine activities and discuss nationalist ideas (Bexley & Tchailoro, 2013).

At this time, teaching positions in Timor-Leste's provinces were monopolised by people from other regions of Indonesia (Baunto, 2011). This was highlighted by Nicolai's (2004) study, where she noted that 90% of teaching staff at secondary level in the Indonesian period were Indonesian (Nicolai, 2004). Some of these teachers were sent to Timor under the direction of the central government in Jakarta (Pedersen & Arneberg,1999) but some also came to Timor as they were following relatives who had settled ahead in Timor as military, police or as part of the public service.

One could see here the pattern to Indonesianise the Timorese (Shah, 2012) which started with the military invasion, which was strongly criticised internationally, moving to a 'gentler' public service (Pedersen & Arneberg, 1999) and then to a 'softer' form of enforcing the Indonesian ideology through an educational system pedagogy. As mentioned earlier, this was apparent in the banking system of teaching, where students where merely fed with knowledge (Freire, 1970), that is knowledge that was based on Indonesian contexts which became the measurement to either pass or fail a Timorese student during this period. In other words, imbibing the Indonesian ideology was the measurement for successfully passing school exams, including those in science subjects. This pedagogy, along with how education was used as a colonising tool during the Portuguese period, will be explored in the subsequent section that delves into Timor-Leste education during the transition period which was under the United Nations (UN) administration.

2.5. Timor-Leste Education in the Transitional Period: (Re)Building from the Colonial Past

With the intention to 'free'Timor-Leste from the Indonesian occupation, the UN facilitated a series of negotiations between Portugal and Indonesia (Chomsky, 1999). In the spirit of democracy, it was agreed that a referendum would be held on May 5, 1999, for Timorese to decide whether to remain as part of Indonesia or be independent and become a sovereign state (Chomsky, 1999). This vote was won by a large majority, with 78.5% (334,580 voters) of participants voting to reject Timor-Leste remaining the 27th province of Indonesia. Due to this stance, after the vote, the militia and the Indonesian military ravaged and plundered most of the country's resources and the infrastructure that they had built during their occupation.

The educational facilities were no exception. Nearly 95% of schools were damaged or demolished and 80% of them were totally destroyed (World Bank, 2004). Moreover, approximately 90% of the professional Indonesian schoolteachers, administrators and officials left the country and headed back to their places of origin in Indonesia (Shah, 2013). Besides having a ruined physical structure, such as school buildings, East Timor was left with a severely reduced workforce (World Bank, 2004).

In early 2000, a number of international and local organisations such as the United Nations Transitional Administration in East Timor (UNTAET[1]), Conselho Nacional de Resistência Timorense (CNRT[2]), United Nation agencies, and International Nongovernment Organisations (INGO[3]) collaborated with Timorese leaders to rebuild the country. This group began the campaign for the reconstruction of schools with financial and technical assistance from many international parties, 604 primary schools, 62 pre-secondary schools and 23 high schools were reconstructed. According to the figures documented by Soares (2010) at the beginning of 2001, the country had approximately 700 elementary schools, 70 pre-secondary schools, 32 secondary schools, and one state university with about 5,000 students.

In addition to the infrastructure building programme, the transitional government hired 5,000 teaching staff for elementary education. Most pre-secondary and secondary science teachers were recruited from university students from various backgrounds (Shah, 2011). Because there was a shortage of teachers, prior teaching experience was not a vital criterion for the teacher candidates. However, the candidates did need either a formal education certificate or to have earned some units in any university – where they could show that they had completed a minimum of six semesters (Belo, 2010). Many of these teachers remain in the teacher workforce today, and this has had an important impact on the challenges facing education at the present time (Shah & Quinn, 2014).

By the time of the country's independence in 2002, and despite the fact that the country had been physically separated from its occupiers, the educational system remained

1 United Nations Transitional Administration in East Timor (UNTAET)

2 *Conselho Nacional de Resistência Timorense* [CNRT] or The National Counsil of Timorese Resistence

3 International nongovernment organisations (INGO)

patterned after the colonisers' models. This was because the transitional government left decisions on educational content to the new Timorese government. As a result, teaching and learning processes still followed the Indonesian educational system (Shah, 2013).

In conclusion, the transitional government restored educational access for thousands of students and got them back to school; however, they left out the essential aspect that the country is still struggling to put in place until today – namely the quality and the relevance of education itself, including education of the teachers.

2.6 Timor-Leste's Education Since Independence: Towards a New Science Education Pedagogy

After independence in 2002, the Timor-Leste government identified education and health as the fundamental pillars for the country's development as it would eradicate poverty (RDTL, 2002). This aim was found in the 2002 National Development Plan (NDP), which stated: "Meeting East Timor's goals for basic needs in health and education is vital for the nation's development, in reducing poverty, promoting economic growth, and in improving the livelihoods of its population" (RDTL, 2002, p. 143). The government believed that people's education and health were foremost in enhancing the other aspects of life such as improving the economic status of their families. In other words, if the people were well educated and healthy, they would have a better chance of becoming active citizens and being able to participate in building their country.

Factors that hindered the NDP plan were that most of the new country's teachers were a product of previous regimes. Thus, most of these teachers had the tendency to reproduce the same teaching style that they had been taught. This pedagogical change has become a difficult challenge in education and the one for which the country is now seeking solutions (Shah, 2013).

Science classes under the first constitutional government, 2002–2006, were dominated by unqualified teachers. Science teaching was formulaic; teachers were the main information channel, and there was no linking of scientific concepts to real life. There is little direct research on classroom activity in Timor-Leste; however, one researcher, observing grade 6, described how the physical arrangement of the

classroom was such that students sat in rows, which reinforced the dominance of teachers over the students (da Costa Cabral, 2015). Although her research field was linguistic ethnography in Timor-Leste, da Costa Cabral (2015) observed both environmental science and Portuguese language classes and found that "the interactions in the Year 6 lessons were teacher-led, and guided by a transmissive pedagogy and a strict hierarchical relationship between teachers and pupils" (p. 118).

Since 2007, the government has attempted to operationalise the educational framework as laid down in the NDP and the medium-term development goals (RDTL, 2002). This began by formulating a series of new laws that would govern the education sector. The national educational system was also created to replace the previous Indonesian education system. The basic law was created as an anchor for all educational operations and activities. This law sets out the right of citizens to access education (RDTL, 2008).

The new education system covers nine years of compulsory basic education which is "universal, mandatory, and free in the sense that it covers school fees, charges and emoluments related to enrolment, attendance and certification" (MoE, 2011, p. 43). The cycle of education in the Timor-Leste education system is that every school-age child is required to attend primary education for the whole cycle, while further education up to secondary and higher education levels is optional. Primary education is categorised into three cycles. The 1st cycle consists of Grades 1 to 4, the 2nd cycle covers Grades 5 and 6, while the 3rd cycle ranges from Grades 7 to 9. At the early stage of independence, only primary education was free and compulsory. Currently, secondary education is free but not compulsory.

Despite the passage of these new laws, research conducted in recent years suggests there is a significant gap between the laws and how they are implemented. For example, Soares' (2011) study on feasible laboratory facilities for the new 3rd cycle curriculum implementation showed that most of the participants (teachers and headmasters) stated that Timor-Leste science classrooms did not possess necessary equipment, that there was a lack of qualified teachers in schools and there had been no professional development for teachers about how to do science experiments. Another study done by Shah (2013), concerning the implementation of learning centre pedagogy, showed that most primary school teachers were delivering their lessons in

an old-fashioned, teacher-centred approach, with knowledge transfer without any interaction among them or any facilitated classroom discussions. A summary of the Timor-Leste educational system since Portuguese colonisation and up to independence is displayed in Table 2.1. Note that this study limited this research and analysis only to the enactment of the *3rd Cycle Science Curriculum*.

Table 2.1

The History of Timor-Leste Education up till 2012

Portuguese (1512–1975)	**Indonesia (1975–1999)**	**Transitional (UN) (2000–2002)**	**Independence (2002–2012)**
Education was established for noble families and religion associated	Education was established For all people,	Education was established To re-activate for all Timorese	Education was established For all Timorese
Goal of education To civilise people	Goal of education • To Indonesianise the Timorese people • To educate for one culture, one language, one country - Indonesia	Goal of education Literacy and numeracy To understanding of Timorese history and culture	Goal of education Prosperity for people and country Education system – recopied Portuguese legacy with three cycles of basic education
Education system Cycle 1: Grades 1-4 Cycle 2: Grades 5 & 6 Cycle 3: Grades 7-9 Only Grade 1 to 3 was compulsory	Education system 6 years primary education, 3 years presecondary, 3 years secondary and 4 years undergraduate Grade 1 to 6 was compulsory	Education system 6 years primary education, 3 years presecondary, 3 years secondary and 4 years undergraduate Grade 1 to 6 was compulsory	Education system Cycle 1: Grades 1-4 Cycle 2: Grades 5 & 6 Cycle 3: Grades 7-9 Grade 1 to 9 is compulsory
Curriculum Portuguese	Curriculum Indonesian	Curriculum Still followed previous Indonesian version	Curriculum The 3rd cycle was designed by Portuguese experts
Content of science Plants, animals, climate, transportation that existed in Portugal	Content of science Indonesian content – animals, plants, transportations systems such as; trains, cars, and airplanes.	Content of science Still carried Indonesian - as the textbook was re-adopted to the country	Content of science Mixture (Local & western) As the curriculum was designed by Portuguese experts
Teaching staff Portuguese and Timorese	Teaching staff Indonesian and Timorese	Teaching staff Mainly Timorese teachers But the Portuguese and Brazilians do the capacity buildings include Portuguese course.	Teaching staff Timorese While Portuguese and Brazilian do capacity and skills buildings

Some scholars have noted that the gap between policy and implementation may be a condition of the country's continued desire to 'borrow' educational ideas from the West without reflecting on the real conditions of the home country (Shah & Quinn, 2014). Since independence, Timor-Leste has been host to a large international presence as part of the blueprint for the country's rebuild. The educational framework and concept of curriculum has developed based on this input. For instance, the 3rd cycle of the science curriculum was created as a project under the cooperation of Timor-Leste's Ministry of Education, UNICEF and the University of Minho in Portugal, based on a project called Agreement UNICEF/Universidade do Minho, (Pacheco et al., 2009). The curriculum project was funded by UNICEF and designed by Portuguese professors in coordination with the Timor-Leste Ministry of Education. The framework for Timor-Leste's curriculum reformation is discussed in the next section.

2.7. Timor-Leste Curriculum Reformation Since 2010

Timor-Leste's pre-secondary education curriculum has changed three times since 2000. First, there was the transitional curriculum which was adapted from Indonesia and pre-secondary schools that utilised this inherited curriculum for around seven years, 2000–2007. Within the transitional curriculum period, the textbook was replaced with one which included local Timorese political figures, although the content of the learning materials was identical to the Indonesian version. The next period introduced the *Sebenta* curriculum, which was designed by Brazilian experts. This curriculum was used for around three years (2007–2010) until it was replaced by the most recent curriculum. Since 2011 there has been an integrated curriculum version which has been distributed widely. However, there is little published research on how it has been enacted.

While the transitional and *Sebenta* curricula were created without any legal framework, the third curriculum reformation was based on a government resolution (Nu.36/2011, RDTL, 2008) that enabled this 3rd cycle curriculum reformation to be

implemented in schools. A comparison between the structure of the pre-secondary curricula prior to 2010 and the current third cycle curriculum is presented in Table 2.2.

Table 2.2
Pre-Secondary Curriculum Structure: 2000–2019

Transitional and Sebenta curricula 2000–2010	**3rd curriculum reform – 2010 up to now**
1. Portuguese language 2. English 3. Tetum 4. Mathematics 5. Natural science (consisting of physics and biology) 6. Social science (consisting of economics, history and geography) 7. Religion and moral education 8. Civic education/ human rights 9. Physical education, health and hygiene 10. Arts and fine arts	**Language skills** • Tetum • Portuguese • English **Scientific development** • Mathematics • Natural physical science • (Combining physics, biology, chemistry and geology) • History and geography **Personal development and social relationships** • Physical education • Civic education, citizenship and human rights • Arts and culture • Religion and moral education • Skills for market demand (economics)

The transitional and *Sebenta* curricula (Table 2.2) shows the fragmentation and lack of links between subjects. In fact, each subject was perceived as standing alone as well as the teachers teaching them. However, when the 3rd curriculum reformation occurred, the subjects were categorised according to each domain, namely language skills, scientific development, and social relationships. This grouping of subjects was aligned with this new curriculum model, which emphasised a thematic or integrated curriculum.

The government of Timor-Leste had three main aims in its reform of the science curriculum. One was to prepare the young generation for modern life. Second, it hoped to integrate science subjects with education about life aspects such as interpersonal skills, creative thinking, and developing scientific literacy. Finally, it asserted that by allowing young learners to develop skills of *thinking scientifically* it would be giving

them the skills necessary to enter the job market, and able to contribute to society and the country (MoE, 2010b).

At the time of the reform, the government was conscious that science and mathematics were considered as fundamental subjects contributing to the country's development (MoE, 2010b) and this curriculum reformation could answer this need. Education was considered pivotal to preparing the younger generation to handle society's issues, develop the country's economy, and make students aware of contemporary culture. This view and justification appear in several sections of the curriculum document. For example:

> One of the fundamental reasons for the Timor-Leste curriculum reform including the 3rd cycle curriculum is to enhance school education as an essential factor in forming Timorese children and young people, in response to social, economic and contemporary cultural problems (translated from MoE, 2010b, p. 9).

For the science curriculum, the Portuguese designer claims that it contains the most modern and supported theories about education and, in particular, science education (MoE, 2010b). The curriculum developers argued that modern science education should allow students to build their scientific capacities and skills to face modern sophisticated society in the world and contribute to developing a more sustainable future. The intent was to broaden the young students' horizons, giving them a holistic perception of life that would make them capable of living in a modern society – an ambition that the government wants to achieve for its young generation.

To sum up the first part of this chapter, educational policies and curriculum design and implementation in Timor-Leste have always been based from outside. There was a strong desire among Timorese leaders, Ministry of Education officials and educationalists to come up with an educational framework that is truly reflective of a Timorese pedagogy. However, as history tells us, these were always met by challenges that did not allow this to happen. There were several attempts and, in fact, ongoing efforts to reform a colonial educational system. But the very fact that even these efforts to reform are being led by Ministry of Education officials and leaders who have been largely influenced by a colonial background and education and supported by Western

institutions as consultants further complicates the desire for the supposed "liberation" of the Timorese people.

This is where Timor-Leste is now in terms of education, and this positioning will now be examined further.

2.8 Behaviourist Pedagogy Reflecting a Colonial Educational Legacy

To achieve the ambition of this new curriculum education goal (MoE, 2010a; 2010b), it was acknowledged that teaching approaches in the classroom needed to change. Specifically, there was a need to shift from a positivist/behaviourist approach of teaching, to a constructivist approach. This was made explicit in the new curriculum (MoE, 2010a, 2010b). This shift in pedagogy was to allow students to make meaning of their own learning and do away from the banking method.

Additionally, the reforms necessitated that teachers develop their *pedagogical content knowledge* (PCK) (Cochran,DeRuiter & King, 1993), in other words the way in which teachers translate their content knowledge into ways that their students can understand. More importantly, the reforms challenged the fragmented science curriculum and shifted the focus to the teaching of science through an integrated approach (MoE, 2010a, 2010b). The following discussion in this chapter will show how a change in attitude to learning requires a corresponding change in teacher pedagogy.

Up until the time of the 2010 curriculum reform, learning and teaching in Timor-Leste were shaped by behaviourist theories of learning (Ninnes, 2013; Shah, 2013). During the Indonesian era (1975-1999), curriculum content was brought in from the Indonesian capital, Jakarta, and teachers and students were given strong directions about what should be taught and learned. Generally, schools and teachers had to follow the curriculum content because the country adopted a national examination system in which all curriculum content was assessed in the student's final year. Learning activities were conducted based on a compulsory school textbook (Beeby,[4] 1979). During this time, people believed that schools and teachers were the only sources of

[4] C. E. Beeby was a New Zealand educationalist. Between 1970–1975 he was a policy advisor for Indonesian Educational Development. Source: http://www.teara.govt.nz/en/biographies/5b17/beeby-clarence-edward

knowledge. Hence schools, through teachers, provided the information that they considered pivotal for students.

Nagowah and Nagowah (2009) asserted that "behaviourism is a theory of animal and human learning that only focuses objectively, observable behaviours and disregards mental activities" (p. 279). The same view was also shared by Agarkar and Brock (2017) when they claimed that the behaviourist theory is concerned only with observable behaviours of learning and ignores psychological process or entities such as mental states or consciousness. An implication for learning in science classrooms is that behaviourism has been associated with drill-like practices and the transmission of facts and principles. Agarkar and Brock provided an example of this situation by stating that a (physics) teacher may focus on testing the verbatim recall of Newton's laws rather than a student's ability to apply those principles to novel situations.

Research shows that the effectiveness of approaches that focus on rote learning is contentious (Agarkar & Brock, 2017). In fact, Agarkar and Brock (2012) concluded that behaviourist learning principles were developed from experiments on animals and therefore might not adequately reflect the complexity of human learning. Some psychologists argue that memory is more than a passive store of conditions and responses and behaviourist models do not represent learning as an active process. Finally, certain interpretations of behaviourism have been associated with an authoritarian and teacher-centred model of teaching. Even though behaviourist principles of learning are criticised, some consequences of behaviourist theory still exert a dominant influence on contemporary classrooms (Agarkar & Brock, 2012), especially in Timor-Leste.

To elaborate on how this view of learning is carried out in the classroom: teachers perceive knowledge as objective, fixed, absolute, and orderly in structure. The function of the teacher is to steer students to find out knowledge and teachers believe that their teaching provides an opportunity for students to build their knowledge gradually from a small base, which then broadens to a complex array of knowledge (Fosnot & Perry, 2005). The implication of such a behaviourist approach for science teaching in the Timorese classroom is that it is usually dominated by teachers who impart knowledge (Shah, 2011). For instance, within a physics pedagogy, a lesson can begin with an explanation of a theory, which is followed by the teacher presenting formulae relating

to theory and then practice of the formulae by students. This practice was followed in the physics textbook written by Kanginan (2000). This linear pedagogical pathway was inherited in Timor-Leste from the Indonesian education system and up to now it has been a common pedagogy.

Therefore, a behaviourist theory of learning encourages pedagogy that focuses on knowledge transmission with patterns of precision. As Carr et al. (1997) observed, transmissive teaching avoids discussion and student interactions. The consequence of a behaviourist learning approach is that it hinders and delays students from learning certain life skills such as problem solving, critical thinking, and the application of skills (Bruning, Schraw, Ronning 1999). For Timor-Leste this was important because at the time the new curriculum was mandated, these approaches were seen to be preventing students from being active, engaged, and critical citizens of the new country.

It appears that Timor-Leste education has relied on students being able to learn by heart the knowledge they require to pass exams. It could be useful to find out how these behaviourist views of learning have impacted on science education and caused problems with the enactment of the new curriculum.

The next sections discuss a constructivist learning approach in relation to PCK.

2.9 How Constructivist Learning Underpins the New Curriculum Requirements

With the new reforms, the government attempted to remove the separation which existed between students' understanding of their world and scientific content as stated by Driver & Oldham (1986). The government wanted to foster student-centred learning (Shah, 2014). These goals are very much reflected in the curriculum discourse (MoE, 2010b) – a guide for teachers which states that:

(a) in terms of cultural relevance, it is important that the content relates to reality and promotes learning that is associated with the experience of students;
(b) in relation to integrated human development, it is considered that teaching and learning should be based on students' prior ideas and knowledge that links it to acquired knowledge for an understanding and makes intervention immediate if needed, and articulates it with another subject;

(c) in terms of learning, promoting student-centred learning which considers real situations, and practical and experimental activities. (translated from MoE, 2010b, p. 4).

From the above statement, it is apparent that this curriculum statement reflects a social constructivist learning approach. Constructivism is a theory of knowing or how people learn things (Baviskar, Hartle, & Whitney, 2009). Constructivism movements were sparked to oppose the behaviourist views of knowing and it became prevalent in contemporary world education, especially science education (Baviskar et al., 2009). The views that underpin constructivism are that there is no fixed body of truths about the real world and instead people actively construct their realities based on their prior knowledge and experiences (Skamp, 2018). This theory of learning was very influential in the 1980s and 1990s, especially in science education (Gilbert, 2018).

This move to a constructivist approach in science was led by a University of Waikato science research team, who were concerned about how students learned science. They researched this process and Carr at al., (1997) proposed that "the new paradigm regards science as a human and social construct, and views learning as the personal construction of new knowledge" (p. 163). In regard to ways of knowledge construction, including science content for schools, the team noted that "we construct meaning for the world around us from our prior attempts to make sense of it" (p. 163). This means, learning makes sense if the new content or information has strong links to prior knowledge. The knowledge construction about concepts keeps evolving throughout one's life of living and learning where the endpoint is an understanding of science concepts that reflects a scientist's explanation.

Concerning the process and time span of knowledge construction, Driver and Oldham (1986) argued that learner constructions are seen as tentative models which are continually being tested against experience and, if necessary, are modified. This view of learning recognises the influence of beliefs and emotions of individuals as well as their conceptualisations and recognises the influence that prior experience has on the way phenomena are perceived and interpreted. Consequently, constructivist scholars such as Osborne and Wittrock (1983) emphasised that it is imperative for science educators to find out what learners bring with them to the learning situation and

recognise the active construction of meaning which goes on constantly as individuals interact with their environment and learn about it.

Skamp (2018) suggests that when learning science, it can be understood as either personal constructivism or social constructivism. These two types of constructivism are not always on a continuum, but instead may be two dimensions of learning that can occur together. Here, he differentiates the two where personal constructivism concerns the individual where "learning science as concept development within the individual" (p.34). This means constructivist accounts of learning and development highlight the contributions of individuals to what is learned (Bereiter 1994; Schunk, 2012). According to Skamp (2018), an individual encounters new experiences, they relate their new experience to their prior knowledge and then through reflection, decide whether or not to build on or change their knowledge constructs. In this way a learner actively internally constructs their knowledge in a way that is particular to them, making it highly personalised (Skamp, 2018).

Regarding social constructivism, Skamp (2018) argues that learning can also occur "as a process of becoming a member of a 'learning [here, scientific] community'" (p.35). In this case, an individual interacts with others, discussing ideas in a particular context and negotiating their understanding. This makes learning a situated activity. Schunk (2012) agrees that social interactions are important to develop students' skills and knowledge.

Reflecting on these two views of learning, Bell (2005) maintains that the concerns of science educators is how to help students make sense of their world. When teaching science from a constructivist approach, a teacher needs to impart new information or concepts which are familiar to students' lives and help to build their understanding (Bell, 2005; Richardson, 2005). Hence, within a constructivist learning pedagogy, teachers need to create a situation where students can build their understanding and construct their own ideas about the scientific concept they are learning (Schunk, 2012; Skamp & Preston, 2015; Weimer, 2002). This style of learning is based on the belief that learners should be responsible for their own learning – thus a teacher's role is to provide opportunities so that students can make sense of their world in their own way

with teacher support (Bell, 2005; Tan, 2017). Therefore, Bell suggested that when designing effective learning environments teachers need a comprehensive understanding of what children know when they come to the classroom. This means that teachers need to be conscious of the uniqueness of each student when learning. Thus, the science curriculum is not about learning facts or banking information (Freire, 2004); instead, students are supported in their own learning and science education is viewed as providing "a set of experiences from which the learners construct a view closer to the scientists' view" (Ling, 1999, p. 20).

However, constructivist learning theory's influence has begun to fade as researchers began to critique its tenets (Gilbert, 2018). One of the most powerful critiques was constructivism's emphasis on relativism (Schunk, 2012). Relativism refers to the way that because learners individually construct their knowledge, so all forms of knowledge are justifiable but as Schunk (2012) argues, some forms of knowledge are exogenous. This means that on occasions, the knowledge learners construct is a "reconstruction of the external world" (p. 232), for example the concept of melting, and this knowledge is regarded as accurate as it reflects external reality and thus negates this relativist perspective.

Gilbert (2018) argues that another reason for the decline in constructivism's use is that there are many meanings of constructivism, which creates confusion. She identifies four meanings of constructivism. These are:

- *Personal constructivism* – the internal process of constructing and re-constructing one's intellectual structures (a learning focus);
- *Constructivist pedagogy* – particular approach to teaching where activities are provided for learners and designed to build their conceptual understanding (learning and content knowledge building focus);
- *Educationally oriented social constructivism (or social constructivism)* – where learning is viewed as a collaborative and social process, taking place and mediated by interactions with others (focus on learning that occurs in the spaces between individuals);
- *Knowledge, not learning* – based on sociological origins, this meaning is a theory of how knowledge is constructed and used to study how disciplinary knowledge is built in research (knowledge is the focus).

(Gilbert, 2018)

Therefore, according to Gilbert (2018) it is important when using the term constructivism, to understand how it is being used in order to avoid confusion and mis-interpretation.

Finally, constructivist pedagogy is difficult for teachers to implement (Baviskar et al., 2009). This difficulty arises because there is no "specific formula" for teachers to follow when using a constructivist pedagogy (p. 542). Instead, a teacher needs to design a learning experience that gives students the best opportunities to learn, creating a context where all learners are motivated to learn. Using a constructivist pedagogy requires a deep understanding of this theory and the use of four critical elements, but not in a 'recipe-type' method: eliciting prior knowledge; creating cognitive dissonance; application of knowledge with feedback; and reflection on learning (Baviskar et al., 2009, pp. 542-543). Consequently teachers require a high degree of skill and knowledge.

Despite these critiques, Timor-Leste's new curriculum is based on a constructivist pedagogy. It is anticipated with the implementation of this new curriculum in Timor-Leste that teachers need to shift their views of teaching from being an information carrier to being a "motivator, diagnostician, guider, innovator, experimenter, and researcher*"* (Osborne & Freyberg, 1985, p. 91). Consequently, in Timor-Leste, the challenge for science teachers is to present science, including some abstract concepts, in an appropriate way that is real for students.

There could be an opportunity to find out how teachers are facing this challenge to make science concepts relevant for Timor-Leste students.

The significance of this pedagogical shift in focus for a country like Timor-Leste is that by using this approach teachers can bring students towards the science education goals inspired by the government; namely to build students' scientific capacities in order to interact with modern society and develop a more sustainable future (MoE, 2010b). All of this is linked to a broader aspiration of supporting Timor-Leste's entry into a knowledge-based society that is appropriate for the 21st century.

In conclusion, a constructivist pedagogy aims to promote meaningful learning and enables a situation where learners actively construct their own understanding based on what they have encountered and absorbed from society (Richardson, 2005). When

constructivist pedagogy takes place, and schools and teachers are not the main source for learners to acquire their knowledge, then teachers are a channel to provide opportunities to facilitate students to build on their previous knowledge. These goals for education resonate with Timor-Leste's new curriculum intentions (MoE, 2010b), which call for the training of teachers to move from a content–expert teaching approach to being facilitators of learning.

It would be useful to find out if there are any examples of teachers being facilitators of learning for their students.

2.10 Exploring Change in Teachers' Pedagogy Using PCK

Changing the role of teachers from knowledge givers to knowledge facilitators requires a different way of teaching (Anney, 2013; Freire, 2004; Weimer, 2002); this change will be discussed in this section. This change could be summarised as developing Pedagogical Content Knowing (PCKg) which is outlined in Cochran et al.'s (1993) PCKg model, which can be applied to teacher training. The origins of PCK, its potential for examining teachers' pedagogy and details of the model (Figure 2.3) are discussed as follows.

Origins and Potential of PCK

PCK is combination of teachers' pedagogical knowledge and their subject matter knowledge (Cochran, 1991). Shulman (1987) was the pioneer of this concept and described the concept of PCK as follows:

> [PCK] represents the blending of content and pedagogy into an understanding of how particular topics, problems, or issues are organised, represented, adapted to the diverse interests and abilities of learners, and presented for instruction. (p.6)

Shulman (1987) discussed the link between teachers and learners and states that a knowledgeable teacher should be conscious of students' circumstances and of their pre-knowledge. This resonates with the tenets of the constructivist learning paradigm, where the background and previous knowledge of both teachers and students are an important consideration in the learning process (Richardson, 2005). Shulman (1987) added that PCK should illustrate how teachers adjust the content according to students' ability and situation. According to Shulman, teachers' knowledge of the

prerequisite content before teaching is important but understanding the various strategies for delivering the content, or pedagogical knowledge, is even more vital.

Since Shulman's conception of PCK, many models have been developed for use in initial teacher education and professional development programmes to help teachers to refine their pedagogy (Birdsall, 2015). These models built on Shulman's elements of content and pedagogical knowledge and now include other elements such as knowledge of assessment, knowledge of students, and curriculum knowledge but with different emphases on these elements (Lee & Luft, 2008). It is also generally agreed that these elements interact with each other and can be used to analyse a teacher's pedagogy.

Theorising about the elements of PCK has continued, especially in science education (Abell, 2008). Recent work has expanded the number of types of knowledges used by teachers to include content, pedagogical, curriculum, assessment and knowledge of students. Further complexity has been added in the way that the types of knowledge interact with a teacher's professional knowledge and skills, particular subject practices and habits of mind, and all of these elements are filtered through a teacher's personal values, beliefs and experiences (Berry, Nilsson, Van Driel, & Carlson, 2017; Gess-Newsome, 2013). However, to date no model of PCK seems to take into account a theory that explains how the complexity of PCK is developed.

Choice of PCKg Model

It is proposed that PCK could help to analyse how teachers can be equipped to teach Timor-Leste students using the *3rd Cycle Science Education Curriculum* in order to help students meet the demands of modern science knowledge and understanding and to encourage them to keep learning in a world that is continuously changing.

The development model of Pedagogical Content Knowing (PCKg) developed by Cochran et al. (1993) was chosen for this project. As shown in Figure 2.1, it has four components: knowledge of pedagogy; knowledge of subject matter; knowledge of students; and knowledge of the environmental context. Knowledge of pedagogy refers to a teacher's knowledge about types of teaching approaches, strategies and experiences. Knowledge of subject matter is a teacher's content knowledge of the

topic that they are teaching. Knowledge of students is a teacher's understanding of the particular students in their class, such as their abilities, preferred learning strategies, attitudes, motivations and prior knowledge. The final component of knowledge of the environmental context refers to a teacher's understanding of the "social, political, cultural and physical environmental contexts" that influence the ways in which teaching and learning occur (Cochran et al., 1993, p. 267).

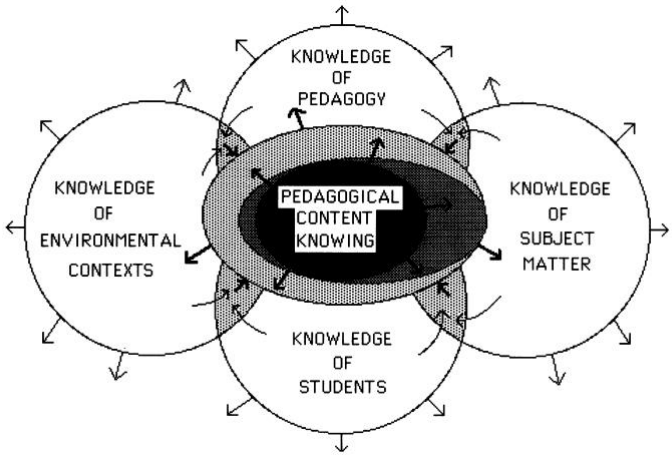

Figure 2.3. A development model of pedagogical content knowing (PCKg) as a framework for teaching (Cochran et al., 1993, p. 267).

Figure 2.1 shows how these components of PCKg overlap, illustrating how these components interact as a teacher is engaged in the teaching process. It illustrates how a teacher brings all four components together to reflect their PCKg shown as the dark oval in the centre. The dark and shaded areas in this model are significant because they show the interactions. The shaded areas illustrate the way that as a teacher's PCKg develops, - the boundaries between the components become so blurred - it is impossible to differentiate between the separate components. Cochran et al. (1993) refer to this process as "simultaneous integration" (p. 267).

The arrows shown in Figure 2.1 are also significant in that they depict how a teacher's PCKg can develop and grow over time, but not necessarily all components in a simultaneous manner. As the boundaries between the components blur and disappear, the dark centre of PCKg expands to reflect the growth in a teacher's expertise.

In this way, a teacher's PCKg is not constant, but evolving over time. It is expected that a freshly graduated teacher's PCKg could be less than an experienced teacher's (Cochran et al, 1993). Thus, the more teachers encounter chances to practise professionally, the more they will learn. For example, they may learn to compare their pedagogy with others and experiment with new teaching strategies. This interaction can cultivate the development of their PCKg. Consequently, PCKg evolves and grows from the creativity and skills that teachers develop as they engage in teaching (Beijaard, Meijer, Morine-Dershimer, & Tillema, 2005). Underpinning this acknowledgement of a teacher's PCKg development is constructivist learning theory.

It is proposed that Cochran et al.'s (1993) PCKg model is the most suitable for analysing the situation in Timor-Leste because it acknowledges that PCKg can develop and is underpinned by constructivist learning theory. It appears that other models fail to illustrate how teachers' PCKg can develop and grow over time as their models are static. Cochran et al. (1993) argue that a constructivist learning foundation is appropriate because teachers actively build their understandings based on their experiences in their world – a tenet of constructivist learning theory (Skamp, 2018). In other words, their experiences of teaching in their classrooms and schools develop their PCKg. Also, constructivist learning posits that learning is continuously integrated into existing knowledge. Cochran et al. (1993) refer to this constant integration as way in which a learner is continually differentiating between breaking up the totality of their knowledge into its parts and integrating these parts back into the totality. In terms of teaching, as teachers develop their pedagogy, they are constantly integrating their experiences with everything they know and have experienced, including their understandings about and experiences of their teaching.

The constructivist learning foundation was considered important for three reasons. First both this PCKg model to examine teaching and the 3rd Cycle Science Education Curriculum have this same foundation, enabling a common understanding of both teachers' learning and students' learning for this project. Second, it was hoped that the PCKg model might be able to identify change in Timor-Leste teachers' pedagogy as a result of them enacting the new curriculum. Third, because Cochran et al. (1993) argue that growth of the four components is not necessarily simultaneous, it was hoped

that this model could reveal Timor-Leste teachers' strengths and areas for development, which can then inform future professional development programmes.

In addition, it was hoped that the two components of knowledge of students and knowledge of the environmental context could provide space to reflect on the special situation of Timor-Leste as a developing country where teachers are influenced by many different cultural and educational factors.

It would be interesting to see if the PCKg model can identify changes in teachers' pedagogy as a result of them enacting this new curriculum. Also, it would be interesting to explore which components of PCKg teachers draw on when using the 3rd Cycle Science Education Curriculum as they integrate their knowledge of physics, chemistry, biology and earth science and experience.

2.11 The Challenge of Developing a Pedagogy to Teach Integrated Science

Scholars worldwide are conscious that science learning that predominately directs students to master unique subject content is no longer relevant. Hence, contemporary curriculum reform has shifted from special issues to big ideas or big pictures of learning (Czerniak & Johnson, 2007).

Rennie, Venville & Wallace (2013) claim that during the 21st Century most countries have demonstrated their intention to reform their science curriculum to reflect the demands of the global community as well as supporting the growth of citizens who can contribute to their country. Countries have become aware that when the science curriculum is offered as separate subjects there is a neglect of scientific attitudes and the relationship between science technology and society (STS) as well as the internal relationships between different science subjects. Parker (2012) supports this movement towards an integrated curriculum when he comments that if the aim is to develop citizens who are able to make decisions in the modern world they need to have experience in integrating knowledge across the traditional disciplines such as science.

Worldwide curriculum reform has provided a range of issues that could help Timor-Leste in their curriculum reform not just in the planning but also in the enactment by teachers. Consequently, this section will first identify curriculum reform that aspirational as well as reform that is pertinent to Timor-Leste as a developing and post

conflict country. Second, it is important to recognise that the enactment of a new curriculum is dependent on teachers' views of an appropriate pedagogy and a review of research about teachers' perspectives will be described and critiqued.

Curriculum reform worldwide

Even though the advantages of curriculum integration allows flexibility for teachers in the selection of key skills and understanding as well a providing meaningful connections between subject areas all the while unifying their students' learning that reflects the real world (Atwa & Gouda; 2014) there are disadvantages that have emerged. Dowden (2007) through an extensive study claimed that the main shortcoming of curriculum integration is that it is time consuming in that it takes too much time and effort for teachers to plan classroom activities. Furthermore (Greenwood, 2013) reported that an integrated curriculum required skilful teachers that were equipped with a broad pedagogical repertoire.

Even given the advantages and disadvantages of an integrated curriculum model, this reform gained worldwide popularity. Several Asian and African countries chose the integrated curriculum paradigm and adopted it into their own education system.

For example China reformed their curriculum in 2001 (Sun, Wang, Xie, & Boon, 2013; Wei, 2009), followed by South Africa in 2010 (Naidoo, 2010), Timor-Leste in 2010 (MoE, 2010); and Indonesia (Prihantoro, 2015) in 2013. The intention behind each country's adoption of this integrated curriculum was very similar to that of Timor-Leste - that is to prepare their subsequent generation to be ready to encounter the demands of the 21st century (MoE, 2010a & 2010b)

However the implementation of curriculum integration in China did not follow an expected pathway. According to Sun et al. (2013) after applying the idea of curriculum integration in science classes for a few years, a number of schools and teachers in some provinces abandoned the idea of an integrated science instruction and then reverted to a previous compartmentalised science instruction. Several reasons were raised as hindering factors. These included the inequality of school facilities such as science textbooks, lack of professional science teachers, assessment issues and parental

pressure (Sun, Wang, Xie & Boon, 2013). The summary of the foremost obstacles are noted as follows:

> The major challenges the teachers confronted in the instruction of integrated science was that they had limited competency dealing with the integration of with-subject knowledge with other knowledge (e.g. inquiry activities, STS content, scientific experiment), further they lacked knowledge on the nature of STS instruction and teaching strategies on the inquiry and experiments, as well as sophisticated teaching skills on the interacting with students. Their subject specialism also influenced their design and implementation of the integrated science curriculum (p. 38).

China's government has sought various approaches to resolve the challenges. After identifying obstacles during the trial period, as aforementioned, the Chinese government established an undergraduate science education programme to prepare science teachers who are well rounded in combination of various subjects. In addition China's government mobilised a team of science curriculum specialists, scholars, and science educators to design a curriculum model alongside integrated curriculum standards for junior secondary schools. In this period the government also gave flexibility to each province to develop their own instructional textbook to accomplish a 'one syllabus multiple textbooks' programme (Sun et al., 2013).

Like China, South Africa's new science curriculum implementation encountered the same issues. Science teachers did not agree to change their pedagogy of teaching because they found that an integration approach did not provide enough understanding in the learner for them to connect the concept to its application (Naidoo, 2010). Science teachers had strong prior beliefs that deep, fundamental conceptual knowledge within the disciplines was necessary for students, before they could apply it in an interdisciplinary way. They believed that while an integrated approach idea could be valid for teaching certain subjects, not every science subject could be taught in such a way. The statement below emphasised these teachers' perceptions:

> There are certain concepts that we have to teach in Science …we have to start with basics and teach the basics before – until they can reach the outcomes.

> Let's take electricity and its effect on the environment – hydroelectric power schemes and things like that – I would find it very difficult to teach electricity without having taught the basics about what electrical current is and how it is produced – so we find that we have to develop the basics – the ground rule, and then we will be happy to integrate (Naidoo, 2010, p.146).

These issues were also reiterated from curriculum research reports from Nigeria where researchers reported that there was little or no science equipment, materials or laboratories to enact these curriculum demands (Oludipe, 2011). This lack of resources compounded the problem as many teachers were unqualified.

This reluctance to implement an integrated curriculum was also echoed in developed countries with Singapore teachers also identifying the obstacles being teachers' own perceived lack of subject knowledge as well as a misalignment with the assessment system (Lam, Alviar-Martin, Adler & Sim, (2013). These eleven teachers from six schools recognised that this focus on integration of the curriculum was not their greatest challenge, instead the national and standardized examinations were the main drivers of the curriculum and this prioritisation of examinations over integrated curriculum goals of science information for citizenship were more influential on teachers.

The Australian curriculum reform reported by Lowe & Appleton (2014) had the same focus of preparing students for the 21st Century by developing interrelated strands that could be integrated. However, what was significant was this curriculum identified a need for a pedagogy to move from a transmission model to a more inquiry-based one. Teachers identified obstacles to the enactment of these were that teachers were given little time to adjust to these pedagogical demands as well as not having adequate science teaching facilities.

The Timor-Leste curriculum document claims that the new form of an integrated science approach was envisioned to counteract the past curriculum system, which separated two science disciplines – physics and biology – and which barely mentioned the other two subjects – chemistry and geology (MoE, 2010a). The name of the subject changed from "natural science" to "natural physical science" or, in the original term,

Ciencia Fisico Naturais (CFN). Now, the new curriculum brings together knowledge of four science areas: biology, physics, chemistry and geology, so it can be organised in an integrated form, around themes which are relevant for students (MoE, 2010a).

These changes are not limited to just science subjects; there are also calls for the need to connect science horizontally and vertically. Horizontally means science subjects need to link with other subjects taught at the same level, such as social sciences. The vertically integrated challenge is to design and address concepts at several different depths, abstractions, and complexities showing that issues are inter-related (MoE, 2010a). These different foci require an integrated curriculum approach. Consequently, as well as requiring teachers to change their pedagogy from delivering knowledge to their students, this new curriculum (MoE, 2010a) required teacher to focus on developing an integrated curriculum focusing on scientific literacy.

Scientific literacy is term that is used in describe the process by which people use science to make decisions which is an ask of being a citizen in the 21st century (Hurd, 1998; Lederman, Antink, & Bartos, 2014) and has been globally adopted as goal of science education (Murphy, Smith, & Broderick, 2019). Moreover, Murphy et al. claim that curriculum reform documents worldwide (National Research Council, 2012) suggest that if students are to become scientifically literate it is essential that they develop their understanding of science processes, and the kind of knowledge that science produces, and have the ability to apply this scientific knowledge in every day contexts.

However, there have been debates about the enactment of scientific literacy, with Roberts (2007) describing this vision of science education as Vision I and Vision II. He attributes the view of science teaching in Vision I to those who look towards the canon of orthodox natural science where the products and processes of science are learned about. Consequently, this focus produces a pedagogy that attempts to provide students with an understanding of scientific principles so that successful students can enter and take part in this scientific world. He describes Vision II as having a focus on learning the science that they might encounter as citizens so that context is important and students are introduced to science through science-related situations (Roberts, 2007).

The Organisation for Economic Cooperation and Development (OECD, 2004) portrays scientific literacy from a Vision II perspective in the following definition. "The capacity to use scientific knowledge, identify scientific questions and draw evidence-based conclusions, in order to understand and help make decisions about the natural world and the changes made to it through human activity" (p. 16). Added to this, a scientifically literate community considers using scientific reasoning and technological mechanisms to respond to problems and their circumstances (Miller, 1998). For example, being scientifically literate in Timor-Leste would mean that citizens would have a scientific understanding about the issue of plastic bags and their detrimental effect on the environment.

This is the type of society that the Timor-Leste government desires, but its aspirations are even higher in that they aim for students to develop a critical perspective on the role of science and its role in society. There has been debate about the level at which this critical scientific literacy can be developed and expressed, and Vision III has been proposed that takes into account a view of scientific literacy that is less Eurocentric and that provides insight into other indigenous science traditions (Aikenhead & Ogawa, 2007).

In fact, the Timor-Leste government sees science as one of the key subjects for the development of people and the nation (MoE, 2010b). This inspiration is broadly reflected in the description of scientific literacy competencies and skills that constitute the Timor-Leste science curriculum (MoE 2010b). In this new Timorese curriculum, it is proposed that the development of scientific literacy would underpin the acquisition of four essential values: science and technology, appreciating other knowledges, the values of ethics and the complexity of critical thinking – all of these values are considered to be closely related to the competencies that the country aims to develop (MoE, 2010a & 2010b). Thus, the goals of knowledge, skills and competencies such as reading and writing skills, interpretation, critical thinking, planning, researching and reasoning should be encouraged in the students through classroom learning so that they know how to apply scientific knowledge to interpret the problems of their world and be able to provide professional solutions to issues and problems.

Teaching for scientific literacy requires a significant paradigm shift by teachers with the aim to engage students to see the connection between the concepts being

emphasised and their experiences in their lives. Changing teacher expectations is not an easy task, because "teaching and learning of science are complex; what is taught; how it is taught, and what makes up the 'content' of that teaching all impact on the perceived value of scientific literacy, and how it might be recognized or assessed" (Smith, Loughran, Berry, & Dimitrakopoulos, 2012, p. 128).

However, before teachers are convinced of the worth of this new focus on scientific literacy it is important that they develop a pedagogy that supports an integrated view of science education, which may have an end point of scientific literacy.

Teacher belief influencing their pedagogy

It is argued that teachers' views on integration and the best way for teaching will affect their uptake of a new curriculum. Such curriculum enactment is very influenced by teachers' perceptions of the process. It has been shown that when teachers are faced with enacting a new curriculum, teachers' beliefs about effective classroom practice has a strong influence in their acceptance of these changes (Smith, 1999; Lowe & Appleton, 2014).

Pajares (1992) states that beliefs are a personal conviction rather than as a universally accepted tenet. Furthermore he states that these early established beliefs are incorporated into their belief structure and are more difficult to alter.

Studies in countries such as New Zealand (Anderson, 2015) and Singapore (Lam, Alviar-Martin, Adler & Sim, 2013) have shown that teacher beliefs, indeed, impact on their knowledge and practice. Further, Anderson (2015) argues that beliefs can be conceptualised in many ways. She maintains that beliefs can be understood in the context of one's perceptions, values, and attitudes.

Bryan (2003) provided a profile of a teacher's beliefs in the context of science education. Her foundational beliefs were about the value of science and science teaching, the nature of scientific concepts and goals of science teaching, and the science teacher's role. This teacher held dually opposing beliefs about how children learn science and the role of students and teachers in learning science. For instance, one set of beliefs was founded in her science learner experience that reflected a didactic teaching belief that guided her pedagogy. But the other set of beliefs were those that supported a hands-on approach to science teaching and inspired her view of science

teacher practice. These contradictory beliefs about science teaching meant although she believed that children best learn through their own active learning she did not have the pedagogy to enact this view of learning and often reverted to a didactic view of learning and teaching.

It would be useful to see if these contradictory beliefs about a teacher's pedagogy could be identified when examining the pedagogy of Timor-Leste's science teachers.

A similar research investigation was carried out in Taiwan where 37 Taiwanese science teachers were interviewed about their beliefs about teaching and learning science as well as the nature of science (Tsai, 2002) . The responses were categized into three groups- those with traditional beliefs – where learning science is acquiring or "reproducing" knowledge from credible sources. More than half of the teachers held these traditional beliefs. A view of science learning that focused on the processes of science or problem-solving was held by 27-32% of teachers while a small number of teachers 11-16% held the belief that science was a way of knowing and knowledge was invented through scientists' agreed conventions and paradigms (Tsai, 2002, p. 776). Moreover, it appeared that teachers' beliefs were congruent – that is their belief about the nature of science, science learning and teaching. These belief systems were called "nested epistemologies" (Tsai, 2002, p.777). This positivist view of knowledge development and learning was consistent with a view that the teacher is a presenter of the factual content of scientific knowledge, by transferring knowledge to students.

A range of studies have been conducted to identify the components of teacher beliefs that have a significant effect on science curriculum enactment (Anderson, 2015; Mansour, 2009). These beliefs can be grouped into beliefs about the purpose of science education, how science is conducted and how science knowledge is best taught and learnt. This can be identified as teachers' practical knowledge which can be seen as the core of a teacher's professional view of their role (van Driel, Beijard, Verloop; 2001). This view of knowledge is identified as action orientated as it is directly related to the teacher and the context that they are teaching. Because it is integrated with formal and everyday knowledge and used in many teaching situations it is described as implicit or tacit knowledge. All of these components are interpreted and integrated by the teacher as they interpret and organise the knowledge that they believe important (Pajares, 1992; Richardson, 1996).

These beliefs about the practical nature of their knowledge of teaching has been formalised into a view of knowledge (Pedagogical Content Knowledge). Here it is acknowledged that their beliefs will impact on how they emphasise pedagogy or knowledge (Gess-Newsome, 2013). Because PCK is defined as knowledge and action by and from the teacher, it means that it is highly contextual - that is topic, teacher and context specific. Consequently teachers' beliefs can act as an amplifier or filter between how the teacher receives professional development and their subsequent classroom practice (Gess-Newsom, 2013).

Mansour (2013) proposed that the beliefs of teachers about their practices is complex and context-dependent. In a study of ten Egyptian science teachers, he found that teachers' prior experiences could mould their educational thinking – especially through the interpretation of their religious experiences which they in turn used to evaluate their own teaching practice. Furthermore, school text-books and curriculum documents (written in a determinist style) validated a didactic authoritarian way of learning science. Yet again another outside influence of the examination system acted as a constraint on these teachers. He observed that purpose of the examination system was to identify and train a functional ruling elite. He concluded in this research report that these Egyptian teachers are restricted in the way they teach because of sociocultural forces (i.e. the examination system, lack of time, work overload, high student classroom density and a lack of resources. All of these factors set limits on what these teachers could achieve.

Amongst the different teacher beliefs, Anderson (2015) argues that those related to the purpose of science education has the greatest influence on the teaching pedagogies of teachers. This presents as an important finding especially in relation to the purpose of curriculum reform for scientific literacy. For example, teacher beliefs about the purpose of scientific literacy will greatly influence their classroom practice (Lowe & Appleton, 2014). Thus, when teachers develop an understanding of the purpose of science education for a critically-informed citizenry (Vieira, & Tenreiro-Vieira, 2016). Anderson (2015) proposes that this belief will manifest in the manner they teach science for scientific literacy. In short, teachers who have developed a belief that critical thinking would develop through a scientific literacy activity will manifest this in their classroom pedagogies (Vieira, & Tenreiro-Vieira, 2016).

At this stage, even a belief of this view of integration that involves science technology, society and environment (STSE) would be a significant step for their pedagogy. This support for the first stage of integration is signalled in the textbook *Lets Learn Science* (MoE, n.d.).

Parker (2012) defined curriculum integration as:

> A curriculum approach that purposefully draws together knowledge, perspectives, and methods of inquiry from more than one discipline to develop more powerful understanding of an issue, person, event or big idea. The purpose is not to eliminate the individual disciplines but to use them in combination. (p. 397)

With such a belief in an integrated curriculum, teachers would be expected to arrange and provide insights into various perspectives and integrate them into a larger context so that students could understand the association between subjects. Consequently teachers would need to develop strategies to facilitate learning that envelop a package of information, ability, and behaviour simultaneously. It is significant to note that a focus on one subject over another need not occur, as educators promoting integration argue that all science disciplines complement each other (Venville, Wallace, Rennie, & Malone, 1998). Moreover it is relevant that the aim of scientific literacy, as identified in the Timor-Leste curriculum, has suggested that an integrated approach could help develop scientific literacy in different contexts. It is argued that even though scientific literacy could be developed through an integrated curriculum, this viewpoint is more than just an integration of science subjects and requires critical discussion alongside learning of science concepts.

The importance of teacher training in curriculum enactment

While this pedagogical shift can be difficult for many Timor-Leste teachers, the significance of this is seen as a potential response to some of the issues raised in a colonial-based educational system. This could be a difficult change in pedagogy for many Timor-Leste teachers. In the past, Timor-Leste's pre-service teacher training focused on teachers mastering their own subject content (Cardoso, 2012; Gabrielson, et al., 2011; Ninnes, 2013). This was based on the assumption that by mastering the subject content well teachers could then transmit the same knowledge to their students, a belief that aligned with a behaviourist's view of teaching. Likewise, science teachers

in middle school or junior high school only covered physics and biology and these were taught by specialised teachers (Ninnes, 2013). In practice, teachers who taught physics did not explain its connection to biology and other branches of science. More than that, teachers never made connections with social sciences or the application of content.

This pedagogical practice was challenged by the 2010 curriculum reform, which called for an integrated science pedagogy (MoE, 2010a). Adopting this curriculum was seen by Timorese policy makers and educators as one of the strategies for advancing the development of the country (MoE, 2010b).

Czerniak and Johnson's (2007) research showed that educators who prefer to continue teaching their subject content worry that efforts to combine subjects sometimes cause students to miss some prerequisite concepts that they think important. These researchers also commented that participants feared that the merging of the disciplines might cause people to lose important philosophical, methodological, and historical differences between the subjects.

It has been shown that these beliefs can also develop from teacher's professional development training Lowe & Appleton, 2014. There have been critiques about the professional development of teachers on enacting curriculum reform as being tokenistic (Garii, 2006, p. 83) in that professional development is carried out without regard for teachers' deeply held beliefs or long-established practices. Therefore these differences in teacher beliefs should be highlighted when providing in depth and continuing professional development sessions for teachers (Lowe & Appleton, 2014).

It would be interesting to see if Timor-Leste teachers had the same strong teacher beliefs towards the role of science and how science understanding should be taught.

It is important that the science education reforms of Timor-Leste are supported by an appropriate PCK that enhances constructivist learning and fosters a view of science education that shows science as integrated, where students can use their learning and experiences to critique scientific based situations and solutions. Therefore, it is important to explore how integrated science is taught and how this understanding can be developed to develop scientific literacy in Timor-Leste.

2.12 Language Challenges When Implementing the Science Curriculum

This section draws from prior international and national studies about language education issues in Timor-Leste. As Quinn (2013) noted, in a multilingual setting the policy focus is often which language to use rather than how to use the linguistic resources available to teachers.

Cardoso (2012), when researching the implementation of *3rd Cycle Science Education Curriculum* in Timor-Leste, found that one of the challenges faced by teachers was the language of instruction. This was because the Portuguese language was re-adopted as an official language after independence in 2002 (da Silva Sarmento, 2013). However, as well as Portuguese, Indonesian is also widely used, especially in universities (Cardoso, 2012). So, there is a need to use multiple languages on different occasions. The particular problem in the adoption of Portuguese is that most Timorese teachers, including science teachers, completed their education under Indonesian rule or within an Indonesian-inherited system in the languages of Indonesian or Tetum. But the new policy requires teachers to teach science in Portuguese and this has become a problem in schools (da Silva Sarmento, 2013). Portuguese scholars studying secondary curriculum implementation have found the same issues. They emphasised that teacher's lack of Portuguese language proficiency is a huge problem for teachers implementing the new curriculum (Cardoso, 2012; Capelo, Cabrita, & Lucas, 2015).

Reflecting on the language education challenges in Timor-Leste, with its linguistic diversity (Quinn, 2013), the question then is what does this mean for new curriculum demands when science teachers are required to be well-rounded teachers who are expected to achieve science competencies as part of the new curriculum requirements? (MoE, 2010b).

The requirements mean that teachers and students need to understand science concepts through three language pathways – that is through scientific language, academic language that is found in text books and language that the student would use in the classroom and their daily life. This goal is shown in the curriculum statements that require teachers and students to be able to communicate in the appropriate language to promote:

(a) an understanding of, and the ability to apply in day-to-day life (personal, social and environment), some basic concepts of scientific understanding of the physical and natural worlds.
(b) an understanding of some key characteristics of methodologies used by physics, chemistry, geology and biology and the capacity to apply these in an informal context.
(c) the ability to read, write and interpret scientific text and share science within physical or natural science.
(d) the construction of a complex and critical view of science and a constant ethical reflection on science, technology and their product. (translated from MoE, 2010a)

Consequently, the curriculum discourse means that teaching science is not solely transmitting scientific information, theories, formulae and definitions that are found in the curricula, but it should go far beyond. It requires teachers to teach an understanding of science concepts so students are able to communicate with them.

Despite the language challenges that the Timorese educators face (particularly science educators), science education scholars believe that language holds a significant meaning in science education (Webb & Mayaba, 2010; Yore, 2008; Yore & Treagust, 2006). However, because many science teachers have learned their science and the science terms and technical language in Indonesian, they have difficulty recognising and using Portuguese terms for science concepts and technical terms. For these teachers and students, the language that was utilised in constructing their knowledge and beliefs through a science lens is different from the daily communication language of Tetum and the mother tongue that students and society have used. As Fang (2006) commented, the language used to construct knowledge, beliefs, and worldviews in school science is distinct from the social language that students use in their everyday ordinary life. Consequently, the challenge for teachers is that they need language competence and confidence to be able to switch between languages to explain science concepts as well as develop their students' competence to critique science-based solutions as they develop their critical scientific literacy. The ability to "code switch" needs a pedagogy where teachers manage talk that promotes learning through active discussion and productive talk patterns (Quinn, 2013).

Such a pedagogy requires a PCK that encourages discussion where open rather than closed questions are posed by teachers in order to increase student interaction with content. This code switching could occur when teachers are encouraging students to tell their ideas in Tetum and/or Portuguese (Quinn, 2013).

It would be useful to find out the challenges confronting teachers when, implementing the 3rd cycle curriculum, they are faced with a Portuguese language text book and are required to teach science concepts and technical terms in Portuguese.

2.13 School Facilities and Infrastructure Challenges

Most scholars (Lopes, Almeida, Martinho, & Capelo, 2014; Shah, 2013; Taylor & Leech, 2013) who have researched or dealt with the Timor-Leste educational system have identified the problems involved and have witnessed that the young country is indeed facing school infrastructure and facility problems.

Even the curriculum designer team from University of Minho (UMINHO)–Portugal (Pacheco et al., 2009) have signalled these poor school facilities have limited the current curriculum for Timorese to use. But they were optimistic that these infrastructure issues should not be considered big enough to push back the reformation that needs to take place. Hence, the student textbook and teachers' guidelines have suggested various school activities for schools to perform that range from those needing more specific scientific equipment to activities that require simple equipment.

However, Soares' (2011) study about Timor-Leste science laboratory and school facilities found that all schools in Timor-Leste operated without any school laboratories. Hence, science teachers who embrace hands-on activities in their teaching can only utilise classrooms for their science activities.

The same concerns have been revealed in the past ten years. A study done by Stringer (2005), about an action for policy development in Timor-Leste, found that indeed Timor-Leste lacked school materials, laboratories, sanitation, appropriate roofing, computer equipment and a proper environment for students to play freely.

Moreover, a lack of appropriate school infrastructure meant that schools have to accommodate up to 60 students in a class at a time (Cardoso, 2012), and some schools are forced to organise shifts of teaching and learning up to three times in a day. As a

result of limited lesson times, learning is not effective. For instance, studies conducted by Hu (2008) in China and Lam, Alviar-Martin, Adler and Sim (2013) in Singapore proved that inadequate school infrastructures and facilities had an effect on the implementation of the integrated science classroom.

Given these challenges, it is important to know what challenges pre-secondary or 3rd cycle teachers face when teaching the new concept of scientific literacy.

2.14. Conclusion

This description of the development of the educational system in Timor-Leste, specifically as this relates to science pedagogy and the curriculum, sets an understanding of how the agenda of occupation of the colonial past continues to manifest in current educational policies and programmes of the country. These historical accounts provide that while there were previous and ongoing efforts of the Timorese government to come up with a pedagogy on their own, such as the new curriculum, these have not been fully successful up to the present. This comes from the fact that those espousing the reforms were educated and trained under the colonial rule. Thus, while some of these educators may have addressed the issue, they may have likewise perpetuated the colonial system of education that they were supposed to address.

The behaviourist or positivist perspective, which has the potential of reinforcing a banking system of education, can be challenged through a discussion of a constructivist pedagogy. The banking system of education has been critiqued as a tool for imposing one's beliefs and values on another group of learners. In fact, this has been a powerful tool of the colonisers to influence the Timorese to assimilate into their culture and ideologies.

It is proposed by the new curriculum writers that a constructivist learning paradigm may offer a space for Timorese science education to counter the non-contextual context way of learning by providing a context that Timorese are familiar with, and know, and recognise as an integral part of their daily living. This approach could provide a way of introducing the concepts of PCK which has been reframed as pedagogical content knowing to incorporate knowledge, context, and experiences as the framework for understanding the issues and challenges of science education in

Timor-Leste, specifically as this relates to the 3rd cycle of the new curriculum. This pedagogical model could be a way of introducing the ultimate goal of scientific literacy to Timor-Leste students.

However, at this point it is unclear how teachers are meeting the challenge of enacting this new curriculum. As identified in Chapter 1, the aim of this research is to:

> explore how integrated science subjects have been taught and interpreted in the current 3rd cycle curriculum in Timor-Leste in order to identify areas for future professional development.

Because this new curriculum has been developed by outside experts and the content and language of instruction signals that Timor-Leste educators and teachers have not had a strong input into this development, it is important that the education community is consulted about their attempts to enact this 3rd cycle curriculum reformation for Grades 7–9 science education.

Consequently, the overall research question for this research is:

> What are the issues that influence the 3rd cycle curriculum reformation for Grades 7–9 science education in Timor-Leste?

Because the enactment of a new curriculum requires everyone who is involved to have a clear vision of this educational reform, it was important to find out how different groups perceived this curriculum and its goals as well as how they hoped it would be enacted. Consequently, the following research sub-question was posed:

> How has the vision of an integrated science curriculum been interpreted by the Ministry of Education officials and educationalists involved in this curriculum reformation?

Teachers are the front line for any enactment of a curriculum and this researcher wanted to find out the issues when teachers enacted this curriculum. This focus on teacher opinion and comment could provide some input for future professional development when answering the following research sub-question:

> What are the challenges for teachers as they enact the new 3rd cycle science curriculum?

But most importantly, how teachers enact the curriculum is revealed when they are asked about how students learn. It was hoped that this dialogue with teachers would provide some information about the pedagogy that is commonly practised in this *3rd Cycle Science Education Curriculum*.

> What pedagogical strategies do teachers use when enacting the 3rd cycle science education curriculum?

CHAPTER 3:

RESEARCH DESIGN

3.1 Chapter Introduction

This study aimed to explore how Timor-Leste Ministry officials and educationalists interpreted the vision of an integrated spiral science education 3rd cycle curriculum. It also explored how teachers and student teachers enacted this curriculum in order to identify areas for future professional development.

This research was guided by the following research questions. The overall research question was: What are the issues that influence the 3rd cycle curriculum reformation for Grades 7–9 science education in Timor-Leste?

In particular, the following research sub-questions provided evidence to discuss this science education issue:

- How has the vision of an integrated science curriculum been interpreted by Ministry of Education officials and educationalists involved in this curriculum reformation?
- What are the challenges for teachers as they enact the new *3rd Cycle Science Education Curriculum*?
- What pedagogical strategies do teachers use when enacting this *3rd Cycle Science Education Curriculum*?

In this chapter, Section 3.2 describes the ontology, epistemology and methodological underpinning the study. Following this, Section 3.3 presents the outline of the research project. Section 3.4 presents how the researcher selected the sampling of the study. Section 3.5 introduces the research participants. Section 3.6 describes the process of data gathering. Section 3.7 describes the process of data analysis, and Section 3.8 describes the trustworthiness of the study.

3.2 Ontological, Epistemological and Methodological Underpinning

To investigate this issue, the researcher chose to use an interpretive-qualitative mode of inquiry. This paradigm holds that there is no one objective “truth” as people

construct their own realities, resulting in multiple realities. Hence an interpretive-qualitative mode was chosen because it would enable the researcher to make meaning of and understand how people make sense of their world in a particular context (Schwartz-Shea & Yanow, 2013) in their particular way. The researcher believed that her choice of paradigm would enable her to collect and analyse the differing ideas that Ministry of Education officials and educationalists had about the vision of the *3rd Cycle Science Education Curriculum*. She also believed that her choice of paradigm would allow her to collect and analyse the range of ideas and opinions that teachers had about their enactment of the curriculum, the challenges they faced and how they managed these challenges.

3.2.1 Ontology

Ontology is an area of philosophy that "ask[s] what reality is and what the fundamental categories of reality are" (Neuman, 2011, p. 92). The ontology that underpins an interpretive-qualitative mode is social constructionism. Neuman (2011) defined social constructionism in terms of reality as "consisting of people who construct meaning and create interpretations through their daily social interactions" (p. 93). This means that the reality that we know and understand is derived from our personal perceptions and interpretations. As Sarantakos (2005) argued, since reality is constructed from individual perceptions and experiences, these constructed realities are varied. Furthermore, as Neuman (2011) added, these different constructions of reality are all valid and there is no single interpretation that is more meaningful than another. This ontological perspective of reality is important to this study. It enabled the researcher to collect a wide range of data and then gain a deeper understanding of how and why the different participants had varied understandings and interpretations of the new curriculum. In line with this ontology, the researcher did not judge or evaluate their beliefs or practices, but instead sought to better understand the perspectives from which they had come to understand and enact the 3rd cycle curriculum.

3.2.2 Epistemology

Epistemology is concerned with the knowledge construction process and an interpretive paradigm holds knowledge as being "socially constructed through language and interaction, and reality as connected and known through society's culture, and ideological categories" (Tracy, 2012, p. 41). This means that knowledge

is constructed from individual perceptions of reality that have been constructed through interactions with others (Creswell, 2009).

In addition, Sarantakos (2005) argued that a social constructivist epistemology highlights that the meaning-making by individuals and groups is dynamic and continues to take shape according to their contexts and "how they experience everyday life" (p. 40). This aspect enabled the researcher to explain the differences in the perceptions, understandings and enactment of the new curriculum by the participants. For instance, the teachers experienced everyday life differently from the high-profile Ministry of Education officials. Therefore, while the participants had all had experiences of and with the curriculum, they would have had varied interpretations of the new curriculum. Similarly, not all teachers had the same perceptions of the new curriculum and this is because they had different experiences as they enacted this curriculum, which, according to Sarantakos, is fundamental in the interpretivist paradigm. O'Donoghue (2007) affirmed this by saying that the context in which knowledge has been constructed is significant and strongly influences the knowledge constructed.

Moreover, a social constructivist epistemology acknowledges that society holds an understanding of knowledge that is based on its people's historical, social and political experiences (Schwartz-Shea & Yanow, 2013). These realities have been constructed by individuals and specific groups according to the circumstances surrounding the "context" of their experiences. Thus, collectively, the Timor-Leste science teachers' understanding of the new curriculum may have been based on their education experiences in both the Portuguese and Indonesian systems.

The researcher also acknowledges that her positionality in the research was important (LeCompte & Schensul, 2010). It was important because she is a science teacher herself and also a teacher trainer. This meant that she also had her own constructed meanings, experiences and interpretations of the new curriculum. However, throughout the data collection process, she consciously immersed herself in her participants' understanding of the new curriculum according to how they spoke about their everyday life experiences, rather than considering her own experiences.

3.2.3 Qualitative methodology

A qualitative methodology is aligned with an interpretive mode of inquiry. It involves collecting non-numerical data in natural settings, which provides a researcher with holistic information about participants' contexts and insights into their experiences (Creswell, 2009). By collecting data in a natural setting, a researcher can develop a rapport with participants (Creswell, 2009), which means that participants can express their ideas more freely. It also allows for a more flexibility in a study's methodology, enabling a range of different data collection methods and for questions to be refined and developed throughout the study.

These characteristics enabled the researcher to use a variety of data collection methods, such as individual interviews and focus group interviews, according to their particular context. She was able to conduct interviews with participants in places that were familiar to them, for example interviewing the Ministry of Education officials in their offices and the teachers at a place familiar to them in their municipality, assisting with building a rapport. It also allowed her to refine questions as the study progressed. For example, the questions used in the individual teacher interviews were refined based on the responses given during focus group interviews. Hence the researcher was able to gain deeper insights into participants' interpretations and enactment of the new curriculum.

3.3. Outline of the Research Project

Once the research questions had been finalised and ethics approval gained, data collection started. Table 3.1 shows the time frame, participants, data collection strategies used and the types of data collected.

There were three phases in this research. In Phase I, the researcher analysed relevant documents to gain information about the aims/goals of the curriculum. Phase II involved a series of focus group interviews with nine groups of teachers in three municipalities, Baukau, Dili and Likisa. Through these interviews, the researcher collected data about teacher perceptions about the new curriculum. Information about strategies that the teachers had taken to overcome these challenges was also gathered. In Phase III the researcher interviewed the Ministry of Education officials, and educationalists, and had individual interviews with student teachers and teachers.

Table 3.1
Outline of the Timeline of the Research Project

Time frame	Research activities	Participants involved	Data collection strategy	Data collected
Phase I June 2016	Document analysis		Analysis of documents such as: curriculum, syllabus, teacher guidelines, student textbooks	Gained information about the aims and goal of the curriculum teacher teaching guidelines, and lesson activities
Phase II May–June 2017	Posed research questions 1, 2, 3 & 4	Teachers	Focus group interviews	Gained information about teachers' perception of new curriculum, challenges and efforts to overcome the curriculum shortcomings
Phase III July–August 2017	Posed research question 1	Ministry of Education officials	Individual interview	Gained information about educational officers' understanding of curriculum intention
August–September 2017	Posed research questions 1, 2, 3 & 4	Teachers	Individual interview	Gained detailed understanding of individual perceptions and implementation
August 2017		Educationalists	Individual interview	Gained understanding of how they interpreted the curriculum and trained teachers at schools
September 2017		Student teachers	Individual interview	Gained understanding of how they taught students and what challenges they faced in implementation

3.4. Sampling and Selection

Punch (2014) claims that we cannot study everything all at once. Hence, sampling is utilised to select the representativeness of the interested population. He further emphasised that in qualitative research, social researchers frequently apply purposive sampling, which means samples are chosen with some purpose or focus in mind

Purposive sampling was chosen as a sampling method because participants needed to be able to provide relevant information to answer the research questions that the researcher was pursuing. Hence, the participants selected to take part in this study were Timorese Ministry of Education officials and educationalists (teacher trainers), along with science teachers and student teachers who were either directly or indirectly using and implementing the new curriculum.

The Ministry of Education officials who participated were those who were directly involved in the conceptualising, formulation and implementation of the new curriculum and who agreed to become part of the research. Hence, the criteria used to select these participants were that the selected participants held responsibility for disseminating, monitoring and assessing the implementation of the 3rd cycle curriculum and its effectiveness.

Educationalists were also selected to participate in this study. They were selected because they are the ones who interpreted and prepared teachers to implement the curriculum at the school level. The criteria used to select these participants were that they had delivered and been involved in national teacher training for more than 4 years.

Because this study was investigating the implementation of a new science curriculum, science teachers were also selected to take part. The criteria for their selection were that they had taught the natural physical science subject for a minimum of 3 years since the implementation and were teaching in Grades 7, 8 and 9. Also, teachers from the municipalities of Bacau, Likisa and Dili were selected because they were the teachers most familiar with the *3rd Cycle Science Education Curriculum* due to their participation in teacher training courses on its implementation.

The last group of participants selected to take part comprised student teachers. They were selected to participate because they also experienced implementing the new curriculum for school students for a short time. The researcher thought that they could

provide a different insight about the science curriculum because they were just beginning their teaching career and had not been influenced by the former curriculum. The criteria used to select student teachers were that they had a science background such as physics, chemistry and biology and had utilised the new curriculum and taught it to students.

3.5 Introducing the Participants

There were four groups involved in this research. They were three Ministry of Education officials from the national office, two educationalists involved in teacher training, 45 science teachers from the three municipalities of Dili, Baukau and Likisa, and three student teachers from a national pre-service teacher training institution. Each group will now be introduced.

3.5.1 Ministry of Education officials

These Ministry officials were the educational bureaucrats who were responsible for the implementation of the *3rd Cycle Science Education Curriculum*. One held the position of director of national curriculum. This officer was involved in decision making to adopt the new curriculum ideas from Portugal. He also participated in curriculum design and textbook writing. Another policy maker was the head of the curriculum office, and held responsibility for socialising and disseminating the curriculum intentions to science teachers at a central and municipal level. The participant in the position of director of national evaluation and assessment was responsible for assessing learning of curriculum concepts and its implementation (see Appendix A).

3.5.2 Educationalists

There were two educationalists from two teacher training institutions involved in this study – one from the National Institute for the Training of Teachers and Education Professionals (Instituto Nacional de Formação de Docentes e Profissionais da Educação [INFORDEPE]) and the other from a science organisation funded by UNESCO (see Appendix A). INFORDEPE is run by the Ministry of Education, and it exists to enhance teachers' capacity and professionalism. This institution has two types of educationalists. Some are permanent staff while others are seasonal. Seasonal means the educationalists were employed only to cover a particular project or training for a

short period of time, but after that period they are expected to go back to their original schools as teachers. This was the case with the educationalists who were recruited to deliver the 3rd cycle curriculum content in 2013. These educationalists were chosen to facilitate the new curriculum for their fellow teachers. After the target was accomplished, these educationalists went back to their original schools. At the time of the study, there was only one science educationalist available who took part in this study. She is of Indonesian descent and married to a Timorese man. She completed her undergraduate study at an agricultural faculty in Indonesia. In 2012 she completed her master's degree in education at a faculty of UNTL which has a cooperative agreement with a Portuguese university.

The science organisation is funded by UNESCO and was established in 2012. Initially, the organisation was formed to assist teachers to do hands-on activities with their students at schools. The organisation coordinator claimed that the action is in line with the organisation's philosophy, which believes that if teachers want to learn, then they have to touch it, feel it and discover it by themselves. Since the curriculum reformation took place, this organisation also took the initiative to help teachers learn the new curriculum content. Most of their educationalists are science school teachers.

One of the participants involved in the study is the coordinator of this organisation. He had a physics background from UNTL. He was one of the members who initiated the organisation with other colleagues. His role was to design and plan the training programme, then implement and evaluate its implementation. Before holding the position of permanent organisation coordinator, he taught in one of general secondary schools in Dili owned by the Portuguese and known as the Portuguese school.

3.5.3 The teachers

Baukau municipality

There were 15 teachers from Baukau municipality who were involved in the study. These teachers came from 15 schools out of 35 basic education schools that make up part of Baukau municipality (see Appendix A).

These teachers had a range of experience and educational backgrounds. Seven had taught since 2000, during the time when the transitional government reactivated the school system in Timor-Leste. The other eight teachers' careers began after they

completed their study around 2005 onwards. All of these teachers were teaching at the time the *3rd Cycle Science Education Curriculum* was introduced.

These teachers had different educational backgrounds. Four of them held a general secondary school certificate. One teacher was a graduate from an agricultural faculty, while another completed their education at the INFORDEPE teacher institution where a teacher training course is run by Brazilian and Portuguese professors. The other 12 completed their teacher training at a pre-service teacher institution that runs an initial teacher education course. Of these 12 teachers, two were biology specialists, five were physics specialists, four have a diploma in engineering and one in Portuguese language.

Dili municipality

Sixteen teachers from the Dili municipality signed the consent form to contribute their voice to this research. These 16 teachers represented six of the 30 basic education schools that exist in the Dili area (see Appendix A).

Three of these teachers had taught in schools since the reactivation of the educational system in 2000, while the others had started their teaching career from 2008 onward, which was before the implementation of the new curriculum.

Of these 16 teachers, 14 had completed an undergraduate initial teacher education degree at either UNTL or Kristal Higher Institution. Nine of these 14 teachers had specialised in physics education, four teachers had specialised in biology education and the others had a social science background. The remaining two participants held a general secondary education certificate.

Likisa municipality

There were 14 teachers from Likisa municipality who consented to join this research project. These 14 teachers worked in seven of the 11 basic education schools that are scattered over four towns that make up part of Likisa municipality: Boboro; Loes; Leorema; and Likisa City. One of the teachers taught in a Catholic school and the others in public schools (see Appendix A).

Two of these teachers had been teaching since Indonesian times (1990–1999), but the other 12 had started their teaching careers from 2008 onwards. This meant that all of these teachers were already teaching when the new curriculum was implemented.

The difference between the Likisa municipality and the Dili and Baukau municipalities was that all science teachers in the Likisa municipality had gained an undergraduate teaching certificate from one of the three teacher training institutions: INFORDEPE, UNTL, or Kristal. Eight of the teachers had specialised in physics education and the other five had specialised in biology education, with one specialising in history education.

3.5.4 Student teachers

The three student teachers who were involved in this project were final-year student teachers who had been assigned teaching practice to meet one of their course requirements. One had specialised in physics, one in biology and one in chemistry education (see Appendix A).

3.5.5 Coding system

The researcher developed a coding system to maintain the confidentiality of the participants' identities. Each participant had a specific code that comprised either two or three letters of their name. To identify data that came from an individual interview, the letters II followed the letters from the participant's name. For example, a participant who contributed data from an individual interview would have the code FM (letters of name), II (individual interview), p.14 (transcript page number) – FM, II, p. 14.

The focus group interview data included the letters 'FGI' to identify that form of data gathering. Next the researcher used either G7. G8 or G9 to indicate the grade level the teacher taught. Finally, the page number from where the quote was retrieved in the transcript was recorded. For example, a focus group interview participant's quote would have the code MBE (letters of name), FGI (focus group interview), G8(grade level)- (name of the municipality), p. 3 (transcript page number) - MBE, FGI, G8-municipality, p. 3.

The name of the teacher training organisation has been given the pseudonym MISES so that it is not identifiable by an overseas reader.

3.6 Data Gathering

This study used three approaches in generating data. The first stage was documentary analysis. The second stage was focus group discussions and the third stage was

individual interviews. Both focus group discussions and individual interviews were facilitated by the researcher.

3.6.1 Document collection

According to Cohen, Manion and Morrison (2011), a document is defined as a "record of an event or process" (p. 248). Patton (2002) added that documents could offer abundant information that a researcher cannot obtain through other data gathering approaches, such as interviews, focus group discussions or observation (Creswell, 2014). The reason the researcher gathered data from documents was because it provided her with information about the essence of the curriculum intentions that could not be gained through interviews and focus group discussions alone.

The documents that were collected encompassed official documents that cover government policies and discourse, school textbooks, teacher guidelines and lesson plans, and exam materials. Documents gathered for analysis included teachers' teaching manuals, official curriculum documents that are released by the office of Timor-Leste's Minister of Education, students' textbooks from Grades 7 to 9, national examination materials, teachers' lesson plans and other relevant documents such as newspapers and Ministry of Education trimestral magazines.

3.6.2 Interviews

Because interpretive researchers should use a variety of methods in data collection, interviews can enrich the explanations of the documented evidence that is being studied (Denzin, Lincoln, & Giardina, 2006; Trainor, 2013). Consequently, an interview is considered as one of many complementary tools that can be used for data collection.

For interpretive researchers, the interview is most vital because the researcher can only come to understand a participant's views by talking to them directly. Through the language that two people use during an interview, a researcher can interpret the meanings that this member of society holds (Trainor & Graue, 2013). During an interview, two or more people can meet to exchange information or ideas through questions and answers to enable the construction of meaning for a particular topic that the researcher is interested in (Trainor, 2013). As this study is about the interpretation and implementation of the 3rd cycle integrated science curriculum in Timor-Leste,

various types of people involved in education, who were considered to be directly involved, were interviewed.

An interview is a qualitative data collection technique that involves collecting data through verbal interactions between an interviewer and the interviewee (Seidman, 2006). According to Seidman (2006), interviews are conducted when the researcher is intrigued to understand "the lived experiences, of other people and the meaning they make of that experiences" (p. 9). Punch classified interviews into three types: a fully structured interview, a focused/semi-structured interview, and unstructured interviews (Anney, 2013). As this study aimed to explore how integrated science subjects have been taught and interpreted in the current 3rd cycle curriculum in Timor-Leste, the researcher adopted a semi-structured type of interview to collect specific data from research participants (Merriam, 2002). A semi-structured interview was chosen because it provided flexibility for the researcher to delve deeply into issues that she was pursuing. Punch (2005) and Robson (2002) explained that semi-structured interviews enable a researcher to generate specific information relevant to their study. Furthermore, interviews were chosen because Timor-Leste has an oral traditional culture and could encourage participants to express their ideas in more depth through the spoken word rather than in writing.

There are two types of interviews – individual interviews and focus group interviews. An individual interview is when two people meet face to face to share their experiences and feelings about certain issues. The researcher used this type of interview when interviewing Ministry of Education officials, teacher trainers, some of the teachers who chose to talk more deeply about their experiences, and student teachers.

A focus group interview is when people from the same background or experiences gather together to discuss a specific topic of interest. The researcher acted as discussion facilitator and posed the research questions about participants' ideas, perceptions and beliefs towards curriculum implementation and the challenges that they faced when implementing it. The researcher used this type of interview with the teacher participants. Each will now be discussed in turn.

Individual interviews

Participants for the individual interviews came from three groups at different levels – Ministry of Education officials were at the top level; educationalists, who were national teacher trainers who interpreted and adjusted the curriculum's content to train teachers in the implementation, were at the middle level; and teachers and student teachers who applied the ideas in their classrooms were at the school level. Each group of interviews will now be discussed in turn.

Ministry of Education officials

Three Ministry of Education officials were interviewed individually in their offices. These interviews lasted for 30–60 minutes.

Questions asked in the interview investigated their role in making sense of the implementation process, underscored by the belief that the instructional ideas that implementers construct from policy are critical in understanding their enactment of that policy (Cohen et al., 2011; Spillane, 1999; Yanow, 1996) (See Appendix B). Other questions explored how they interpreted policy in order to decide how to adapt or adopt policy makers' recommendations, and how they interpreted the intention of the new curriculum and disseminated it to teachers in schools. Data were also collected about the investment that the Ministry of Education had made to ensure the new curriculum implementation succeeded. Assessment and evaluation data were collected around the criteria used to measure and assess students' performance.

Educationalists

Considering that the educationalists hold an important role in the curriculum implementation, two were involved in this project. These interviews were done in their work offices and lasted 60 to 90 minutes.

Questions were asked about how they understood, prepared, trained and influenced teachers to implement the curriculum in the classroom (See Appendix C).

Teachers

The individual interviews with teachers were conducted to delve more deeply into their ideas based on the focus group discussions. There were seven teachers who agreed to provide more information personally. These teachers comprised three teachers from the Dili municipality, three from the Likisa Municipality and one from the Baukau

municipality. The individual interviews took place in the teachers' schools or in a place that was convenient to them and lasted between 45 to 60 minutes.

The questions posed in these individual interviews encouraged teachers to discuss the teaching challenges that they experienced in implementing the new curriculum in depth (See Appendix D).

Student teachers

As the student teachers had just completed their teaching practice at this time of this study, it was regarded as important to explore their teaching experiences in schools. These interviews were conducted at the student teachers' learning institution and lasted for about 60 to 90 minutes.

Questions were asked about their experiences teaching the 3rd cycle curriculum and the challenges that they had experienced when teaching students using this curriculum (See Appendix E).

Teachers focus group interviews

Trainor (2013) described a focus group interview as a vibrant group discussion on certain issues that are raised by an investigator. The fundamental characteristic of a focus group is the establishment of a forum for group discussion and collective expression of perspectives (Neuman, 2011). Furthermore, Wilkinson (1998) emphasised that focus group interviewing is appropriate for use in a study that is aimed at gaining people's "understanding, opinions and views, or to explore how these are advanced, elaborated, and negotiated in a social context" (p. 187). Thus, this chosen method concurs with the aim of the study which was to explore how integrated science subjects have been taught and interpreted in the current 3rd cycle curriculum in Timor-Leste. These focus group interviews were conducted using a semi-structured approach. This approach was taken to give more flexibility to participants to freely express and convey their understanding, feelings, experiences, challenges, and the struggles that they have faced in adopting and applying the new science curriculum. Also, the researcher chose a focus group interview strategy because teachers might have felt reluctant to express their ideas and opinions individually, so a collective expression of perspectives could encourage a greater variety and depth of responses (Neuman, 2011).

As a Timorese citizen who holds a science education degree and is fluent in the Timorese lingua franca Tetum, the researcher acted as group facilitator during the focus group interviews. The focus group interviews were conducted in three municipalities of Dili, Likisa and Baukau. Nine focus groups were conducted, with three in each of the municipalities. Each focus group interview involved four to six science teachers from Grades 7, 8 and 9. These focus group lasted for 90 to 120 minutes.

During interview sessions, the researcher collected rich relevant information about teachers' understandings about the curriculum goals, some challenges that they faced during their teaching activities, and the efforts that they took to keep learning alive and help students understand what was being taught (Appendix F).

3.7 Data Analysis Process

Merriam and Tisdell (2015) claimed that data analysis is "the process of making sense out of the data" (p. 202). This means that after collecting data, a researcher needs to organise and interpret these data in order to make them understandable for a reader. Merriam and Tisdell also specified that making sense out of data is basically the process used to answer the research questions that a researcher is exploring.

Data analysis involves consolidating, reducing, and interpreting what research participants have said and what the researcher has seen and read. LeCompte and Schensul (1999) argued that analysis of data is a stage where various kinds of data are transformed into succinct statements that describe, explain, or predict something about what the researcher has studied. For LeCompte and Preissle (1993), analysis is a bit like taking apart puzzles and reassembling them. However, puzzles cannot be completed if pieces are missing, warped, or broken (LeCompte, 2000). Likewise, if pieces of data are incomplete or biased, the research questions will not be answered adequately.

Cohen, Manion, and Morrison (2011) claim that there is no single or best way to analyse qualitative data. The decision of how to carry out data analysis depends on "fitness of purpose" of the research questions (p. 537). Hence in this study the researcher has combined various approaches to analyse data. These approaches are qualitative content data analysis (Merriam & Tisdell, 2015) and the thematic analysis

process of Braun and Clarke (2006). Using these two approaches enabled the researcher to make sense of the data in order to translate and transform them and answer the research questions.

3.7.1 Qualitative content data analysis

In this study, the documents were analysed using a content analysis approach using predetermined themes to scrutinise the information that is present in the documents, particularly to identify the patterns and indicators within these documents.

In content analysis researchers index and code data to identify key themes that generate theoretical categories and identify patterns (Downe-Wamboldt, 1992). From the themes, categories can be established for the terms, concepts, phrases, and definitions identified. These categories were: curriculum intentions, goals, and indicators of integration.

To index and code data, identify key themes to generate the theoretical categories and identify patterns, the researcher established categories for terms, concepts, phrases, and definitions of curriculum intentions or goals. An example of this analysis is shown in Table 3.2.

Table 3.2
Examples of Curriculum Content Analysis

Theme	Excerpt from document	Example of participants' interpretation
Curriculum intentions	The interconnecting of vertical and horizontal articulation of the curriculum is intended to contribute to help develop an integrated competency profile that: • Make it possible for students to continue at secondary level, or possibly to continue to higher education or any professional qualification; • Allows students to participate in a responsible and critical way in the construction of a sustainable society and forms of development in Timor-Leste.	*So, the objective of the third cycle is for the students to dominate/master NPS so that when they study science or natural science, [in secondary level] they already have basic knowledge about these. (ASP, II, p. 4)* *Doing elementary school in order to continue their study. For example, when you are doing CFN is a general science, basic, for example, if you like math or physics more, and then you can l study these later when you go to secondary school. (FM, II, p. 14)*

3.7.2 Thematic analysis

The researcher used thematic analysis to analyse the interview data because this approach provides a flexible and useful way to potentially provide a rich and detailed, yet complex, account of the data (Braun & Clarke, 2006).

Thematic analysis is a "method for identifying, analysing and reporting patterns [themes] within data" (Braun & Clarke, 2006, p. 79). A theme is defined as a specific pattern conveying a similar meaning that is found in the data, which is of potential interest to the researcher. The thematic analysis approach is widely used in analysing qualitative data generated from interviews, field notes, documents, photographs, video recordings and participant observations (Taylor-Powell & Renner, 2003).

The researcher used Braun and Clarke's (2006) six-step approach to analyse the data. In the first stage, the researcher familiarised herself with the data through listening to audio-tapes, transcribing raw data from both the individual and focus group interviews, reading and re-reading the transcribed text, and noting down initial ideas (Braun & Clarke, 2006). In the second stage, the researcher repeatedly returned to all transcribed text of both individual and groups to generate initial codes. In this stage, coding was done in two ways: deductive (see Table 3.3) and inductive coding (see Table 3.4). The deductive coding was done using predetermined themes that the researcher had identified through a literature review. This type of theme related to the types of challenges that teachers faced when implementing the curriculum. While doing this stage, the researcher was analysing data by re-evaluating the purpose of the study and looking at what the study intended to find out. Inductive coding was also carried out at this point to identify codes generated from participants' experiences and not already identified through the literature review.

In the following stage, Stage 3, the researcher collated the available codes into potential themes, gathering all data relevant to each potential theme. Next the researcher reviewed the themes, checking to see if the established themes fitted the given codes and the entire data set. In Stage 5, the researcher defined and named each theme by refining it. In the final stage – Stage 6 – the researcher produced this thesis which reflected the research questions, literature and data analysis.

Table 3.3
Examples of Deductive Thematic Analysis

Indicator words/phrases of *Challenges* themes	**Examples of participants' responses**
Indicator words of challenges of **subject content matter** that was out of their specialised area: • Some content that we do not know • Because my major is biology • I have only mastered biology	*To be honest, this would put students into a problem [hole] because there is some content that we do not know, so how would we teach it? Because my major is biology, I have only mastered biology. So, if the government forces us, then we will teach other subjects. It means we learn and teach them, but we might pick them up the wrong way. If we learned it wrongly, automatically, we would teach it to the students wrongly.*
Indicator words for **language challenges:** • Language is an obstacle • The textbook written in Portuguese • We do not understand the meaning of it • Portuguese is hard • To translate these to Portuguese is challenging	*For me, language is an obstacle because the textbooks were written in Portuguese. Tetum was there, but they just changed the letter, so we do not understand the meaning of it. Hence, we should prepare ourselves to understand it in Tetum. In Portuguese it's hard. There are some references available in Indonesian but to translate these into Portuguese is challenging.*
Indicator words for **resources challenges** • The content requires places to listen to sounds but in reality, our school is not high tech • Some walls of the rooms are old and almost collapsed • In school there is no laboratory equipment	*In our school, we have 36 or 37 students in one classroom...but the content required places in order to listen to sounds. But in reality, our school is not high tech so that we can make a sound and the children will listen. Some walls of the rooms are built from a palm tree, and the wall is old and almost collapsed. We could not make sounds since these would disturb the class on the other side of the room.* *Last year, I attended a training in INFORDEPE, DILI…We also learned about how to do practical work in the laboratory. We focused on how to teach a student to use laboratory tools. The problem is, in school, there is no laboratory. After the training, it could not be applied. We could not practise it because there is no laboratory equipment.*
Indicator words of **textbook challenges** • There they only gave Malae's context • We also have our own, but it is not written in the textbook • When we teach this to students, they are doubtful	*When we talk about astronomy, there, they only give Malae's context, we also have our own knowledge, but it is not written in this textbook so that we explain it to our students. When we teach this to students, they are doubtful because it is all about others.*
Indicator words of the **National Evaluation System challenge** • The exams which present as multiple-choice system also sometimes demotivated students to study	*The recent curriculum exams, which present as multiple-choice system also sometimes demotivated students to study.*

Table 3.3 provides examples of how the deductive data analysis was undertaken. These themes were found in literature, for example language was identified as a theme

because Quinn (2013) discussed the need for teachers to code switch because Portuguese was the language of instruction yet students did not commonly use this language in their everyday lives. Resources were identified as another theme because Cardoso (2012), Gabrielson et al. (2011), Ninnes (2013) and Soares (2011) indicated that a lack of physical resources and scientific equipment presented challenges for teachers.

However, when analysing the pedagogical strategies employed by these teachers to overcome challenges, inductive analysis was used. Table 3.4 illustrates examples of some of the themes identified.

Table 3.4
Examples of Themes Identified Through Inductive Analysis

Indicator words/phrases of themes	Examples of theme in participants' responses
Using note taking • Gave notes • Note taking • To give notes • Write my explanation on the board	*So, I will only write my explanation on the board, and while I do the explanation, no one can make notes. Your obligation is a seat, listen and convey your difficulties, I will not clean it, and after we are done, then you can copy from the board. But all should have the notes.*
Using a textbook • Textbook	*When I do teach, if we need textbook then we get the textbook from the library. Then distribute them to the students, two students share one textbook. So that when I explain, I ask them to have a look at a certain page; they can do it.*
Using media • I present it with video • Display video	*I present it with video and provide some picture that makes children could imagine. As I mentioned, my method was displayed video to students in 7 or 8 minutes. They watch a video about how a volcano occurs. Because it included in the textbook, the tsunami is there as well. Thus, I display video so that the children could watch it.*
Using a discussion approach • We discuss one subtopic • When we apply discussion • They discuss things • Before discussing the relevant topic	*When we are just lecturing, the students tend to get sleepy, but when we apply discussion, they are involved directly, they share their ideas, and they discuss things that they have to,… upon they conveyed, and we can complete it. This is the difference; it makes the classroom more alive. Rather than solely explaining. There is time for the teacher to explain but there should be time for them to speak up.*

Table 3.4 shows that when analysing data relating to the types of pedagogical strategies used by these teachers, some teachers referred, for example, to ways that they either got their students to make notes or else they prepared notes for their students. These comments were coded as "note taking" and then the instances of note

taking were counted. In this way the patterns of the types of pedagogical strategies used by these teachers were identified.

3.8 Trustworthiness

Trustworthiness is a way to convince the readers of a research study that the study's findings are sufficiently authentic and trustable (Merriam & Tisdell, 2015). Decrop (2004) opined that considering trustworthiness issues is important in helping qualitative and interpretative studies be more rigorous. Merriam and Tisdell (2015) suggested that since the criteria set up by traditional, quantitative researchers to meet authenticity and reliability of research are widely recognised, these should be applied in qualitative studies but using different terms. Hence, Guba (1981) suggested four terms that are more appropriate for interpretivist researchers to convince the readers about the trustworthiness of qualitative study. These criteria are credibility, transferability, dependability and confirmability. Each will now be discussed.

3.8.1 Credibility

Credibility involves ensuring that a research study tests or measures what is intended, in this case these participants' interpretations of the *3rd Cycle Science Education Curriculum*. According to Merriam and Tisdell (2015), one way to ensure the credibility in a qualitative study involves questions such as "How congruent are the finding with reality?" and "Do the findings capture what is really there?" (p. 242). This means that the credibility of this study primarily depends on the authenticity of the information or data provided by participants and the interpretation of the researcher. As this research aimed to explore the 3rd cycle new science curriculum implementation in Timor-Leste, two techniques identified by Shenton (2004) were used to ensure the credibility of the study. These were tactics to help ensure honesty in informants when they contribute data and frequent debriefing sessions (Shenton, 2004).

One of the techniques recommended by Shenton (2004) to ensure credibility is *tactics to help ensure honesty in informants* when they contribute data. To implement this technique, the researcher reminded teachers in the study at the beginning of the focus group discussions and individual interviews that this was a chance for them to express their teaching circumstances, challenges or other concerns that they faced during

curriculum implementation. It was also emphasised that their involvement in the study was voluntary and their identities would remain confidential to the researcher and her supervisors. They were also informed that they were free to leave the focus group discussions and individual interviews whenever they wanted to. Hence, the researcher believed that the participants involved in this study were those who were willing to honestly and freely share their feelings about and the challenges that they faced in implementing the new curriculum. Shenton argued that this technique is a way to minimise the power relations during the study and ensure credibility.

3.8.2 Transferability

Another criterion to meet the trustworthiness of a qualitative study is transferability. Transferability is concerned with external validity (Shenton, 2004) or readers of a study being able to apply its research findings to other settings or groups. Transferability is achieved when the findings of a study have meaning to other individuals who are not involved in that study and readers can associate these results with their own experiences.

In order to meet this transferability criterion, the researcher collected rich, thick and detailed data about the context of this study – how participants were selected (Section 3.4), the number of participants (Appendix A), the data collection methods (Section 3.6), the number and length of data collection sessions (Section 3.6), and the time period when data were collected (Section 3.3). By providing these rich, detailed descriptions of the context, readers can decide the degree to which these findings are transferable to their particular context.

3.8.3 Dependability

Dependability is concerned with replicability or being able to obtain similar results if the study is repeated (Bitsch, 2005; Shenton, 2004). However, when carrying out interpretive research, reality is not fixed and immutable, but fluid and contextual. Therefore, knowledge generated is not absolutely bound by time, context, culture and values, and replicability is impossible because of changes to time and space (Decrop, 2004). This means even if the study were repeated by the same researcher, in the same context, with the same participants, the result of the new study is unlikely to be totally consistent with the previous study. Hence, dependability is concerned with "not

whether the findings will be found again but whether the results are consistent with the data collected" (Merriam & Tisdell, 2015, p. 251).

To promote the dependability of this study, the processes and procedures followed need to be reported both accurately and in detail. First the researcher has presented an audit trail (see Section 3.3) where the processes and procedures taken when implementing this study have been outlined. Details about the participants can be found in Section 3.5, data collection methods have been discussed in Section 3.6 and a reflection about the limitations is outlined in Section 7.8 (Shenton, 2004). Hence dependability has been ensured.

3.8.4 Confirmability

Confirmability relates to objectivity. However, Lincoln and Guba (1985) argued that a researcher can never be totally objective. Instead the researcher needs to make sure that their interpretation reflects the ideas and experiences of the participants, rather than the researcher's personal ideas. Confirmability can be met through the researcher explaining their own beliefs and assumptions about the issue (see Chapter 1), and being transparent about the study's underpinning methodological philosophy (see Section 3.2) (Shenton, 2004). Providing an audit trail (see Section 3.3) also helps to ensure confirmability because it allows readers to scrutinise the integrity of the study's findings. In these ways, confirmability can be ensured.

3.9 Ethical Considerations

In social research, the researcher has a moral responsibility to protect those who are being studied (Gilbert & Stoneman, 2015). The foremost ethical concerns in any social research that involves human beings – informed consent, confidentially and power relationships – relate to potential harm to the research participants (Anney, 2013; Behi & Nolan, 1995; Bryman, 2008; Cohen et al., 2011; Diener & Crandall, 1978).

Ethical approval for this study was obtained from the University of Auckland Human Participants Ethics Committee on March 9, 2017, Reference No. 018618. A number of ethical issues arose during this study, such as ensuring informed consent was obtained, maintaining confidentiality of participants and mitigating power relationships. These issues and how they were dealt with will now be discussed.

3.9.1 Informed consent

It is important to gain participants' freely given consent before beginning data collection. To inform participants of their commitment to this project, information sheets that provided all the details about the research process and what participants needed to do as part of this project were handed out (see Appendix G for Ministry of Education official's information sheet). Participants were given the chance to read these information sheets and to ask questions before signing a consent form (See Appendix H for teacher's focus group discussion consent form). To help participants understand their commitment, all information sheets and consent forms were translated from English into Tetum.

3.9.2 Confidentiality

It is important that participants' rights to privacy are maintained and readers of a study cannot identify participants. To protect all research participants' identities, they were asked to provide a pseudonym for the researcher to use when reporting the research findings. As some of them provided a very long pseudonym, three letters from their pseudonyms were used as their code.

Focus group interviews involve issues about confidentiality. To protect teacher participants' identities and contributions to these interviews, teachers were asked to keep what was said by whom confidential to only the members of the focus group interview.

Additionally, the researcher took steps to disguise the research settings. Instead of referring to teachers' schools, only the school's municipality was mentioned.

3.9.3 Power relationships

When undertaking research, the researcher is in a position of power over participants and it is important that steps are taken to minimise power relationships so that participants can consent to participate voluntarily.

As the researcher had a role as a national science trainer and was a senior science tutor in the only national university in the country, having her ask participants directly to take part could be seen as a demand from a powerful person. Participants might feel coerced to take part and express their ideas. Consequently, the researcher did not

approach the educationalists or any teacher participants directly to invite them to take part. Instead these participants were recruited through a third party.

Recruitment began with the researcher approaching the Director-General of Education for a letter of introduction and support (see Appendix I). This official was asked to identify potential Ministry of Education officials to interview. Once the researcher had the letter and names of potential participants, she then approached these officials directly. A direct approach was made in this instance because these officials were in a position of power above that of the researcher.

Site access to the teacher training institutes was gained through the Director of UNESCO. This director then approached the educationalists on behalf of the researcher, distributing the information sheets and consent forms to them. The Dean of the Faculty of Education was approached to grant site access and he then recruited the student teachers, distributing the information sheets and consent forms to these participants. Teachers were recruited by the Dili, Likisa and Baukau Municipality education directors. Each director called a meeting of teachers and explained the project to them and distributed the information sheets and consent forms. To further mitigate coercion, the Director-General of Education, Director of UNESCO, and Dean of the Faculty of Education were asked to give an assurance that any participant's decision to participate in this research, or not, would have no effect on their employment status or relationship with their institution/school (see Appendix J).

To further mitigate power relationships, all participants were informed about their right to withdraw their participation and/or data. Those participants taking part in individual interviews were informed that they could refuse to answer any question during the interview or have the audio-recorder stopped at any time. They were also able to withdraw their data up to 3 weeks following their interview with the researcher. Because of the nature of a focus group interview, these teachers were told that while they could refuse to answer any questions during the interview or leave the room, they were not able to withdraw their contributions to the interview.

In these ways, the ethical issues that arose during this project were managed.

3.10. Chapter Summary

This chapter has outlined the mode of inquiry used in this study and described how the study adopted a qualitative methodology within the interpretive paradigm to explore the research problem. A purposive sampling technique used to select participants was described and the participants were introduced.

Through various methods of data collection, such as focus group interviews, individual interviews and documentary analysis, the researcher explored participants' perceptions about and experiences with the new *3rd Cycle Science Education Curriculum*. Thematic analysis was used to analyse the data set. The six phases of Braun and Clarke's (2006) method were employed in a deductive and inductive manner. How trustworthiness issues were addressed was discussed and ethical considerations related to this study were also presented.

The next chapter presents the research findings related to the Ministry of Education officials' and educationalists' perceptions about their interpretation of the vision of the *3rd Cycle Science Education Curriculum.*

CHAPTER 4

THE INTERPRETATION OF CURRICULUM INTENTIONS

4.1 Introduction

An important component of this research is to find out the views of Ministry of Education officials (Ministry officials) and those who are responsible for the implementation of the new curriculum: the educationalists. The following research question guided the interpretation of the data:

> How has the vision of an integrated science curriculum been interpreted by Ministry of Education officials and educationalists involved in this curriculum reformation?

It is proposed that the viewpoints of these different groups will be seen from the specific discourses and statements that are presented in this chapter.

This chapter comprises six sections. Section 4.2 describes Ministry officials' perception and interpretation of the new curriculum vision. Section 4.3 will portray the Ministry officials' interpretation of the new curriculum model. Section 4.4 will explore the problems of having the vision of the new curriculum being driven from outside of the country. Section 4.5 reports that Ministry officials believe that teachers have access to the curriculum documents. Section 4.6 reports on the Ministry officials' perception that teachers have a shared view of the curriculum document. Section 4.7 describes the role and influence of curriculum support by MISES (pseudonym) Section 4.8 summarises the main findings of this chapter.

4.2 Interpreting the Vision of the New Curriculum

The country's educational leaders are conscious that Timor-Leste society, particularly the new generation, needs to acknowledge and cope with the recent world trends in education and their implication for social life. Therefore, school education is an appropriate arena for students to be influenced and equipped with ideas and awareness of the vision that the country hopes them to have. The country's educational organic law[5] states that the *"*Ministry of Education is the central body of the government

[5] An online dictionary defines organic law as "the body of laws that are fundamental to defining and creating a government and its legal system, whether written (such as a constitution) or unwritten". The

responsible for the design, execution, coordination, and evaluation of the policies defined and approved by the Council of Ministries for the areas of education, science, technology and culture*"* (MoE, 2010, p. 2). This statement indicates that the Ministry of Education holds the essential responsibility to take the broad political vision for education and will identify how to achieve this through education reform and effective implementation.

The articulation of the vision into science classroom curricula and activities for schools is that the natural physical science (NPS) discipline will articulate all factors contributing to the development of what the curriculum document has claimed as transversal competencies such as: team working, practising communication skills and cooperative work with others, respecting other's ideas, overcoming conflicts and solving problems (MoE, 2010a).

This will mean that at a classroom level, teachers will foster active learning, encourage students to talk and become independent learners, and support an interactive approach which will provide educational outcomes that synchronise with 21st century education that involves thinking scientifically and developing their interpersonal skills.

Primarily, as stated in the curriculum, the Timor-Leste government through the Minister of Education has set out three main aims. One was to prepare the young generation for modern life. Second, it hoped to integrate science subjects with other life education aspects such as: interpersonal skills, creative thinking, and being scientifically literate. Finally, it asserted that by allowing young learners to develop skills of "thinking scientifically" it would give them the skills necessary to enter the job market, and able to contribute to the society and country (MoE, 2010a, p. 5.). Also, the subject syllabus claims student-centred learning as one of its organising principles. To augment this view of learning, the syllabus espouses the virtues of cooperative learning, practical work and fieldwork (MoE, 2010b).

Yet, in field implementation, this reformation agenda is not always realised as intended. In one Ministry official's point of view, an intention for 3rd cycle students

Timor-Leste educational organic law follows this process when establishing educational laws and relevant regulations.

studying NPS was to gain the prerequisite content knowledge for the next level of education. This Ministry official sees that content knowledge is essential for students to legitimatise their staying in school and moving to the subsequent level. Therefore, for basic education, this official hopes that teachers and schools will provide the general knowledge of the subject content that students need. As one of them stated:

> *So, the objective of the third cycle is for the students to dominate/master NPS so that when they study science or [natural sciences], they already have basic knowledge about these.* (ASP, II, p. 4)

From this statement, we note that this Ministry official's view of science education was academically driven and limited to being content focused. This official believes that learners will need to gain basic knowledge of physics, biology, chemistry, and geology, which is written in each level of the 3rd cycle education. When this interpretation is compared with the intent of the curriculum as described earlier, it can be seen that there is a significant gap of understanding from what was intended and how it has been interpreted.

In fact, the new curriculum was intended to be implemented through an integrated learning approach that emphasised and hoped that learners would gain skills that the current world demands such as having interconnecting skills and scientific knowledge. However, these officials see the purpose of the NPS curriculum narrowly – that is, to gain the relevant basic knowledge needed for further education at a higher level. The educational official further emphasised this interpretation as follows:

> *Doing elementary school in order to continue their study. For example, when you are doing CFN is a general science, basic, for example, if you like math or physics more, and then you can study this content later when you go to secondary school*. (FM, II, p. 14)

This quote indicates that this senior official seems not to have clear understanding of the vision of the new curriculum. While the new curriculum intended to direct students to gain skills that are required for the new era, this official (FM) sees learning science solely as a way to equip students with basic content knowledge that allows them to enrol for the following level. If one took this view of just learning content, it would mean that it would be hard for learners to achieve new curriculum intentions from a milieu that merely trains students to master a single piece of knowledge without looking at the wider applications of science which prepares students to be democratic

citizens or to develop what the curriculum terms *transversal competencies* (see MoE, 2010a, p. 5).

In short, this curriculum vision states that learning is to enable students to gain values and skills that enable them to adjust to the new era vision. However, with a content-driven view, teachers are encouraged to provide a prescribed content and students are driven to master this for academic purposes. By focusing merely on the content-driven material, other skills that the curriculum will supposedly provide and incorporate with other areas of study are possibly neglected.

Moreover, this senior official believes that the new curriculum will provide the content that will qualify Timorese students to continue their education abroad. This official believes that by learning and coping with similar content to that learned by students from other countries, Timorese students will embrace a competitive spirit towards progress like that of other countries.

> *It is for everybody to compete at national and international level, so we cannot make a different curriculum for Timor, which has limited concept, little understanding, its knowledge is little. If we do this way, then when can we involve in competition. If you want to go to study in other country, after secondary school or university, if you have not understood concept of logarithm, integral, derivative, how can we go to other countries.* (FM, II, p. 14)

This senior official emphasised that students who enrol in 3rd cycle education should be prepared and given science content at a level equal to students internationally. In another words, the science content should enable the learner to compete domestically or internationally.

4.3 The Interpretation of the New Curriculum Model

Besides being unsure of the real intentions of the new curriculum, the Timorese Ministry officials are uncertain of the appropriate teaching approach needed for this given curriculum model. A spiral model approach is proposed for this curriculum (MoE, 2010b, p. 31).

The 2010 curriculum document claimed that spiral curriculum is where the learners are guided to revisit the same topic several times with the depth and abstraction or

complexity of the topic is increased each time (MoE, 2010b). This means that students at certain levels of education will deal with the same topic throughout their study programme. With this model, students are encouraged to revisit a similar topic/theme at different levels of education by increasing the level of difficulty of the concept or topic that is being studied. The difference between this new model of curriculum and a traditional curriculum is with a traditional curriculum each topic stands on its own with its own assessment (Harden, 1999). This means that, at each meeting, learning is limited to a single area of knowledge without thinking about the continual linkage of the concept to other areas. In the new curriculum, the basic concepts learned are expected to be developed continuously, even though the learning themes are different. For example, in an NPS subject, there are various themes that are related to the four areas of physics, chemistry, biology and earth science, but, during the learning process, the concept will continue to be developed from another context that had been previously learned.

For example, the concept of energy could be assessed through different science areas. In physics, the concept of energy is the quantitative property that is transferred to an object in order to perform work, or to heat the object. In chemistry, energy could be discussed when it changes or converts from one form to another. For example, if we connected a battery to a bulb, it could produce a light. In biology, an energy concept could be discussed within the process of photosynthesis where light energy is captured and converted into carbohydrates. In earth science, energy could be discussed when talking about earthquakes – that is, the energy in seismic waves that causes the ground to shake.

So, with the new spiral curriculum model, learning is based on a core idea or key feature that one hopes the learner will develop throughout their studies. The new spiral curriculum model hopes to develop knowledge, skills, ability and competencies of education simultaneously with learning science. It is relevant to note that the new curriculum development was grounded on a constructivist learning belief, which believes that children learn better when the new knowledge and skills are built upon previous learning experiences (Skamp & Preston, 2015).

However, because the new curriculum is new to the country in its field implementation, the country's educationalists and Ministry officials translate and

interpret it in different ways. This view can be seen with the suggested themes that can be facilitated in science classrooms. This modern view of the curriculum delivery could be seen in ASP's comment urging teachers to teach science in an integrated spiral way:

> *I want to clarify that this curriculum system is a spiral system. We might repeat the contents, but the level or complexity is not the same. For example, biology, in 7th grade, the students only know the organs of the body, then when the students are in 8th grade, they study about the system of the organs, and when they are in the 9th grade, they study about the function of these systems. The general topic is similar, but in details, they are different. This is how a spiral system is. It is what we are adapting.* (ASP, II, p. 5)

This comment reflects that this official is conscious that in a spiral curriculum, the learning theme is same in each school year but the learning concept gets deeper and more complex as the students move to higher levels.

However, when elaborating on the way it is taught, ASP introduced another view when he insists that all of the content must be taught completely. He believes that if some content is skipped, then this would matter, as students would be missing the previous content. This interpretation was apparent when this official raised his concerns over the consequences of teachers ignoring some of the content in their teaching when they found it difficult to teach.

> *If the teachers just skip teaching some of the contents because they do not understand it, it is an issue that the students would not achieve the goal that was set in the curricular plan. Because they did not learn it completely. The students will be the ones to suffer the consequences. Our goals and objectives should be implemented as set. . . because it is already the law, and the hierarchy of the system is already structured. If we just skip one, the knowledge will not complete.* (ASP, II, p. 3)

The statement of ASP signals that he still holds to an old pattern of curriculum, which is a content-driven approach. This approach urges teachers to provide all the content sequentially and directs students to master that content while they reach the predetermined learning goals that have been set in school textbooks. He was not aware that by changing the curriculum model, the teaching approach automatically changes

too. With a content-driven approach, at each meeting students are directed to focus and memorise certain content that had been agreed upon.

With thematic teaching approach, learning is directed to help students reach an understanding of the big picture of a learning theme rather than presenting the details of the learning content as the old curriculum did. In fact, content presented on a thematic basis will mean that it does not matter if some content is missed because with a thematic approach the topic will be dealt with again in the following year. This vision is echoed in programme curriculum document 2010:

> Enumeration of the topics about a certain problematic theme does not mean that they should be approached sequentially in the same school year... This enumeration of topics is intended to support and as a reference to a spiral curricular approach, with ample flexibility by schools and teachers. This says that, each of the problematic issues will be addressed in more than a year, with a level of depth and greater abstraction. (translated from MoE, 2010a, pp. 10–11)

The above quote from the curriculum document outlines the way the curriculum is supposed to be implemented and provides some direction or reference for educators to follow. However, the lack of curriculum documentation and understanding of the distinction between the old curriculum and the recent new curriculum has led to a constant vagueness of understanding by educationalists during this implementation.

In fact, this curriculum statement highlights that a given theme does not have to be taught sequentially. In other words, science teachers are required to be flexible in presenting and facilitating the learning content. If students are found to have a lack of understanding of some concepts they can come back to the same concept and learn more about it at the next level. It is proposed that teaching within a spiral model will provide a chance for teachers to reflect upon their teaching strategies. For example, in the case of a teaching strategy that did not help students to learn or when a teacher has omitted content because that content was out of their study area and they found themselves unprepared to teach, students and teachers can revisit the topic concerned in subsequent years. Hence, skipping a concept in any given year should not become a big concern when learning other topics, because each big idea and related concept will be revisited throughout their enrolment in the 3rd cycle of the education.

At present it appears that the implementation of the new curriculum has not fulfilled its expectations because the vision, aims and spiral model approach have not been understood by the country's educationalists and officials. This view will be supported and discussed in the next three data chapters.

The researcher proposes that this lack of understanding by educationalists is because this vision has been copied and borrowed from outside of the country.

4.4 The Recognition that the Vision of the Curriculum Was Driven from Outside of the Country

The evidence that the new curriculum vision has been borrowed from other places is reflected in the recognition of the involvement of foreigners in leading and designing the new curriculum and its implementation, for example:

> *Begin from 1st to 3rd cycle we have cooperation between the Ministry of Education and University of Minho [UMINHO], Portugal, to elaborate our national curriculum. At the time, they develop the curriculum program, it was not done by UMINHO alone but been cooperated with MoE through the division of national curriculum and school action.* (FM, II, p. 4)

The statement indicates that the country's curriculum was created and developed by Portuguese professors, particularly from the University of Minho. FM recognised that during the development process, a few Timorese (members of the division of national curriculum and school action) had been involved and the content of the subject was identified, elaborated and determined by outsiders.

> *After developing the program with the Timorese then we invited an agency that produces books, Porto Editora, those who design book for schools in Portugal. So, the MoE did a contract with this agency to elaborate our content. We bought and distributed [to schools].* (FM, II, p. 4)

The evidence that the new curriculum vision and content have been framed and developed by outsiders was also emphasised by another Ministry official.

> *The people who elaborated it are foreigners, they did involve some teachers but not many, and at the end, they produce the context that is more relevant to other countries.* (ASP, II, p. 4)

This statement highlights that the curriculum vision and content was substantively elaborated and developed in Portugal rather than the country that bought it for schools to use and students to learn.

This happened because the country's educational leaders wanted Timorese students to be at the same educational level as other countries. They hoped that Timorese students would be coping with subject content or knowledge such as other countries have. They wanted students to be engaging with an ability and capacity that the world demands. As one of the policy makers claimed:

> *The ability that we expect is: the children can compete with others and science is for everyone is the same. So that students can compete at national and international level. Therefore, we could not say, we are Timorese, we cannot, we are hindering with this then when will we do this? Because Timor does not stand alone, but Timor live with others. Hence, the ability and capacity that we gain should be the same. So that student could compete with others.* (FM, II, p. 3)

The educational official's statement embodies a very general view of an educational output for the country. He perceived that there is some ability and knowledge that he hoped students would gain which would eventually enable them to compete with students in other countries, but he did not explain the real form of these abilities. However, he did emphasise that an ability that would engage them was have a competitive spirit. This means that these educational officials were conscious of what Timorese students would be like, but they do not know about the pathway to reach their dreams. Hence, it appears that they were pleased to let outsiders write the vision of the education for the country without understanding the process that should be taken to achieve this educational provision. As a consequence of using imported vision, the interpretation of its implementation did not synchronise with what the new curriculum intended.

4.5. Ministry Officials Believe that Teachers Have Access to Curriculum Documents

It was apparent in the interview that the Ministry officials did not recognise that teachers still do not have access to all the new curriculum documents. Because these

officials recognised that the curriculum document was vital for teachers, once the reformation law was approved, they believed that the Ministry of Education had distributed all documents that came with it.

> *Any document that we create for teachers and the students is obviously important. It is clear that MoE produces the curriculum document for its use in the field, who uses it? The teachers and the students. MoE hands it to them. MoE does not keep it.… MoE facilitates to hand it out, in order for teachers to transfer their knowledge to the students… MoE has obligation to provide.* (FM, II, p. 6)

This Ministry official stated that all documents that the Timor-Leste Ministry of Education produced are for schools' use. Hence, since the idea of reformation was issued, they had distributed it to facilitate teachers teaching and students learning. They were not aware that many teachers had not received these physical documents and had not seen the 3rd cycle science syllabus that the Ministry body has distributed.

Instead, these Ministry officials believed that once the MoE released the curriculum documents such as *the students' manual, teachers guide, and programme,* that were packed with the new reformation agenda, and would automatically reach teachers at school. Further to that, he claimed *we give it to them for teaching. How can they teach if they do not have one?* This comment shows that this Ministry official thinks that curriculum documents include all documents that are referenced by all of the country's educational stakeholders such as the policy makers' body, the teacher trainers, teachers and students. He wonders why the information in the documents has been missed by teachers. In his view, if some of the teachers do not have these documents, then he questioned how they perform their responsibilities without them.

He did not acknowledge that some teachers have only taught students using students' textbooks for information and some schools do not even have any resources (see Section 5.5). Consequently, the Ministry officials do not recognise that most of teachers have not physically touched the curriculum document, particularly the subject programme or school syllabus, where teachers can find out about the teaching objectives and information about the new curriculum model.

4.6 Ministry Officials and MISES Believe that They Have Shared the Curriculum Model with Teachers

As mentioned, the new curriculum reformation is a radical change, from a single science area taught by a specialised teacher to the need for a well-rounded teacher who can teach all the sciences in an integrated way. However, up until now, none of the teachers have understood why the new curriculum had been structured differently.

From a MISES point of view, this kind of information had been shared before they delivered the content of the subject during the national training. As one of them explained:

> *In first day of our training, we always remind them that primarily you should understand the type of the curriculum… the model of the curriculum is spiral, this means the content that learned in Grade 7, for instance, solar system, in Grade 8, it still exists, but the deepest of the content is different.* (VIO, II, p. 7)

This educationalist working for MISES affirmed that ahead of delivering the training materials, they had informed teachers about background information that related to the new curriculum model through a PowerPoint presentation. Their presentation included the themes covered in each grade and the reason why the topics were being repeated. At the end of this curriculum model presentation and discussion, they then concluded the reason for the similarity of topics that reoccurred was because of this curriculum model that the Ministry of Education had adopted for the use of the country's education system.

The same issues of lack of understanding were voiced by a Ministry official when I questioned him about why teachers were confused about the model of new curriculum. One of these Ministry officials claimed that he did tell teachers through a dissemination period, as he expressed:

> *I know this on my own because when the law is approved, I was the one who did the dissemination, I talk regularly with them. The one that deals directly with the teachers is INFORDEPE. I sometimes deal with them through the school director. Our level is not the same in the process. They are the one who knows, but the materials of the training include information like these. It should not be questioned anymore because it is common information.* (ASP, II, p. 4)

The Ministry official stated that teachers no longer need to question the model of the new curriculum because such information had been informed frequently by both the INFORDEPE in-service training institution and by himself. This Ministry official assumed that once they shared or told curriculum information, teachers would understand this concept of curriculum design and would use these ideas when teaching their students. They did not understand how long it would be for teachers to change their mind-set, from being a very specialised teacher teaching content to becoming a teacher who could tune in to a spiral integrated curriculum model mind-set.

These Ministry officials did not understand that to change a teacher's mind-set takes time and effort. The Ministry officials expected teachers to keep up with curriculum changes. They recognised that for elementary level, the learning content and concepts were easy, hence once there was available training, teachers should be able to learn then implement them in their teaching activities.

One of the Ministry officials affirmed this view when I informed him that most teachers found it hard to implement the new curriculum, particularly to teach areas that were out of their expertise, and some of them even omitted challenging content. He disagreed that teachers would have a problem teaching content out of their area:

> *Therefore, I said, no, to teachers when they talk about it. Because, it is a general concept, not specialised yet in each area. So, you teachers can teach biology, but physics that exists there is not a specific concept. Therefore, the teachers can learn that then INFORDEPE institution itself will provide training such discipline. Even if you are specialised in chemistry you have an obligation to participate the training in order to teach science to the students*. (FM, II, p. 11)

The policy makers believed that teaching elementary school is an easy job, hence they hoped teachers would welcome the idea of the new curriculum reformation, learn the areas that were out of their specialisation and then teach them to their students. For instance, teachers who had a biology background would be able to teach other areas that were beyond their specialisation. In this circumstance, this Ministry official did not understand how difficult it is for teachers to understand new areas beyond their specialisation. So, the Ministry officials kept calling for teachers to become generalist teachers once the new curriculum was released. More than that, the national

curriculum emphasised that it is part of teachers' profession to be in tune with every policy change. As he voiced:

> *To be honest that the elementary education's teachers, we do not need to find any reason, because we always have a reason in Timor. Sometimes, we also forget our professional ethics, sometimes we forget, that we have a responsibility as a technical person. Our problem is that if we are aware, as elementary school teachers then we do not need to teach chemistry separately, physics separately. We have thought afar. This is my thought, who teaches elementary school, we talked earlier about training to benefit from.* (FM, II, p. 8)

The statement implies that this Ministry official urged teachers to continue attending and learning relevant knowledge that was provided by INFORDEPE. In his view, once teachers were part of the teaching profession, they were responsible to find ways to enhance their capacity in order to teach. Teachers also needed to be aware that they were basic education teachers and the curriculum was integrated, so they would have to do all the tasks expected by the Ministry of Education. This Ministry official believed that the content was basic and general, therefore there was no reason for teachers to omit curriculum content. He believed that teachers who found themselves lacking in the specialised areas of knowledge such as physics, biology, chemistry, and earth sciences should take every opportunity to expand their knowledge horizons in order to teach these areas.

4.7 Curriculum Implementation Support by MISES Organisation

Another influence that has to be considered in exploring the intention of the new curriculum is the in-service teacher's institution, MISES. MISES was developed to assist MoE in implementing the new science curriculum. This cooperation was possible as the Timor-Leste Ministry of Education has the flexibility to collaborate with any independent institution or organisation that is capable of enhancing the quality of education in the country. This is echoed in the statement below:

> The education system is developed through various structures and actions, by initiative and under the responsibility of different public, private and cooperative agencies and bodies, cooperating among themselves to maintain a balanced and updated network of educational offers, able to provide the

> necessary knowledge, skills, and values for full individual and professional realisation in today's society (RDTL, 2008, p. 1)

Because the curriculum was brought from outside, each educational supporter, such as MISES, had the freedom to interpret the intentions of the new curriculum based on their previous experience. The initial initiative to analyse and interpret the new curriculum was geared from an integrated model approach. However, the organisation found that most teachers found it difficult to plan and teach within the given themes. Hence, the MISES members grouped themselves based on their specialisations to study the latest curriculum to identify certain content that teachers missed in their formal education. As one of the members stated:

> *We did not do a comparison with the earlier curriculum, the old one, but we just based on the actual curriculum, which was realised in 2010. We examine from there; we grouped based on our discipline, for instance, physics in one group, math separate, chemistry separate, we conclude that based on our view, when we read, we analyse, hard to be understood, it takes time to be understood. So, we meet, we consider that for those that difficult and a bit high, better we do not elaborate it and give to teachers to teach it.* (VIO, II, p. 2)

This statement reflects that the MISES representative and his team had analysed the new curriculum based solely on knowledge since they found that there was a mismatch between the available teachers and the demands of the new curriculum (that is, for well-rounded teachers able to teach all science subjects with an integrated approach). They attempted to sort this out by making plans to deliver the missing content for teachers at schools. The content of the training delivered by MISES was based on the MISES trainers' understanding. This means that they assisted teachers' learning based on information that they felt was understandable for them. If they found that the content in the textbook or reference materials was too complex or complicated for them to understand, they did not recommend that teachers used this material to teach their students. For example, in the students' textbook there is activity about antiquity astronomy, where students Grades 7 are asked to learn about the magic and mythology (Costa, Rodrigues, & Dias, n.d., p. 9). However, the national science trainer recommended schoolteachers not teach this material to students. The suggestion was made because they considered that the content was alien to both the trainer and the teachers.

Another area of misunderstanding for the MISES trainers was their view of integration. It appeared that the country's educational stakeholders (educational officials and those organisations that supported the new curriculum implementation) found the essence of the new curriculum ambiguous. Moreover, they also had only a vague understanding of some important terms in the new curriculum, such as the concept of integration. According to Lake (1994) "the movement towards integrated curriculum is a move away from memorisation and recitation of isolated facts and figures to more meaningful concepts and the connections between concepts" (p.194). In the new *3rd Cycle Science Education Curriculum* document integration means: an amalgamation of four knowledge; physics, biology, chemistry and geology or earth science (MoE, 2010a). Through this new concept of science as a subject, teachers are invited to dismantle the traditional teaching models, where subjects are formerly taught separately with their own goals. Now, in the new curriculum, knowledge needs to be contextualised and integrated. However, it was noted that, in the field implementation, MISES members still provided training as single-area teachers, where each of them delivered training based on their specialisation area. As one of them claimed:

> *In subjects such as chemistry, biology, physics, we all there, we sought how to understand the whole to experiment, even in biology, chemistry or physics. But we do not want, usually, in practicum, discussion took a long time, because there are some that we also do not understand, so, we want, people who graduate from biology subject. S/he should teach biology, while we others provide assistance there. We aim to go there to help the teacher understand better, not to cause them getting more confused.* (VIO, II, p. 5)

The statement indicates that switching a personal teaching approach, from being a single-area tutor to becoming an integrated teacher as the new curriculum calls for was, in fact, challenging for a country where a fragmented teaching approach was firmly established. In training sessions, the MISES organisation members still assisted teachers to learn science based on the members' educational background that was focused on content knowledge.

However, it must be recognised that the MISES effort to assist teachers has made a significant contribution to learning science in Timor-Leste. But with all this effort there is still missing the essential intention that the new curriculum expected – that is

to equip youngsters with up-to-date skills through an integrated teaching approach. In short, the MISES assistance with curriculum implementation was limited to helping teachers cope with the content that teachers were missing and facilitating practical work in science classrooms but not the essential aims that the new curriculum intended.

This unclear understanding by MISES of the essential concepts of the new curriculum meant that they were uncertain of the new vision as they helped teachers. Consequently, there was a contradiction between belief and actual action in training sessions. For example, on one hand they saw integrated learning as a form of connection between several areas and aspects, but on the other hand, they did not model this integration vision when delivering the training. This lack of understanding is very much reflected in the statement below:

> *First, we would like to say, to implement the integration does not mean bad… if the science is integrated then when we talk about any activities, for instance, when we talk about physics topic should always relate to chemistry or always relate to biology, integration is something good, because if teacher idea was integrated… science does not only this, but it always link to other things*. (VIO, II, p. 3)

Among the MISES trainers, integration was understood as the interconnection between one science area and another. But, realising the idea of integration and mastering it to provide content was still the main challenge that teachers needed to meet. As one of them expressed:

> *So, in training, we always tell that if you only did physics in your education, in this training you can also learn biology, you can also learn chemistry, you can also learn geology, differently. Not just take only one, but a manner that you assemble by yourself, touch by yourself, so that you can also understand better, even slowly but little in a while, you can understand all of these four pieces of knowledge.* (*VIO, II, p. 3*)

While familiarising science teachers with the science context and activities, MISES also encouraged teachers to see that integration would be possible if teachers were eager to learn content other than their specialisation area. This is very much reflected in the way MISES planned and facilitated the training. However, in the training

sessions, each of trainers took a turn to deliver the training based on their expertise or study background. While training was worthwhile for teachers and students, it generated a negative impression among the teacher participants. They could see that the national trainers did not model the qualities of a good integrated teacher. That is a teacher who was well rounded in knowledge so as to be able to cover four content areas that are combined in the NPS subject. Instead, the MISES in-service teacher trainers were focused on improving teachers' knowledge rather than giving them the pedagogy to integrate and teach concepts with themes in order to show how the spiral model of re-teaching concepts again and again can be implemented.

4.8. Chapter Summary

The policy makers recognised that the new curriculum was designed and framed by Portuguese scholars then brought into the country for Timorese learning. However, they did not recognise that it challenged teachers and students to cope with and understand the structure of the curriculum.

The policy makers perceived that the new curriculum was aimed to equip students with the prerequisite content which could qualify students to continue their education in the following level, either in the country or when they went abroad. This limited view of the curriculum delivering content meant that the primary goal of the curriculum, to teach science with an integrated approach in order to develop citizens who were scientifically literate, was made difficult.

The in-service science teacher's organisation that supported the curriculum implementation (MISES) revamped and re-adjusted the new curriculum for the local context in order to ease teachers' learning and their implementation of the new curriculum. However, most of the focus was to encourage and assist teachers to provide resources and expertise for teachers to carry out hands-on activities. Their support did not help teachers to see the big picture that the curriculum developers hoped to achieve through an integrated teaching approach.

The Ministry of Education officers believed that teachers had been given information about this curriculum development; however, this belief was ill founded as most teachers had not received the curriculum material even though Ministry officials thought they had.

Even though the new curriculum was attempting to embrace the latest views of science education, which demands an integration of life skills and modern knowledge, the different interpretations of the Ministry officials on the curriculum and their emphasis on a content-driven framework meant that the idea of integration was not able to be fully realised in the Timorese education system.

However, many teacher educators and teachers continued to find their way through the issues of this implementation. Chapter 5 will report on the challenges they faced and Chapter 6 will reveal the ways in which they attempted to overcome these issues when teaching the students of Timor-Leste.

CHAPTER 5

THE CHALLENGES OF CURRICULUM IMPLEMENTATION

5.1 Introduction

As identified and discussed in Chapter 4, the problems of implementing the curriculum are the result of the different visions of the policy makers, the external curriculum developers, educationalists and the trainers of teachers who are faced with this new view of curriculum and curriculum implementation. These circumstances challenged teachers when they were faced with implementing the new curriculum requirements.

This chapter will focus on teachers' responses when answering the research question:

> What are the challenges for teachers as they enact the new 3rd cycle science curriculum implementation?

This chapter will describe and explain teachers' perceptions of the factors that challenged them when implementing the recent curriculum. Findings from the study show that there were six main constraining factors. Section 5.2 explores the differences in curriculum vision and structure or context which contextualise the teachers' challenges in shifting their teaching style from the old curriculum focus to the new curriculum. Section 5.3 describes the teachers' professional learning and development, and presents the process of passing the intended curriculum from national trainer to teachers at school. Section 5.4 presents how the instructional language was also a problematic factor for teachers when conveying scientific knowledge. Section 5.5 depicts how teachers have been challenged to implement the ideas due to the lack of educational resources. Section 5.6 presents teachers' views of the alleged inappropriate contexts in textbooks which they found challenging to deliver in Timorese situations. Section 5.7 then presents the reasons for the national testing system where the Ministry of Education officials have a separate agenda than teachers. The chapter ends with a summary (Section 5.8).

Themes within the analysis were derived from participants' responses to four questions:

(1) What is the content of curriculum document?

(2) How has the curriculum message been delivered to the educators?

(3) What do teachers perceive as challenges in implementing the new curriculum?

(4) How are the teaching materials relevant to local context?

5.2 Difference in Curriculum Vision, Structure and Context: From Content to Thematic Problems

Differences between the old and new curriculum have been a source of struggle and challenge for teachers in Timor-Leste who have trained under the old curriculum. In order to have a better understanding of their struggles, the background and differences between these two curricula will be discussed in this section. This explanation is to provide a background for the succeeding discussions on the challenges of curriculum implementation. It begins with a discussion of the old and new curricula. The old curriculum was knowledge based while the recent curriculum is more focused on thematic issues. In the new curriculum, the vision, structure, and the content are arranged differently. These differences have been amplified by the oversight of the national and the municipal trainers[6] when introducing the curriculum message to the teachers (see Chapter 4). As a consequence, it has caused problems with the views of teachers on how science should be taught in the classroom.

The Timorese teachers, as curriculum users, have found the new curriculum is a challenge to follow up at school because there are new subject titles and the content is arranged following thematic areas rather than merely providing content for students to learn – as it was in the old curriculum. These new subject titles require a different teaching pedagogy. This includes having comprehensive skills, such as understanding the theory of curriculum, and the requisite pedagogy to deliver the intended message. Lack of these vital competencies can lead to different views and ways of implementation. This discussion can be further understood in the context of the philosophical changes that are embodied in the new curriculum.

There are three major principles of learning that govern the new curriculum (translated from MoE, 2010a 2010b) these are: (1) cultural relevance and relevance to the

[6] The group of municipal trainers only existed in the period when the curriculum was introduced to the country. They were selected from science teachers who taught Grades 7 to 9. As the country had 13 districts at that time, the educational officials selected one teacher to represent each district to receive the training from Portuguese and Brazilian teachers.

students' real lives (2) promoting integrated human development by linking to students' previous learning in science and learning the other subjects, and (3) the need for student-centred learning.

The goal of scientific literacy, which is one of the foci of the new curriculum, emphasises the acquisition of four essential values. These are awareness of science and technology; appreciation of other knowledge; the value of ethics, and value of complex critical thinking. All these values are considered to be closely related to the competencies that Timor-Leste identifies in the curriculum (MoE, 2010b). It is hoped that these values will be gained through dynamic teaching and learning which embodies skills and competencies such as reading and writing skills, interpretation, critical thinking, planning, researching, and reasoning. (MoE, 2010a, p. 5).

Overall, this approach envisions that students will be able to apply scientific knowledge to interpret and solve the problems in their world and can, therefore, provide professional solutions to issues and problems. When this goal is applied to the way in which science content is presented in the curriculum it signals that science subjects are integrated and given a context that will be relevant for Timor-Leste students. These goals and values are distinct from the previous curriculum which relied on a positivistic philosophy about learning (Ninnes, 2013). This view of learning occurred where students were directed to memorise facts, ideas and expert theories through a procedural knowledge approach (Fosnot & Perry, 1996). Hence, teaching and learning were organised to be presented in a sequential manner and students were directed to achieve predetermined educational outcomes. The difference between the aims of the previous and the recent curriculum is encapsulated through the way the content of the subjects has been structured. For example, the physics content for the old Grade 1 junior high students, which was used from 2001 to 2009, and the NPS for basic education Grade 7 in the new system, 2010, are compared in Table 5.1. As well as the evidence provided by the participants in their narratives, these differences are identified from the data that was generated from my review of pre-secondary educational documents. This information was retrieved from the Ministry of Education document which was previously called Ministry of Education Youth and Sport (2003) curriculum as referenced in Table 5.1.

Table 5.1

The Difference Between Physics Subject Content in the Old Curriculum (Minister of Education, Youth and Sport, 2003) and the Thematic Problem Block in the New Curriculum (MoE, 2010b, p. 9).

Previous curriculum content of physics (Old Curriculum,2003)	**Recent curriculum thematic problem block (New Curriculum, 2010b)**
1. Measurement	A. Materials and energy in the Earth and society
2. Substance and form	B. Movement and forces in natural and technological systems
3. Solar system	C. Formation and evolution of the universe and the solar system
4. Straight motion	D. Earth dynamics and geo-conservation
5. Force	E. Life on Earth, ecological dynamics and the protection of diversity
6. Work and energy	F. The human body and health promotion
7. Pressure	G. Sustainability and evolution in Timorese society
8. Vibrations and waves	
9. Sound	

As can be seen in Table 5.1, the content for the subject physics in the previous curriculum was presented as building blocks for learning but not linked to or set in a context. This structure was intended to help students to make connections from one concept to the next easily. Students in different grades would be taught different topics, but still needed to understand the basic procedures and concepts required to be able to apply them to the new topic.

This organisation is contrary to the new curriculum, where the content has combined four areas: physics, chemistry, biology, and geology. The content is structured on a thematic problem block (as shown in Table 5.1) and students are taught this thematic block during their enrolment in the 3rd cycle. This curriculum structure means that teachers have more flexibility in presenting the content. This means that the given content does not need to be presented in a sequential way, instead teachers and schools have flexibility in how they present the content. (MoE, 2010a). The most glaring difference between the new curriculum and the old one is that the new curriculum is themed and therefore has the potential to be contextualised. It is hoped that contextualisation will gain students' interest.

However not all teachers agree with this change to the curriculum. One of the participants of the focus group interview (FGI) expressed that teaching through the old

curriculum facilitates better learning for their students. It appears that teachers at school level lacked this understanding of why the content was organised in this way. Facing these drastic changes, teachers who tried to implement the new ideas were confused and struggled, as one of the participants expressed:

> *From the teaching materials we have, it can be noted that some of the topics we teach in Year 7 also appear as subject areas in Year 8 and 9. Instead of advancing the students' learning into more complicated topics as they go to higher year levels, they seem to be going backwards. In the case of physics, teaching this before was better than now. And if we had carried on the previous curriculum, I think the children might be able to learn more quickly because we used to teach per subject.* (OBA, FGI, G8-Baukau, p. 6)

This answer implies the teacher was surprised by the way the new curriculum presented its content for students. This teacher in the focus group was questioning how it could be that as the grade level of students increased, the content of the curriculum remained the same. He said that this was something that teachers like him found confusing. He added that if they were asked to teach the students as the curriculum requires, which is presenting the content or topic in an integrated and non-sequential way, he believed that this would only confuse the teachers and the students. This meant, for him, that teaching science in a sequential manner was still preferred to doing it by the spiral model that is currently applied in Timor-Leste. He argued that this could be because the new method of presentation was not well explained to teachers in the first place when implementing the new curriculum, or that the local trainers missed out explaining the essential changes of new curriculum structure.

On the part of the local trainers, one of them said that they were conscious that the way the new curriculum presented the content had been altered into a new form. This was revealed when he was asked about the content that they received through the national curriculum training programme. He stated:

> *During the introductory sessions for the new curriculum… they said that there is no significant difference between the thematic block in Grade 7, 8 and 9. There were some differences but in subtopic or subthematic block sections. Because, they said, for instance; the Grade 7 topic will be repeated in Grade 8. The topic and thematic will be the same, but the subtopic will be quite*

*different from Grade 7. The differences are in the quality of knowledge because at Grade 8 the concept is a bit more advanced. (*INO, II, G-9, Baukau, p.7)

It was apparent that during the training, the municipality trainer had been informed that the content of the new curriculum would be arranged differently. They had also been informed that the 3rd cycle students would receive the same topic on subsequent occasions, but the content would be increased in complexity through the sub-themes. But it appears that teachers in schools did not receive this kind of information. Hence, their ambivalence towards content structure has remained. This also means that the municipal trainer did not really understand that the idea of the new curriculum has been structured differently.

When I delved further into the interview, the municipal trainer revealed that when they conveyed the message of the curriculum to the teachers, they did not forward the message as was given exactly by the country trainers – the Portuguese and the Brazilians. Instead, they concentrated on what they believed was worthwhile for teachers to share in the classroom, which was the content of the subject. I quote him below:

At that time, after the participant's gathering, we had a debate. I was asked, "At least from the content, which part is more difficult for you?" At that time, most of my friends commented that chemistry was the most challenging subject because most of us did not have a chemistry background. Therefore, it was difficult for us. Then, for the 1-week training course in Baukau, we only discussed chemistry. We did not talk about other issues. The textbook goes from Grade 7 to 9, but chemistry is emphasised in Grade 9. (INO, II, G9-Baukau, p. 8)

This statement reveals that teachers' focus was on chemistry which was found to be the most difficult content in Grade 9. This meant that the trainer had neglected an essential aspect that teachers needed to cope with, which is the vital distinction between the new curriculum and the previous curriculum. He also emphasised that although the training ran for 1 week, they were more focused on and preoccupied with the content in Grade 9 that the new curriculum required them to convey rather than dealing with the pedagogy for content presentation in the classroom. This idea is likely to have been influenced by what teachers believed about the teaching profession which

is that teachers are supposed to have knowledge in order to share it with the students. Or, in other words, being a teacher means providing knowledge for students.

This issue was not the only part that has been omitted in transmitting the curriculum message. The municipal trainer also neglected to connect with and encourage the fellow teachers to switch their mind-set from teaching the subject in depth to teaching in an integrated way. This could indicate that he did not really understand the new approach that the new curriculum required. This message unfolded when I asked about how they should teach NPS. He recalled his experience:

> *The content that needs to be given in Grade 7 tends to be about the basic idea. They said this should be the basic knowledge. This was a basic introduction. It is an introduction, where students do not need to know each topic deeply, but it can be strengthened in high school. Hence, in elementary school,… the content of the subject that they insert in the curriculum, in the guidelines, we can tell it still very general; hence, when they go to high school they can reinforce it there, or in other words, there, it can be repeated more because we skip it here. (*INO, II, G9-Baukau, p. 3)

The information recalled by the municipal trainer has the same perception that the national curriculum officer holds, that the basic school teachers are mandated to teach the subject generally, not specifically:

> *The concept of science that is taught in CFN for cycle 3, what is gained by the students at that level is not specialised concepts for each discipline, where physics stands alone, chemistry stands alone, or biology stands alone. The science that they get is a general concept. However, we should separate them into specialisations when it comes to secondary education.* (FM, II, p. 2)

This curriculum officer believed that the students are young, so, the content that needs to be taught is not necessarily complete, complex or advanced. Hence the most important thing is to brief them on the basic science ideas as these will be developed at the next education level. He also believed that teachers needed to take into account the learning objectives for the 3rd cycle students studying NPS, which are the four essential values mentioned before.

Misleading curriculum changes also caused the curriculum users to be unsure how it should be applied appropriately. These could be seen in the way they have conveyed the content theoretically. However, it was hard to put into practice the correct way that the new curriculum was to be taught.

It appears that the curriculum document outlines the way the curriculum is supposed to be implemented and provides some direction or reference for educators to follow. However, due to the lack of curriculum documentation and understanding, the distinction between the old curriculum and the recent curriculum, has led to a consistent vagueness by presenters during the implementation. This seemingly problematic approach and procedure in conveying the content of the new curriculum, from the national to the municipal trainers, are further explored in the following section.

5.3 Teacher Professional Learning and Development: Disjunction in Action

This section will describe the process of curriculum transformation from national trainers to its end users, the school teachers. The curriculum message has been channelled through a trickle-down approach. Before applying the new curriculum at the school level, the Timor-Leste Ministry of Education appointed the municipal teacher representatives to attend two weeks training from the Portuguese and Brazilian professors who had developed the curriculum. These chosen teachers received the training for 1 week, then they returned to their original areas and retrained their fellow teachers to implement the curriculum.

It appeared that there was a miscommunication between the curriculum developers, the Portuguese, the professional development carried out by the Brazilian educationalists, and the municipal teachers' training in order to transfer this understanding to school teachers. These transmitting processes meant that the original vision of this integrated science curriculum, which had scientific literacy as its ultimate goal, remained ambiguous among its end users.

It seems that teachers prefer to do what they were qualified for and are not confident about teaching outside of their area of study. Thus, if the government requires them to teach courses other than for their specialisation, they cannot guarantee the accuracy of

the concepts they convey because most of them have had to read about and learn the new content independently. They believed that this government policy would be disadvantageous for the students. One of the participants articulated this view in the following narrative:

> *To be honest, this would put students into a problem [hole] because there is some content that we do not know, so how would we teach it? Because my major is biology, I have only mastered biology. So, if the government forces us, then we will teach other subjects. It means we learn and teach them, but we might pick them up the wrong way. If we learned it wrongly, automatically, we would teach it to the students wrongly because we learn it alone, no one taught us, so there might be some mistakes. If this natural physical science is to be covered by one person, then we need more training. My suggestion is that if the government desires this, then we need one or two years more training, so we can then go back and teach the students. (*VEL, FGI, G7-Dili, p. 5*)*

This teacher signalled that he lacked the capacity and skills to teach part of the curriculum reformation agenda. He was conscious that, as a biology expert, he could not cover other knowledge that he had not mastered. He also stated that if a person delved into a subject alone, he/she might interpret it wrongly. Therefore, if the government required them to teach the NPS subject, which also covers three other areas out of his area of expertise, physics, chemistry, and geology, then he needs a break from his current job to learn the content. He can then be reassigned to his teaching job when he has accomplished this goal.

However, if the government still forces them to teach as the new curriculum and requires and insists they teach a new subject, they will still teach according to their respective majors and apply their ideas and knowledge in this way. This point was raised by one of the FGI participants from Dili district.

> *As I said before, I was surprised when I opened the book, which is why I have shared it with my [teacher] friends. I was told to teach from unit four. I said that I could not do that because unit four is about geology. We had discussions with other colleagues, and I said that I do not know geology, I only can teach from Unit 5 onwards because that is biology which I can teach. (*ULA, FGI, G8-Dili, p. 3)

This teacher participant stated that they found it difficult to change and also said that to learn a concept comprehensively it should be presented in an orderly way, from the simple to the complex. Also, there is a need to consider the level and age of students who are involved in the learning process. As one of the teachers said during a focus group discussion:

> *Then some topics are missing, for example, the digestive system is skipped, just been explained like that, with no explanation about how digestion starts, it more is like materials used for university students. For school students, they might not learn quickly, get confused and become dumber. Because of this need to explain the topic four to five times repeatedly, then they are able to ask question…therefore it is creating more confusion for the children. (ULA, FGI, G8-Dili, p.4*)

To provide some background information, this participant had started teaching 2 years before the curriculum reformation. Hence, she recognised that the way the new curriculum described its content was distinct from her teaching experience and knowledge. She presented content in a complete and detailed way. Thus, she believed that even if she explained the theme repeatedly students would still find it hard to get the meaning as she lacked an opportunity to teach the requisite concept. She also considered that primary students have less knowledge and their understanding is incomplete. Therefore, they require more assistance to guide and help them learn in a step-by-step way. This approach is not necessarily for students at the university level as they are mature and have enough responsibility to learn the given content independently. The statement reflects that this science teacher missed out understanding the new teaching approach that should have been delivered by the municipal curriculum trainer. In short, we could say that at school level the curriculum users remained confused about how to follow up the new curriculum appropriately because they were not sure of the exact intentions of the new curriculum.

The research participants also found themselves unprepared and found it hard to apply this new curriculum in their classrooms because they felt they had not mastered the other three knowledge areas in the kind of depth they learned when at college. One teacher was passionate when I asked his opinion about whether he was ready to teach

another topic, one which did not provide complete information – such as the physics content:

> *My desire is that I want to know the root of the formula. For instance, if this is a ladder, we already at the top, but what if we do not know how we reached it? So, I want to know where it comes from… As I said before if we have mastered the contents, then we know the formula of V = s/t, but what is V, what is s and how? We need to know why each unit was retrieved and put it the formula. We then know the unit for the metre 's' is derived from here. Yes, by this way we can say we mastered the contents. But if we just say, oh the total is 20 metres, it means we have not mastered the content. (*VEL, FGI, G7-Dili, p. 6*)*

The statement reflects that this teacher participant did not want to miss out a piece of information that underpinned the concept or formula. These include the root of a formula and the detailed information that was attached to it. For instance, to deliver the formula and unit of velocity, he preferred to master the details of the magnitude that had been derived. Because, according to him, not knowing those requisite stages means students have not mastered the particular content. The teacher participant's example indicates that even though the country has changed its teaching approach to learn about big issues, this teacher has not understood the new approach because he is still insisting the requisite root of the content which is essential to facilitate the teaching and learning process. This contradicts the new curriculum's teaching objective.

These findings also indicate that teachers see the new curriculum as more conceptually driven rather than focusing on integrated knowledge development in context. In particular, this difference was raised by teachers who teach physics. In fact, the given content covered the same issues but was unfamiliar due to the content description. This is portrayed in the following response:

> *The previous one [curriculum] had more counting in it. And there were also many formulae, while the one now has more definitions and has more stories. It is like only telling stories, so I try to teach from it, and if I do not know something, then I will ask those colleagues who are good at the subjects.* (OAO, FGI, G7-Baukau, p. 8)

This physics teacher expressed his view of how the subject should be delivered. This

view was influenced by the way in which many teachers were trained for teaching, as well as their experiences throughout their formal education system. For example, in the past, in the first semester, a student at Year 7 would be offered the definition of the terms, which were then followed with some examples as an introduction that was designed to lead the student to a deep understanding. In the new curriculum, in Grade 7 students textbook, the authors commenced with the description of the formation and evolution of the universe and the solar system, then the history of the universe and the ideas of philosophers who generated this theory (Costa, Rodrigues & Dias n.d.). These participants considered that the new approach to presenting science concepts was the opposite of what they were used to.

Another thing that research participants considered as challenges to implementing the new curriculum were the limitations of the training information. A participant found it difficult to deliver the new curriculum in a fluent and flowing manner since the given content was presented very briefly and generally, as depicted in Table 5.1. As one participant lamented:

> *Comparing what the students learned from the previous curriculum when we talk about physics then they understand it, oh, oh, physics is like this, they understand when talking about biology. But the students now, they do not understand what physics is and what is biology because we do not teach it as before, so sometimes teachers in secondary school will explain in detail about physics or chemistry separately. There is no base to begin from so how can the students learn better?* (NTO, FGI, Grade 7-Dili, p. 11)

This participant lamented the lack of information that they considered is vital for students to know. For example, definitions of the common terms. He clarified his response by comparing the content to the previous curriculum where the meaning of the learning terms was given, such as, what is biology? Or what is physics? However, in the new curriculum, the meaning of the terms is not required. So, when, the participant teacher tried to teach the students they remained confused because of the lack of meaning or definitions. He questioned why the content was not presented sequentially, which would be more meaningful for students. This response shows that this teacher participant was not conscious of the distinct philosophy of the old and the new curriculum.

In summary, we can say that the new curriculum holds a very modern view of how science should be taught as an issue that integrates many domains, but, in the field, teachers found it very difficult to implement this approach. Hence, they kept teaching the students using a knowledge-based approach.

5.4 The Language Challenges

It was mentioned earlier that the implementation of the new curriculum in Timor-Leste was met with many issues and challenges. This section particularly narrates how teachers find language one of the foremost challenges. The teachers' narratives show that there are three reasons why the Portuguese language emerged as an obstacle for teachers to convey the science message. These are: (1) the absence of science technical language course, (2) lack of explicit science information in a language that is accessible to them, and (3) lack of environment and government body support. These will be discussed in detail in the quotes that follow.

5.4.1 Absence of science technical language.

In Timor-Leste the Portuguese language is perceived as important in education. Portuguese language courses have been made available for everyone, including teachers, who is interested in increasing their language skills. This programme was made possible with the cooperation of the governments of Portugal and Brazil. However, this course does not cover technical terms that are particular for the subjects, such as science, that are required to be taught in the classroom. The only other option was a 3-year diploma course run by one of the Ministry of Education institutions called the Formação dos Professors (teacher training), where all courses are available in Portuguese. However, the number of science teachers who have graduated from this institution is far from what schools were expecting. This institution has now closed for technical reasons that have not been explained.

Given this situation, science teachers who have never been to this teachers' institution lack the technical language to teach students using teaching materials that were provided in Portuguese by Portuguese experts. Thus, the teachers have to translate the Portuguese materials into Tetum because the students would not be able to understand the Portuguese version, but they feel inadequate for this task.

This inadequacy can be seen from the 46 3rd cycle science teachers who were involved in this study, only two of whom had completed their bachelor's degree from this teaching institution. Instead, most of these institution's students are 1st and 2nd cycle teachers. As a consequence, teachers are often burdened by language and science content. One of them said:

> *In Timor-Leste, currently, the teachers face two big challenges, a teacher has to study the content of the subject as well as the language. She/he has to attend training regarding both the content of the subject and the language, which is Portuguese. These two challenges make it more difficult for the teachers to reach the highest potential in teaching, and we have observed that most difficulties come from this reality. There are teachers who have been teaching for a long time and have a vast knowledge in science but still have difficulty in conveying the knowledge to students due to their inability to articulate this in Portuguese. (*INO, FGI, G9-Baukau, p. 8)

The sentiments of this participant reflect how science teachers are challenged because they feel unable to convey their lessons because of both content and language. He also admitted that due to this language challenge, even those who are knowledgeable in their field of study have found it hard to teach the new curriculum. The requirement to use and translate the concepts, in order to make them understandable for the students in Portuguese, is a huge barrier to implementing the new curriculum.

5.4.2 Lack of implicit science information in a language that is accessible to them.

In the same vein, another teacher raised his concern over the use of a manual that was written in Portuguese. While he acknowledged that being multilingual is advantageous as one can use this skill to have a wider connection and view of the world, he admitted that having teaching materials that are in Portuguese and teaching these in Tetum is quite disadvantageous for students. This is because according to him, both Timorese teachers and students are still grappling with the Portuguese language. Portuguese was only recently adopted as an official language in Timor-Leste, and the technical terms in science has not yet been made available to teachers.

> *The manual gives us a difficulty. We could say that we have difficulty with the Portuguese language. We could understand in some parts because there is a translation on one side but the translation is using advanced words, so we are*

> *not able to find their meanings. As teachers, we try to find a way to pass knowledge on to the students, so we have to find or access some other documents in order to be able to teach.* (ULO, FGI, G8-Dili, p. 2)

Teacher participants said that the policy mandating Portuguese to be utilised as an instructional language in schools places them in a difficult situation because they cannot give meaning to concepts that involve advanced terms. However, they still do their best to find other references that provide them with ideas for conveying the content.

Regarding the benefit of flexibility in utilising the language, one of the participants added:

> *As we are known in Timor, we have two official languages, Tetum and Portuguese, but even if the textbooks are written in Portuguese, if the students cannot understand our intentions, then it is problematic. So, in the introduction, we can do it in Tetum or read it in Portuguese then later translate it to Tetum, maybe not for everything but at least we try to make our students understand what we say. However, if they do not get it, then we can explain in their mother tongue so that they could understand it.* (MIG, FGI, G8-Likisa, p. 3)

there is a saying that language is a window to knowledge systems (Maffi, 2001). This means that language is vital in understanding any learning intentions. For science teachers, implementing the new curriculum without sufficient Portuguese language skills has hindered teachers in understanding the content of the textbook, which is mandated by Timor-Leste's Ministry of Education. Facing this situation, they have translated the content for science lessons from an Indonesian textbook into Tetum to teach students in the classroom, while the Portuguese textbook has been utilised as a guide or reference point to find out about the topics that they have to cover. This is necessary so that teachers can make the lessons meaningful. One of the teachers stated:

> *For me, language is an obstacle because the textbooks were written in Portuguese. Tetum was there, but they just changed the letter, so we do not understand the meaning of it. Hence, we should prepare ourselves to understand it in Tetum. In Portuguese it's hard. There are some references available in Indonesian but to translate these into Portuguese is challenging. However, the content of the book, I understand because there are some*

available references in Indonesian. I could also access it through the internet if I need to as it would help me understand better. (MIG, FGI, G8-Likisa, p. 4)

The teacher participants also expressed their dissatisfaction with the way the textbook author provided the terms needed, where they just changed some part of Portuguese word and said it was a Tetum equivalent. This practice was used because many Tetum terms were originally derived from Portuguese words. To give an idea, following are terms that have been adopted and provided in the Grade 9 student textbook which are authored from the Portuguese (Costa, Rodrigues, & Dias, n.d.)

Table 5.2
Examples of Tetum Terms that are Adopted from Portuguese Words

Portuguese	**Tetum**	**English**
Ondas	Onda	Waves
Vibração	Vibrasaun	Vibration
Mecânica	Mekanika	Mechanics
Electromagnética	Elektromagnetika	Electromagnetic
Propagação	Propagassaun	Propagation
Peça	Pesa	Part, piece
Som	Son	Sound
Telecomunicações	Telekomunikasaun	Telecommunication
Aplicações	Aplikasaun	Applications
Reflexão	Refleksaun	Reflection
Trajetória retilínea	Trajetória retilínea	Rectilinear trajectory
Feixe retilíneo	Feixe retilíneu	Rectilinear beam
Raio refletido	Raiu refletidu	Reflected ray
Ângulo de incidência	Angulu insidensia	Angle of incidence
Espelhos planos	Espellu planu sira	Plane mirror
Caleidoscópio	Kaledoskopiu	Kaleidoscope

These teachers found that although the book provided a translation section in one section, it was very unhelpful because the given terms were not the common terms that they were familiar with but included technical terms that they had not encountered. As a result, they felt dissatisfied because it did not help with their teaching tasks at all. Another participant in the focus group discussions highlighted the same issue:

We could understand because we consult with Indonesian language books and understand Indonesian, but then we try to explain it in Tetum. Translating from

the Portuguese language in order to explain it back to the children so that they can understand, is also a problem for us. Although there is a translation from Portuguese words to Tetum [Tetum has many Portuguese terms] it is still Portuguese, so how can we understand it, we can only understand if we link it to the Indonesian language, but how do you explain it to the children so they also can understand as we do. (MBE, FGI, G8-Dili, p. 3)

5.4.3 Lack of environment and government body support.

Another participant claimed that the other reason language remained challenging for teachers and students when learning science is due to Portuguese not being spoken in society or even in the government.

> *Even our members of parliament do not speak Portuguese, they are not giving a good example, so how can you expect us who live among the ordinary citizens, to speak Portuguese? If we do, will we not get hated and cursed at by the citizen? That's why our environment is not favourable yet to speak Portuguese, and the language has only little influence inside the classroom. Most of the students live with their parents in these hostile environments, so how do we enforce them to speak Portuguese?* (INO, II, G9-Baukau, p. 12)

This participant questioned why the members of parliament who imposed the idea of Portuguese as the instructional language were not fluent in Portuguese. He questioned why they forced teachers who live among society, where Portuguese is not spoken, to master this language. He articulated his dissatisfaction over the enforcement of teaching science with Portuguese language and content by raising an important observation. He brought to light the case of the ministers speaking in the media, where he says that when the interview is in Tetum, they also talk in Tetum. However, when the interview shifts to Portuguese, they do not speak at all. He also notes that journalists do not conduct their interviews in Portuguese. He then concludes that, in fact, we do not have any examples to portray, but sometimes they blame the teachers, saying that teachers do not teach well and cause educational quality to be low because of their inability to speak Portuguese fluently.

Furthermore, he emphasised that one of the reasons that teachers face difficulties when conveying science in Portuguese is because it is not spoken in their homes; he said:

> *For students, it is difficult because when students are in the class, they only speak Portuguese but when they are back at home, they no longer speak the language. Therefore, it is also a challenge that we face*. (INO, II, G9-Baukau, p. 13)

A further challenge for teachers is that traditional tribes disregard Portuguese as their communication mode. Therefore, the young generation does not practise it during ceremonies or family gatherings, as he stated:

> *If we have any traditional ceremony coming up where all the family gathers together and we talk to the children in Portuguese then we are seen as being disrespectful to our own culture and language, our environment does not give us the chance to speak in Portuguese.* (INO, II, G9-Baukau, p. 13)

He highlighted that since they do not want to be regarded as someone who breaks their traditional rules among the elders by speaking Portuguese, Portuguese is not spoken in these situations. This had been identified as another aspect that indeed causes Portuguese to become hard to converse in.

To summarise, Timorese teachers are conscious that working in classrooms is not solely teaching and learning but it is also working through languages in order to make the content understandable for students. This is a problem because students also have other diverse mother tongues which are not Tetum. Hence, the lack of Portuguese language skills has hampered them in making the new curriculum programme visible in the classroom.

In dealing with this new curriculum reformation agenda and the other relevant issues, teachers could easily deal with the given content that is related to their area of specialisation, because they can translate it into their familiar languages for communicating it to students. Conversely, if the given material is out of their field of study, then it would be an issue since the language also serves as a constraint for them to understand the intended content.

5.5 Resource Challenges

From the presentation of the challenges with language, this section will describe teachers' concerns about the resourcing challenges that also hinder curriculum implementation.

The findings from the majority of research participants (33 of 44) show that another form of challenge in the implementation of the new curriculum is a lack of sufficient educational infrastructure. The educational infrastructure includes school furniture, school buildings, school equipment, and learning resources. The struggles faced by research participants in implementing the recent curriculum, due to a lack of educational infrastructure, are described in this section.

Research participants admitted that inadequate school buildings and furniture cause them some concerns. This is mainly conveyed by teachers from schools that have limited school buildings and narrow classrooms, where schools have to accommodate many students, resulting in overcrowding. As one of the research participants confessed:

> *Because we have many students in one room, almost 60, then I form groups, but with too many students, sometimes one group involves up to 15 people. With a narrow classroom, the desks are the old model [desk and chair are combined], so we cannot move. So, to form into groups is also hard.* (INO, FGI, G8-Baukau, p. 11)

The participant expressed that due to lack of educational facilities: (such as a limited number of classrooms) his room had to accommodate up to 60 students. However, the classrooms are also narrow, so to do a practical activity is very difficult. It is hard for students to sit as a group as the student desks are too heavy to move around.

Additionally, schools also have not been equipped with a science laboratory. So if teachers want to run a hands-on activity, they have to utilise the classroom that they teach in. He was also conscious that an 80-minute lesson is not sufficient to run a laboratory activity. However, he had put some effort into ensuring students learned through hands-on activities.

> *Hence, I comment, we do not have any special lab for practical, we just utilise this classroom, so, students in this line of desks are one group, this line is another group, and this one is a group as well, so that we have to be quick. Because 80 minutes is short and limited.* (INO, FGDI, G9-Baukau, p. 12)

The lack of instructional space was also encountered by another teacher who taught in a suburban area. She recalled that once they had tried to practise making sounds, as directed by the textbook. Although the number of students in her class is fewer than

other schools, they are also challenged when conducting experiments because their classroom walls are made of palm trees and are already old and dilapidated. It is difficult for children to speak up because their voices can be heard in other classrooms. So, practising the sound experiment was constrained, because it is not good to disturb the class next to you. Her account articulates this constraint:

> *In our school, we have 36 or 37 students in one classroom…. the content required places in order to listen to sounds. But in reality, our school is not high tech so that we can make a sound and the children will listen. Some walls of the rooms are built from a palm tree, and the wall is old and almost collapsed. We could not make sounds since these would disturb the class on the other side of the room*. (INA, FGI, G8-Baukau p. 8)

The participant raised that although she has fewer students in her classrooms, the school's conditions had hindered her from doing sound experiments with her students. Her concerns were that the sounds would produce noisiness and the neighbouring class might be distracted from their learning as the classroom divisions were not appropriate.

Concerning learning resources, the researchers found that there are disparities between schools when receiving the students' textbooks and teachers' manuals. Some schools got more of these resources, while others got fewer. When I tried to confirm this inequality, the research participants were uncertain in their responses. This situation was found either in schools in Dili, the capital city and in other municipalities. For example, from six schools in the Dili area that were involved in this study, only the teachers from two schools had the teacher manual and student textbook. This shortage in teaching resources impacted on the facilitation of students' learning by the teachers. As one of the participants said:

> *We do not have textbooks. We only have this one and only book [showing me the book]. Therefore, we had to spend so much time writing the contents of the book on the board for the students to copy. This leaves us with too little time for doing the explanation of what we wrote on the board. This is a big problem that affects the quality of teaching and learning*. (OBA, FGI, Grade 7-Baukau, p. 4)

Pertaining to the teacher manual he added:

> *I just got this teacher manual less than 7 months ago. This was given to me only after I had been urging the school director to get it from the district education office in Baukau.* (OBA, FGI, G7-Baukau, p. 4)

My observations affirmed this teacher's lamentation. In his school, teachers of each grade rely on only one student textbook from the government as a reference for teaching. Thirty research participants also highlighted the same issue in relation to the teacher's manual which was just recently released.

With regards to laboratory facilities, the same teacher added that while they were provided capacity-building training to utilise these, this training is useless since their school lacks a laboratory and the equipment that they used during their training, such as a microscope. He revealed this when I asked whether he ever participated in any relevant hands-on training. To capture this conversation, I quote him below:

> *Last year, I attended a training in INFORDEPE, Dili. We learned how to design a good teaching plan. We also learned about how to do practical work in the laboratory. We focused on how to teach a student to use laboratory tools. The problem is, in school, there is no laboratory. After the training, it could not be applied. We could not practise it because there is no laboratory equipment. They said, they will send it later, but until today, we still do not have them*. (MIG, II, G8-Likisa, p. 8)

Unfortunately, the promise to distribute the equipment that they have used in training never happened. The problem with lack of teaching resources is not simply about not having the resources per se, but it also lies in the non-fulfilment of these commitments to provide the necessary equipment. As the teachers who were interviewed have articulated, this situation presents a challenge to the implementation of the new curriculum in Timor-Leste. But digging deeper into the problem, it became apparent that the challenge of the lack of resources, such as textbooks and laboratory equipment, compounded by the non-commitment of authorities to deliver these basic instructional needs, is not the only obstacle in attaining the goals of the new curriculum for scientific literacy or at least teaching integrated science in Timor-Leste. Issues of context and pedagogy in the limited textbooks were likewise brought up in the interviews and focus group interviews.

5.6 Textbook Challenges: Issues of Context and Pedagogy

This section will analyse the content of the didactic materials based on teachers' participant voices regarding the feasibility and applicability of the contents of the limited textbooks in Timor-Leste's classrooms. The curriculum document aims to increase students' ability to be scientifically literate. For example, "One of the overarching general intentions of Natural Physical Science (NPS) should therefore to increase the skills related to reading, interpreting, and writing simple scientific texts and disseminating it" (MoE, 2010a, p. 5). In order to achieve this goal, the new curriculum emphasises the skills that are involved in the development of other transversal competencies (MoE, 2010b) such as: team working; practising communication skills and cooperative work with others; respecting other ideas; overcoming conflicts and solving problems. The intention is to:

> Take initiative, show creativity and ability to explore new ideas, exercise criticism, analysing facts and speech from various angles, confronting the evidence, analysing counter-evidence, etc. (MoE, 2010b, p. 4)

Besides this focus it is also expected that students will be able to:

> exercise democratic citizenship, taking a position on public policies, large economic groups, and political powers, justifying their opinions, helping to build societies as forms for sustainable development, which is socially and economically fairer, healthier, happier, greener and humble in their relationship with Earth planet. (MoE, 2010b, p. 5)

The writers of these textbooks acknowledge this ultimate goal of the curriculum developers for students to be scientifically literate and expect that the skill development will happen as teachers work through each topic. This content and expectation to develop scientific literacy will be discussed next.

Physically, the cover and paper of the students' textbook is colourful, and the paper is thick, which should attract students to read it. For example, the Grade 7 student manual textbook has 176 pages and the content of the book is organised into seven themes, as mentioned in Section 5.2. In line with the spiral curriculum model of organisation these seven themes remain the same up to Grade 9, but the complexity of the concepts deepens in line with the expectation that students will develop their capacity to learn more detail.

These main learning areas are *Now I know, or What I have learned* (focuses students to reflect on what they have learned in this section); *Concept mapping* (mapping these concepts and making links); *What I am capable of solving* (focusing on how they can use the material to problem solve); and *What links to science, technology, society, and environment?* (providing science activities for students to carry out or discuss)**.**

However, when I followed up this uniqueness of the teaching strategy with some participants, none of them were conscious of its intentions. It made them confused, so they skipped it. One teacher confessed to his teaching experience of this section:

> *Those caused me to be confused, especially questions like, Now I know as this is never given in national exams. The type of national exam was different from this one because all are multiple-choice questions. So, I was very confused about this. Ha. for the abstract scheme, I got it a little bit. I saw it, but I want to say that, usually I just skipped it, I read it, I did not understand this sub-theme, therefore, and I did not read it but just let it pass*. (VEL, II, G7-Dili, p. 9)

This participant seemed to misunderstand the highlighted points that the authors wanted teachers and students to focus on when learning the subject. VEL's statement indicates that he captured the science activity "Now I know!" as a question that required an answer. He affirmed that regarding his experience, the national examiner never gives this kind of question. Therefore, it made him confused. He did not understand the meaning of this highlighted section. From the four given points that the textbook authors hope the teacher will cope with, he noted that he only understood a bit about the abstract/diagram scheme and ignored the rest.

When I was re-emphasising my questions to clarify the participant's views of the points *science, technology, society, and environment* that the textbook writers are aiming for students to understand, he also said he never facilitated discussions with his students. His concern was:

> *They are asking us to do research, but when we read it carefully, this cannot be implemented in Timor, in Timor we cannot use all these things [while pointing to one example of that topic in his textbook]. There is some part that we can implement, but some that we could not. When we read it, we were not very sure about the content; it is confusing. As you have been asking, these*

> *issues have been repeated in every topic but for me personally, I have never taught this to students – the one about "science, technology, society, and environment."* (VEL, II, G7-Dili, p. 9)

The statement implies that this teacher had ignored the important part that the curriculum designer had urged teachers to cover in the last sessions of each lesson. This is because he found that the given texts were unclear and hardly able to be followed up in the lessons. He added that although some part was understandable, he never went through it with his students.

As well as these issues of not understanding the reasoning for these questions there are also other pedagogical issues that will be discussed in the next paragraphs. First of all, the organisation of the content into block themes. The uniqueness of this textbook compared to the earlier textbook is that although the themes for the subject are various, the main ideas about them, reflecting on their learning and steps towards scientific literacy, are emphasised for each theme.

Each block theme is organised into different types of activities and the issues that will be discussed in this section are the learning content and science activities that coupled with it. The content commenced with introducing the lesson topic with "provocative questions." This is to identify the concepts and the provided content. Some pictorials were used to illustrate the content. This was followed with the authors presenting "practical activities" for teachers to do with their students. The practical activities could be laboratory activities, field trips or group discussions in classrooms. Also science technology society and environment (STSE) activities are provided for students to work through and/or discuss that will emphasise how to develop students' scientific literacy.

In this next section two block themes – *astronomy and the universe*, and *movement and force* will be analysed to illustrate how the textbook is organised for Year 7 basic education 3rd Cycle.

5.6.1 Astronomy and the universe.

Introducing the topic with provocative questions.

Before students learn the concepts of the theme, or topics of the lesson, they are introduced to these ideas with some provocative questions that the authors claim will engage and lead students towards learning the content and applying these concepts to their lives. For example, the focus of the first theme was "formation and evolution of the universe and solar system" that provided provocative questions as follows (Figure 5.1).

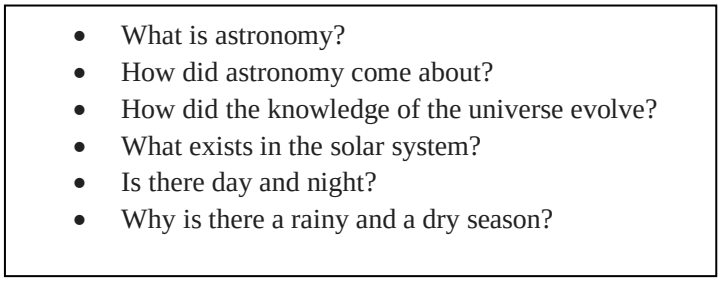

Figure 5.1. Formation and evolution of the universe and solar system using provocative questions (Costa et al., n.d., p. 6)

These provocative questions assume that these Grade 7 students will be immediately presented with information concerning the evolution of the universe and associated scientific terms. The questions also anticipate that students will be engaged to learn the reasons for the changing of days and seasons. The authors assume that information needed by students to discuss these provocative questions will be available either from the internet or from libraries in their school or local areas.

Identifying the concepts and providing content.

In this section the textbook does not direct students to talk about examples that are part of their everyday life as it only gives brief information about the early beginnings of astronomy. Instead it provides information about the "age of magic" – an era when nomadic man believed that everything in the material world such as plants and animals had a spirit and everything that happened was a result of its good or bad disposition. The subject content then tells more about the history of astronomy through the history of Mayan, Babylonian, Minoan and Greek civilisations.

It appears from participant comments that they were dissatisfied with this kind of information because students did not understand the significance of the examples. In

addition, both teachers and students were conscious that the content was a long way from Timorese ancestral knowledge. As one of the participants laments:

> *When we talk about astronomy, there, they only give Malae's context, we also have our own knowledge, but it is not written in this textbook so that we explain it to our students. When we teach this to students, they are doubtful because it is all about others. For instance, in the past our ancestors had their own stories. In ancient times they could tell the time just by looking at their shadow. This kind of information should be covered here so that the students have the interest to learn it.* (TIN, FGI, G7-Likisa, p. 8)

This participant emphasised that most of the astronomy lessons covered Western or *Malae* in Tetum (which means foreigners) content. So, he questioned why the textbook did not also cover the aspects that are part of Timorese history. So far, he knows that his Timorese ancestors could tell the time just by looking at the position of the sun with the naked eye. He believes that if the students' textbook covered this kind of information, teachers and students would be fascinated to learn it as it would be familiar to their own context.

Using pictures to illustrate the content.

To illustrate how different people, view the universe, students are given pictures for each epoch, as shown in the pictures below (Figure 5.2).

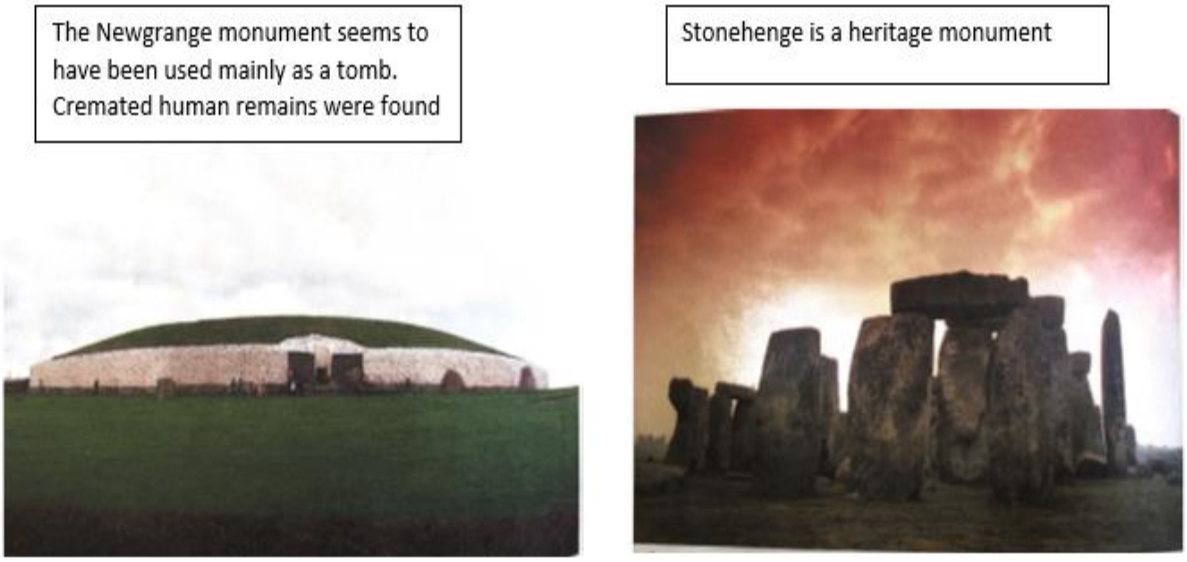

Figure 5.2. Picture of Newgrange monument and Stonehenge (Costa et al., n.d., p. 8)

The textbook claims that the most important proof of prehistoric interest in astronomy is related to a funeral monument which is in Ireland – Newgrange, which was constructed in 3000 BC. Another important monument at that time was Stonehenge, in England. However, the textbook authors do not give any reasons for Timorese students to learn these examples of world primitive history. Hence it was not clear to the Timorese readers what the authors wanted to convey. As OSE claimed:

> *If we see in this textbook, all are telling about Malae's content. Hence, when we make comparison with ours it caused us confused. This because Malae's culture is distinct from ours....I noticed one page of the students' textbook, when I went home and searched it on the internet, it was just copied and pasted, therefore I doubt the content.* (OSE, FGI, G9-Dili, p. 15)

From OSE's statements, we can notice that some of the content has indeed been retrieved from Western content and contexts. Therefore, he was challenged to convey it to students as most of the content had a European focus which is different from a Timorese context.

Practical activities.

In order to develop their understanding of the concepts underpinning astronomy in the past, students are directed to examine and debate the history and background of scientific thought and the beliefs that inspired the development of the theories of the geocentric and heliocentric models of the solar system. An example of some of the text is shown in Figure 5.3.

Practical activity – cooperative work

Over time, several models were proposed on the relative position of the stars in the universe. Aristotle and Ptolemy defended the geocentric model (geocentric is a word of Greek origin, in which *gê* means "Earth" and *kentron* means "centre", that is, the Earth is the centre of the universe) and, in turn, Copernico and Galileo the heliocentric model (heliocentric derives from the Greek, in which helios means "sun" and *kentron* means "centre", that is, the sun is the centre of the universe).

Are any of these models correct?

To answer this question, we must know the ideas of each author. For this, we will work cooperatively.

Figure 5.3. Practicum activity: Formation of evolution of universe and solar system (Costa et al., n.d., p. 10).

These science activities suggest that students are organised into groups to discuss and debate the truth of heliocentric and geocentric theories. However, the participants found that discussing the philosophers' ideas was hard and a challenge for students because 3rd cycle students are still young, and might lack the requisite skills to do so, as one of the participants said:

> *There are many themes, as I mentioned, which were for mature age students. Grade 7 students are still young, between 12 and 13, who do have not have strong analysis skills, but these things are given. Sometimes people comment that students do not understand or we, teachers, do not know how to teach, many ideas are around.* (CIO, FGI, G9-Baukau, p. 12)

This participant found that this science activity required a high level of analysis skills through a discussion approach more suitable for mature students. It appears that the teacher, although recognising that the discussion method is a worthwhile way of developing understanding, felt it required a high level of skills that should not be expected from Grade 7 students as they have not developed this capacity. He added that the consequences of these learning activities were that, if the students were finding it difficult to cope with the given content, the public would question whether the students were the problem, or whether the teachers lacked the pedagogy.

When asked to reflect on his students' learning he commented that teaching students too much non-relevant knowledge would confuse them. Therefore, he suggested that the learning materials should cover the astronomy knowledge of the Timorese ancestors. In summary, the students and tutors were discouraged from learning the astronomy content given in the textbook because it did not cover the Timorese ancestral context.

STSE activities.

In this themed block the authors provided a template for students to develop a science project. This is a summary of what is said on page 19, of the Grade 7 student textbook (Costa et al., n.d.)

> **How to develop a project?**
>
> Throughout the school year you will have to develop various projects; however, to work on a project, you must know its different stages. In fact, a project is a strategy of group work that relates the various subjects of the natural physical sciences. In addition, it allows you to

relate the natural physical sciences to other disciplines, such as a to resolve a certain problem.

A project has its own purpose, such as:

1. To solve a real problem
2. Promote a certain intervention in school (or in community)
3. Promote an activity.

On page 19, students were asked to follow through eight stages when developing a project. At Grade 7, students were not given a project task but at Grade 8 and 9 these were described as follows.

To begin a project, students were asked to choose a project theme and problem that they considered they would be able to solve. The chosen problems and their solutions could be presented as a concept map such as on page 17 of the student textbook (Costa et al., n.d.). The textbook authors then required students to set up a working schedule to carry out the project and distribute the tasks among the members of the group. This is because the authors believed that working in a cooperative way would help them develop their transversal competencies. Following that, students were asked to write up the project and present it to class using posters, movies or even from their own computer. In this presentation session, students were encouraged to question and evaluate the work from other groups. In the final stage, students were asked to publish their project through the school noticeboard, or journal. The writers suggested that if the school did not have these facilities, then they could start creating one in their school.

The way the instructions are given assumes that students are used to working independently. Also, such an activity would only be feasible for students who are equipped with appropriate electronic facilities, such as computer and internet access so that when asked to research this project, they would have alternative sources to go to for information. But, for Timorese conditions, most schools in fact do not have these kinds of facilities and resources; consequently, this task would not feasible to carry out in schools. As one of teachers grumbled about the lack of learning resources:

> *When we attended the training, the trainer presented the materials in [a modern way], they showed it in interesting slides with PowerPoint that engaged us to follow. While here we do not have those kinds of facilities. To download learning materials, it required a good mobile phone, it needs credit*

> *to download. While most of us here, we do not have those kinds of phones. How to present a content in an interesting way with PowerPoint slides? The school itself does not have laptop and the other facilities rather than us teachers, we do not have those facilities. We only have this simple phone. And this causes difficulties to apply the idea here*. (INO, II, G9, p. 14)

The textbook authors also required students to set up a working schedule to carry out the project and asked them to distribute the task among group members. This is because the authors believed that working in a cooperative way would result in benefits for them.

It is presumed that writing a project on astronomy is too difficult for Grade 7 students. It is important to note that students do not have easy or any access to information.

Another example of the textbook resources is presented below.

5.6.2 Movements and force.

Another theme that research participants found challenging to implement in the classroom was the information about movement and forces. Before I give the teachers' concerns about the issues with the content and the activities I will describe and critique the arrangement of the content of this theme block.

First, the provocative questions for the theme are shown in Figure 5.4.

1. *Do you know the distance that it takes you to get to school? And how long does it take?*
2. *What is the trajectory you take during your journey?*
3. *Can you calculate the average speed of your movement?*
4. *What type of movement do you describe when riding a bike or motorcycle? On a straight road to the seashore, with a constant speed?*
5. *When you travel to the mountains, for example, with a motorbike, how do you classify your movement? And during the descent?*
6. *Why do the planets move around the sun without leaving their orbits? What force is responsible for this movement?*

Figure 5.4. Example of provocative questions for *movement and forces* for nature and technology system (Costa et al., n.d., p. 98)

As regards these provocative questions, the first three questions could be asked of students anywhere in the world, while the next three (questions 4–6) might suit students from industrial or developed countries. But these questions do not work for a

non-industrial country such as Timor where most people still go by foot when carrying out their daily activities. Even in the capital city, Dili, most students go to school on foot or in a micro-minibus which costs them 10 cents. This shows that the textbook has been written by authors with little experience of Timorese life and circumstances. Instead the content and context of the Timorese textbook has been derived according to their own experiences.

For the example in question, when they ask students to imagine travelling to the seashore this confuses the Timorese learners since the Timorese landscape is mountainous and hilly and there is little chance of travelling at the same speed and in a straight line. Although there are some parts of the ten municipals where they can see, visit and enjoy the beauty of the beach, in the other three districts – Aileu, Ermera and Ainaro, students are totally isolated from the seashore. Because of the mountainous terrain of Timor-Leste even when a municipality is near the sea only a few suburbs have sea access. Hence, asking students to imagine travelling to the sea is irrelevant to many students.

Identifying the concepts and providing content.

Besides giving unrealistic ways to stimulate students to learn the concept of movement, the way the textbook presents the content is different from the earlier textbook that the science teachers knew. For example, with the previous curriculum teaching approach, teachers led the teaching of content sequentially. The new textbook never presents or gives a definition of science terms that the students need to learn, but instead gives them a context, as a real example. For example, "Around you find a situation where animals, people, and vehicles move more or less quickly. For example, the average speed of a snail, a cheetah, an athlete, a race car or a jet plane are very different" (Costa et al., n.d., p. 100).

The authors claim that a way to engage students to learn the concept of movement is to introduce the concept by having students observe the motion of objects that exist around them, such as race cars, jet planes, snails, and athletes. Parallel to the text, it then immediately gives a real situation for each context in the form of pictures, as shown in Figure 5.5.

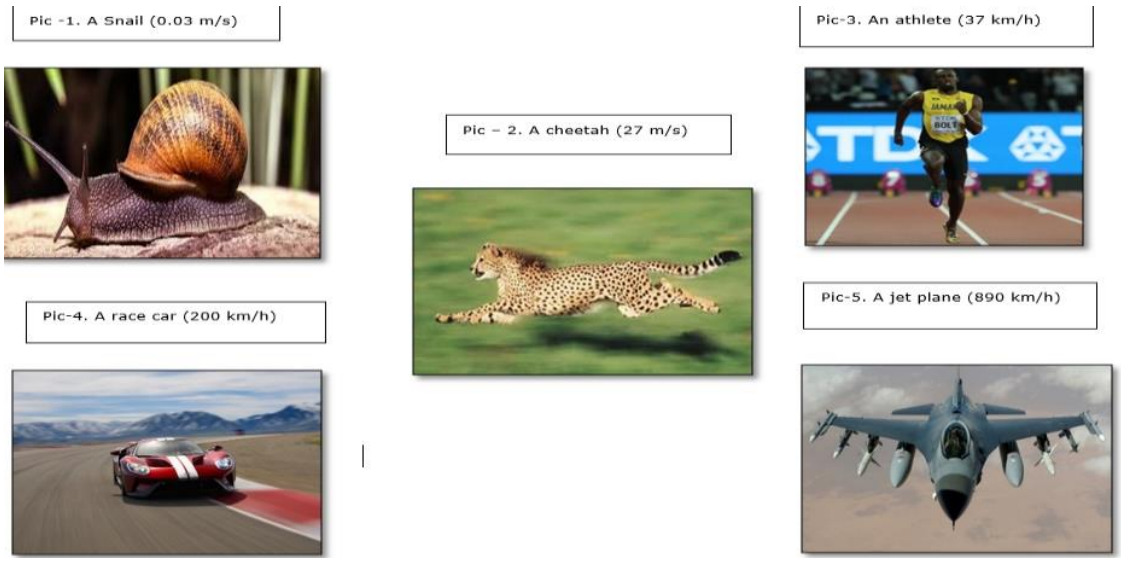

Figure 5.5. The average speeds of different objects and beings (Costa et al., n.d., p. 100)

The pictures in Figure 5.5 invite students to compare the movements of objects and people. It calls for students to differentiate between how fast each of the given objects moves. This kind of information provides a context to learn about the concept. But, if the learners have never these contexts in their life, then their learning would be difficult. For example, in Timor, a snail does exist, but observations of snails are not considered to be important. Also, in Timor, there are no cheetahs, race cars, or jet planes. So, these examples are inappropriate for students and teachers to use to develop an understanding of the concept. Some teachers reacted to this situation by questioning why the Portuguese content should adopted in Timor – that is, in one of their old colonies:

> *Now, the Timorese curriculum, if it is a Timorese curriculum, should use what exists in this country. Now, what we took from Portugal then implemented means, we learn other sciences.* (TIN, FGDI, G7-Likisa, p. 17)

Practical activities.

To deepen the understanding of the concept of movement, students were asked to calculate the average velocity of objects like the planets, cars and trains, a giraffe, and sports cars. For more details, some samples of the exercises are shown in Figure 5.6.

1. A swallow which flies a distance of 240 m in 6 seconds.
2. A giraffe that moves a distance of 64 m in 4 seconds
3. A shark moving around the ocean swims 360 m in 30 seconds.
4. A sports car accelerates evenly, starting from rest and reaches a speed of 24 km/hr in 6 seconds.
5. A train moves with a constant velocity during the ascent of a small hill. After 20 seconds, the velocity of the train increases.

Figure 5.6. Exercises for the questions about movements and forces for nature and technology system (Costa et al., n.d., pp.102–104)

Relating and practising mathematical skills in context is an important stage of the learning process. This gives students the chance to see the feasibility of a theory in real life. However, to capture the concept of movement by illustrating animals and things that are alien to students becomes a problem for teachers, who first need to translate the content. Hence, teachers claim that as most of the content is from Portugal, some figures are just not relevant to the Timorese context. Teachers' dissatisfaction towards these contexts were expressed as follows:

> *Some of the given pictures do not reflect our context. Hence, we already know that this has been designed by our foreign friends.* (STA, FGDI, G7-Dili, p. 5)

Another teacher also had the same concern:

> *Some figures were reflective but some not. For example, a train, now in Timor, we do not have trains, so to explain trains to students was hard. The other is that most of what is presented are the industrial products, things that are advanced, we cannot compare it to ours in Timor, therefore, for the coming [textbook] please include things that exist in our country so that students would easily understand*. (MIG, FGDI, G8-Likisa, p. 8)

These teacher participants indicated that using objects such as those from highly industrial societies, such as trains, to explain the concept of movements was challenging as teachers cannot link these things to reality so that students can discuss and compare the speed to attain the objective of the lesson. These teachers therefore strongly called for the replacement of the non-contextual content with local examples to make it more relevant and meaningful to teach science in Timorese classrooms.

Now I know.

In the reflection section students were reminded of what they had learnt through the *now I know* activity. This section provided a summary of relevant terms and

definitions. It then followed with key concepts, listing all the key concepts that encompassed the first theme. All of these key concepts were then summarised into a concept map that linked the concepts together. Unfortunately, these approaches were ignored by Timorese educators and even the teacher educators.

The text included such summary diagrams.

Summary diagram.

The following is an example of a concept map that showed the relationship between movements and force.

The concept map depicted in Figure 5.7 shows there is a relationship between force and motion. It shows there are two kinds of forces: one that results from contact and one that acts from a distance. An example of contact force is that which results from muscles (muscular force) while examples of forces that act from a distance are gravity, magnetic and electric forces.

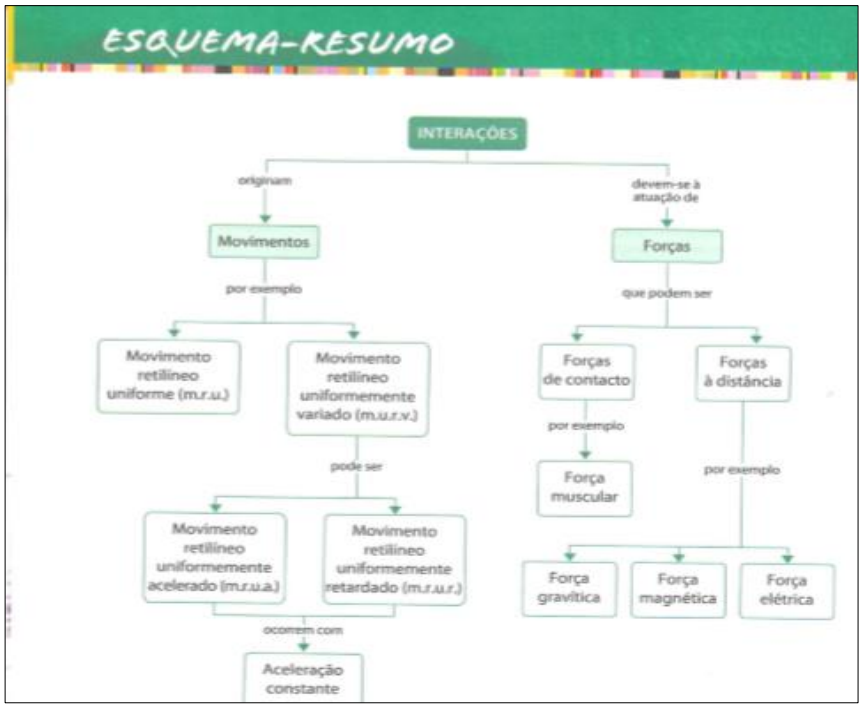

Figure 5.7. Example of summary diagram of the movements and forces for nature and technology system (Costa et al., n.d., pp.102–104).

5.6.3 STSE activities.

The authors aim to provide examples that will link the concepts learned about movement and force in a problem or activity that could help students develop their

awareness of the issues in Timor-Leste that are related to STSE. Figure 5.8 provides an example and illustration of an activity.

STSE activity: How to build new communication in Timor-Leste

Road traffic is increasing in the country. Engineers are designing viaducts and tarmac roads that intersect at distinct levels and thousands of vehicles move through these roads Currently, there are more than 100,000 km of railway lines around the world. The control of rail traffic is carried out through a complex system of signals allowing free circulation in security. Airplanes are increasingly used because they allow travel of thousands of kilometers in relatively short time intervals. Rigorous control by air traffic controllers during take-offs and landings, to avoid accidents, is necessary.

Discuss the text presented with your classmates. Carry out either individually or in a group, an investigation with the purpose of writing a text on the theme:

- The ways of communicating in the future in Timor-Leste
- The processes used by rail and air traffic controllers to prevent accidents.
- Which roads will be better suited to cope with the increase in traffic in Timor-Leste?

Figure 5.8. STSE activity for movements and forces for nature and technology system (Costa et al., n.d., p. 71)

Figure 5.8 describes how the modern society demands that people are able to move between their work and home as well as easily around the country. This requires infrastructure and transportation to facilitate their journey. This application of the concept of movement could be relevant for Timorese students because it is a way for students to learn and to practise discussion and debating about the issues concerned with the demands of modern transportation.

However, I suggest that the content of the debate is too advanced and sophisticated for the students in Timor. Despite the fact that the nation is described as small and mountainous (area 1,400 square kilometres) with a limited population of 1.2 million people it is not feasible to envisage complex travel systems which are not urgent for people in the next few years. This view of transportation might be needed in the next 100 years. Hence, teachers also found this teaching strategy difficult to implement in Timor because it was irrelevant to their lives and those of their students. So, as

mentioned above, the teachers skipped this section of the STSE activities when teaching science to their students.

To summarise – from the challenges that teachers faced regarding the teaching materials, we could say that the textbook authors were attempting to introduce the Timorese learners and educators to the global science context, particularly modern science and technology. However Timorese teachers found it hard to understand as most of the given content was irrelevant to their particular context. Therefore, the expected learning materials and other practical activities were found to be too hard to be used in their teaching.

Other challenges that presented in the implementation of the new curriculum were to do with the national evaluation system. These are discussed in the next section.

5.7 Challenges of the National Evaluation System

The other issue that teachers believed hindered them in implementing the new curriculum is how the country's educational authorities decide the Year 9 students' performance. The curriculum document suggests assessing students' learning accomplishments with three approaches: observation, inquiry, and document analysis (MoE, 2010a). The specific techniques and instruments used to measure each approach are described in Table 5.3.

Table 5.3
Techniques and Instruments of Evaluation (MoE, 2010, p. 35)

Techniques	**Instruments**
Observation	observation grids, checklists
Inquiry	writing test, questions, interviews
Document analysis	notebook of fieldwork, laboratory portfolio, reports, self-evaluation sheets

Consequently, the curriculum assessment prescription calls for schools and teachers to assess final-year students by using the techniques and instruments identified in Table 5.3. It also involves the students in the assessment through students' self-evaluation sheets.

To generate marks using the observation approach, it is expected that students should be given some work where teachers have a chance to see their attitude and their active participation in doing the work. For example, when assessing using the inquiry technique, students are expected to produce a piece of writing. The textbook says that a script could result from laboratory or problem-solving activities, such as procedures for designing a laboratory experiment, and how the result was obtained. Another option to measure students' performance is to examine documents that are relevant to earlier activities, such as field notes or an accumulation of students' practical work, and student self-evaluations. For the students' assessment descriptions, these should cover most of the learning domains and be based on students' participation. (MoE, 2010a).

But these types of assessments have been ignored in Timorese schools. At a school level, some teachers have provided a constructive-response question for students' assessments but, at a national level, the Examinations Committee solely relies on multiple-choice questions. An important factor that affected the implementation of the curriculum was that the Ministry officials were unaware that the national assessment practices kept teachers reproducing the old version of the educational model. The education curriculum was reformed to engage students in coping with the science idea conceptually (MoE, 2010b). However, the national assessment was merely designed to measure students' memorisation with an emphasis on subject content through multiple-choice options. One of the reasons behind this examination practice was a low level of trust in teachers marking students' work manually. As one Ministry Official explained:

> *Because previously in the manual correction, the teachers did the correction, it showed that it was not efficient, why? After the correction the teacher could change the results on a whim, used some coefficient on a whim. But the electronic device: if 1 is 1, 2 is 2. It is more effective*. (JAN, II, p. 5)

This Ministry official admitted that the examination office was forced to change their policy of marking from a hand correction system to a machine correction system as a way of preventing teachers intervening in the marking process, as officials believed that teachers were not to be trusted. However, they did not realise that this decision prevented them from achieving the curriculum goals. The decision to use a machine

to mark students' work also influenced teachers' teaching practice, particularly the Grade 9 science teachers who taught students sitting the exam. Because of the nature of these multiple-choice questions, they found themselves being urged and pressured to focus on subject content rather than helping students engage with an understanding of the scientific concepts. As a result, they avoided science activities that helped students learn science scientifically, such as hands-on activities.

In addition, this Ministry official believed that this method of assessment was a way to audit teachers' work. He believed that teachers did not have the pedagogy to teach science as they had no training. He argued that many teachers did not have a teaching background, and, as a consequence, they lacked teaching pedagogy. As he explained:

> *But nowadays, our teachers are not teachers; most people become teachers because of unemployment, it is not easy to find other jobs. A person can become a teacher without a background of a teacher because there was no other job, he/she is forced to become a teacher to sustain the need of his/her family. So, some of the teachers teach as it is without any methodology of pedagogy. It is what is happening right now*. (JAN, II, p. 4)

This Ministry official said that many teachers did not have teacher training but were able to take a teaching position because of teacher shortages. As a consequence, he believed that schools were filled with non-capable teachers. Because of this, he believed that the national examination teams considered the examination as a way to audit these teachers' teaching capacity. Through assessment this official felt that they could assess science teachers' capacity to teach science because he was not able to visit individual classrooms. This goal of auditing was revealed in the following statement.

> *The national exam evaluates only what they have done. All processes that have been taught for 3 years, I do not see learning processes in schools, in school evaluation we evaluate only the last year's learnings*. (JAN, II, p. 2)

The statement shows that this Ministry official was not sure which educational goals would be measured or the learning processes that would be occurring in classrooms. But one thing that he did know was to measure how much students were able to recall from the content that was contained in students' school textbooks. The Ministry official was not aware that this type of assessment hindered teachers enacting the

curriculum goals that would lead to students understanding scientific ideas that explained modern science.

However, teachers were aware that this reliance on multiple-choice questions reduces the quality of education. In fact, some teacher participants claimed that the way the national office measures the students' performance could prevent students from being diligent because multiple-choice examinations do not need much effort. As one of the participants claimed:

> *For the exams, the students that we noticed were weak at school passed the national examination. When the exams were local, we mark the questions which covered complete the sentence and multiple choice,… and many students failed, but in the past 2 years, last year students were passed 100%, this year some were failed, but not many. But indeed, students that we observed at school, in fact they should have been failed but in reality, all were passed because, even if they just chose the responses randomly, they were also correct. For questions in multiple-choice form, it is easy for them to copy from their friends. But, if it asked to construct an answer from their ideas, it would be hard for them to copy that long sentence.* (CIO, FGDI, G9-Baucau, 18)

The participant argues that the multiple-choice-exam approach actually incurred a nonsense result because they found the national exam results were contradictory to the local examinations conducted at school level. In detail, he affirmed that when they constructed the exams so that students needed to explain their answers, 30% of students failed. However, when the national examiners used a multiple-choice technique for the exams, none of their students failed. Hence, he was deeply sceptical about these circumstances, because some students whom they considered incapable passed. So, he thought that for the type of questions where most of the response options were given, students could guess blindly and the chance of getting answers correct was high. With multiple-choice options, students were able to copy from their friends. If the exam questions required students to construct their own ideas it might be hard for them to copy the long sentences needed for answers from their friends.

These views have been highlighted by another participant from a western municipality. He stated:

> *The recent curriculum exams, which present as multiple-choice system also sometimes demotivated students to study.* (MAL, FGI, G9-Likisa p. 16)

He found that, in fact, the national examination practice demotivated students from learning the lessons because there is nothing to challenge them to study hard. Even if the questions were difficult, as long as the items were provided as multiple choice, students would always be able to guess and often it could be correct. As another participant raised:

> *Indeed, we observed in our students that if the questions were not in the form of multiple choice they would fail, but all of them had passed, why? Because even if they had merely chosen the options randomly, it was still possible to guess the correct answer or, because it was multiple choice, they can copy from each other.* (IDO, FGI, G9-Dili, p. 15)

These teachers, are very concerned about the national evaluation system because students' attitudes to the lessons and other science activities were strongly influenced by the national evaluation office conducting the exams, particularly, how they required students to complete the exam. As some participants complained:

> *Another thing is when it comes to practical sessions, the students told us that "teacher, in the national examination there will be no questions regarding experiment activities. It will only cover multiple choice, so why should we waste our time doing these things?" Hence, often times this discouraged our initiative.* (CIO, FGI, G9-Baucau, p. 19)

This teacher confessed that they were discouraged from doing the hands-on activities because students do not want to do them. The reason for their choice is that the national exams do not cover questions related to experimental activities, therefore they prefer to not spend too much time doing activities that are not examined in national exams.

Another teacher also revealed his concern when I asked whether they are conducting any hands-on activities with their students. He affirmed that he covers some practical activities but not for more than 10 minutes, because they should really prepare students on how to memorise the questions. He voiced this opinion:

> *We do the experiment in 5 or 10 minutes so that they know as, in the national examination, the questions are based on the textbook. The questions are like: what, from what, what is, who, and which should be memorised, so that they*

would able to answer the questions in form of multiple choice. (VID, FGI, G8-Baukau, p. 17)

He affirmed that most national examination items required the lower cognitive domain – such as what, from what, what is, or who. He then added that these questions are directly from the students' textbook, therefore they were better off spending more time practising for the multiple-choice form.

Another teacher also had the same concern; even if they taught students to understand the given concept, they should also prepare students to work through the cognitive test-driven process as she stated:

> *We should give the students lesson summaries that they can memorise to provide answers in national examinations. Memorise, so that they can answer otherwise they would not.* (IMA, FGI, G8-Baukau p. 17)

She highlighted that the important part of their teaching is training students to memorise the lessons. Otherwise the students would find it hard to answer the national exam questions.

From the participants' narratives and affirmed by my observations and review of curriculum documents, teaching and learning at school is driven by how the national examiners measure the students' performance. This has been by conducting multiple-choice exams, so schools frequently ignore other comprehension activities and go for what the exams demand because they do not want students to fail in their final year.

The participants were not only dissatisfied with this assessment method, but also discontented with the way the national evaluation office corrected the students' work. Their sentiments are described:

> *I heard that the national examination was marked by a machine. We have an experience in the last year where the students that we noticed were smart, got lower marks in the national exams, and those that we saw incapable in fact passed the test and got high marks. So, I just want to suggest, it is better the marking is done manually, so that we can really notice the quality*. (NIO, FGDI, G7-Likisa, p. 19)

The participant was suspicious of the work that was given high marks by a machine. He found that there were some irregularities where the students who were more capable at school got lower marks in national exams while some students that were

categorised as lower students, and did not meet the standard to pass the exams, in fact, got more marks. Therefore, he supposed the correction system should be done by humans to ensure accuracy.

The same view was highlighted by another participant from other municipality:

> *But the problem was . . .marking was done by the machine, which sometimes caused a failure. My friend informed me that the students he noticed were smart failed in the examinations but some students that been absent and their name removed from the school list, they emerged there. Hence, we can tell that the failure is immediately caused by the top level, the Ministry itself. This is a new problem for students. But manner of evaluation, we should do this so that we can know the students' process in learning*. (STE, FGDI, G8-Dili, p. 21)

This participant found marking which was done by a machine could cause inaccuracies. He questioned how some students who were clever in school failed in the examinations but some students who were not active in school, and even had their name removed from the student attendance list, eventually passed. He sees this as the educational authority's failure to ensure the quality of education. However, he agreed to keep running the national evaluation so that students' progress could be monitored.

In short, it could be said that teacher participants found the national evaluation system was one challenge to follow up for the new curriculum because it did not challenge students to study and do the other science activities that were offered in the textbooks. It seems that the national evaluation-system approach has affected teacher perceptions of how students should be taught and prepared as the new curriculum intended. Moreover, as gleaned from the national examination officer's narratives, pedagogy and curriculum design in the country had also suffered from civil unrest, which is a remnant of Timor-Leste's long history of occupation by its colonial masters.

5.8. Summary

The intention of the new curriculum for Timor-Leste is to prepare students to be scientifically literate. However unforeseen issues and challenges in the implementation have been given less attention from the design and mandate for its implementation. As the research participants articulated, these issues encompassed the structure of the curriculum, content, and language issues, as well as the lack of

resources and the national evaluation system. From the participants' discussions, the issues and challenges within the textbook circled around one common theme – the problem of context. Consequently, the content in the textbook was confusing as it was based on Western content and contexts. Therefore, teachers found this material alien and confusing when trying to help their students understand this alien content.

The participants raised concerns that the new curriculum structure was confusing as it was different from the curriculum structure that they were familiar with.

Research participants claimed that they were challenged in the field of implementation by the imposition of Portuguese language and content to teach science when this was not appreciated and used in everyday conversations by the media, government and local people.

What made it more difficult was that the physical context in which science content was taught did not have the proper facilities and amenities to facilitate a better understanding among teachers and students of these Western concepts.

And finally, the teachers lament that their quality of teaching is being evaluated based on these challenges, which then puts the blame on them for low quality of education. The teachers who participated in this study summarised, in this chapter, that unless the issues and challenges in the implementation of the new curriculum are addressed, the Timorese education system will continue to be challenged instead of offering a 21st-century modern education as the new curriculum intends.

CHAPTER 6

OVERCOMING CURRICULUM IMPLEMENTATION CHALLENGES

6.1 Introduction

Teachers everywhere in the world want the best for their students and they strive to provide a good learning environment for them to learn in. The same thing holds true for teachers in Timor-Leste. Although the country's education sector is under-resourced and the 3rd cycle curriculum requires teachers to teach using a new instructional language, there are teachers who are able to transcend those challenges by developing their content knowledge, enriching their teaching strategies and finding a way to make the difficult content material understandable for their students. The specific strategies and actions that Timorese teachers have undertaken are discussed in this chapter in order to answer the research question:

> What pedagogical strategies do teachers use when enacting the 3rd cycle science education curriculum?

The chapter has five sections. Section 6.2 provides a presentation of teachers' strategies used to provide and impart information. Section 6.3 describes teachers' endeavours to make scientific knowledge and information accessible to students. Section 6.4 describes a group of teachers who employed the nature of science-teaching strategy in order to show how scientists work. Section 6.5 presents examples of teachers who have utilised certain types of teaching strategies when facilitating students' learning. Section 6.7 is a summary of the chapter.

6.2. Providing and Imparting Information

One of the main roles of teachers is providing and imparting information to students at school. Using thematic analysis, the researcher found that there are various strategies that Timorese teachers have taken to provide information for their students. The specific approaches are depicted in Table 6.1.

Table 6.1
Providing and Imparting Information

Teaching strategies	**Indicator words/ phrases**	**Number of teachers**
Lecturing	I informed them I explain I told them I gave an introduction After doing the theory I taught Lecturing Talk about	38
Note taking	Gave notes Note taking To give notes Write my explanation on the board	16
Using textbook	Textbook	12
Using teachers' summary	Make a summary The summary Summarise Provide a summary Only a short summary Prepare some summary	12
Using media	Display video	3
Omitting difficult content	Sometimes I even skip it We skip those we do not know We do not want to pass on the wrong concept to students	27

From Table 6.1, it can be seen that the research participants, who are teachers and student teachers, have used six different ways of providing and imparting information to their students. The word *provides* refers to specific resources and insights that teachers used to mediate subject content for their students. However, if they found the teaching concept too difficult and challenging, then some omitted this content. The six strategies were: lecturing, note taking, using the textbook, using teachers' summary, using media, and omitting difficult content.

6.2.1 Lecturing.

Interview Data showed that most of the science teachers carried out a type of lecturing when imparting information to their students. Thirty-eight teachers out of 44 research participants confirmed that they used this strategy when I asked about their teaching strategies for teaching science. Responses that encompassed the lecturing strategy

contained indicator words or phrases like *I informed them, I explain, I told them, I gave introduction, after doing the theory, I taught, lecturing,* and *talk about,* were placed in this category. An example of a statement that was categorised as lecturing is:

> *The one about all subjects is that when we explain to the children, the content should have a link with the real situation in the country. We talk about the content, so we might be able to compare with what we know so that the students will try, then they might say that this is like what has been explained by the teacher*. (ESA, FGI, G7-Baukau, p. 12)

This statement indicates that through explanations, ESA believes the content of the subject could reach the students. She added that the explanation of content should be delivered in an interesting way such as by linking the talking content to things that are locally available for students. Using this lecturing strategy, ESA was hoping students would cope with the content and then be able to apply it later in their own lives.

Another teacher also stated that sometimes he had utilised lecturing as the main method during lessons. He voiced this by saying *I stand in front of the class, just deliver the information until the end of the class.* (INO, FGI, G9-Baukau, p. 8). He stressed that during his lessons he only lectured on the content. This method was utilised based on lesson plans and teaching topics that he was assigned to teach.

6.2.2 Note taking.

Besides the lecturing strategy, sixteen teachers indicated that they had used a notetaking strategy to provide scientific information to their students. The indicator words were**:** *gave notes, notetaking, to give notes, write my explanation on the board*. One example was:

> *So, I will only write my explanation on the board, and while I do the explanation, no one can make notes. Your obligation is to sit, listen and convey your difficulties, I will not clean it, and after we are done, then you can copy from the board. But all should have the notes.* (INO, II, G9-Baukau, p. 5)

INO's statement shows that in fact, he realised notes were important for students to have. From his teaching style, one might notice that he holds a traditional way of teaching and learning. However, INO's teaching strategy of providing science notes to his students does reflect this society's views about how their children should be educated at school. Timorese parents want their children to have notes when attending

school. Hence, it becomes inevitable for Timor-Leste teachers that their role is to ensure that students take or have notes when they come to school, as VID said:

> *Parents of the children are not in the year 1975; the parents nowadays seem different, they check the children's notes for a week, a month when the children go back home. More or less, what is the notes from the teaching, they check sometimes. So, if we only practise, just talking, there are no notes then it also becomes a question.* (VID, FGI, G8-Baukau, p. 9)

VID's statement reflected Timor-Leste society's belief about youngsters' education and learning, where most of the parents still rely on their children's notes to illustrate their child's presence and learning at school. A lack of notes could trigger questions by the parents, about whether children have skipped school or are missing classes. Hence, giving notes to students is an integral part of the learning activities that teachers are expected to include in their teaching plan. In addition, Timor-Leste still lacks resources for students to access the relevant information that they need. Therefore, it has become the teacher's role to find ways to ensure that each student has notes.

6.2.3 Using the textbook.

Besides providing science content with lecturing and note taking as mentioned above, 12 science teachers said that they provided textbooks for students while teaching students. The indictor word was *textbook.* For example, CLE said:

> *When I do teaching, if we need textbook then we get the textbook from the library. Then distribute them to the students, two students share one textbook. So that when I explain, I ask them to have a look at a certain page; they can do it.* (CLE, II, G9-Dili, p. 6)

From 28 schools that were involved in this study, CLE's school is one of 12 schools that have access to learning facilities such as students' textbooks. Hence, when teaching science, CLE distributed textbooks to students to help them access the knowledge that he explained.

6.2.4 Using a teacher's summary.

Another group of teachers provided a summary as a strategy to offer information to their students. The indicator words were *make a summary, the summary, summarise, provide a summary, only a short summary,* and *prepare some summaries.*

Realising that note taking was consuming too much time of their learning time, 12 teachers out of the 44 teachers decided to prepare a summary for their students to have and learn. Teachers use the strategy of letting their students copy a short summary provided by them. This activity was driven by the fact that schools have a shortage of learning resources for students including students' textbooks. INO recounted this teaching strategy by saying:

> *But I did a summary of whole content for a year by handwriting. And in the class, I just asked them to photocopy. Then I told them by this we can save time for writing. So, when I got to the class, I urge you to open specific pages to do debate.* (INO, FGI, G9-Baukau, p. 12)

INO's statement illustrates that before a classroom meeting, he provided a short summary of the learning content. By doing this, he found that he could save time from writing on the board and be more focused on explanations and discussions. INO's way of providing information was not to let his students copy all the information as printed in the textbook, but to sort out the important parts that students should have.

Initiating a handy written summary of content for students was also driven by the fact that the textbook information did not provide sufficient information for students. Hence, some teachers had re-formulated and summarised the textbook content for their students. One of the teachers shared her teaching strategy:

> *Yes, make a summary, the summary to teach the children, then the summary is not only from a book, but I also take from other references, because this textbook is not completely written, it only has its title but it is not defined further, therefore I need to look for other references, then summarise then bring it to teach.* (ULA, FGI, G8-Dili, p. 7)

ULA's statement illustrates that she provided notes and information for her students based on her perception of how and what kind of information students should have. Since she found the textbook did not provide the information that the students were supposed to have, she recompiled the science information from various sources for her students to learn. This was a way to provide rich information for her students.

6.2.5 Using media.

Although schools had a shortage of learning resources, some teachers had put effort into providing science information through electronic media such as a video. The

indicator phrase was *displayed video.* Three teachers had taken this strategy to present abstract and non-familiar content for Timorese students. One of the teachers expressed this by saying:

> *I present it with video and provide some picture that makes children could imagine. As I mentioned, my method was displayed video to students in 7 or 8 minutes. They watch a video about how a volcano occurs. Because it included in the textbook, the tsunami is there as well. Thus, I display video so that the children could watch it.* (ITO, II, ST, p. 6)

ITO's statement illustrates that he had put a lot of effort to help his students learn the concept of a volcanic eruption. Even though this phenomenon did not occur in Timor, since the textbook covered the content and it had relevance to other learning topics, he tried to fulfil the new curriculum requirements by displaying this event to students. He also believed that through this media teaching strategy students could gain an idea about the real form of a concept that they were directed to learn, particularly the consequences of activities beneath the surface of the Earth.

6.2.6 Omitted the difficult content.

A significant number of teachers left out information or knowledge that was out of their study area. These study findings show that 27 teachers out of the 44 omitted the content that they found difficult and challenging to deliver. The indicator words or phrases were: *sometimes I even skip it, we skip those we do not know,* and *we do not want to pass on the wrong concept to students*. One of the teachers recounted her teaching experience:

> *We would like to say that chapter that we like very much is the one relevant to our profession so that it would become an interesting topic to us, so we give something that we already know. Some other topics that we do not fully understand such as geology, biology, then we just say whatever we know, and we skip those we do not know, we cannot lie to them.* (MBE, FGI, G8-Dili, p. 9)

MBE's statement indicates that she was more confident to teach content that was relevant to her specialisation area. Since the new curriculum, teachers have had to cover other science domains that they had not mastered. They found it challenging to handle because they felt less competent to impart content that was out of their major

area. Their decisions were made because they did not want their students to develop incorrect concepts due to their uncertainty about the concept. Hence, they preferred to omit the required concept that they should have delivered.

6.3 Teaching Strategies to Help Students Understand Science Concepts

Another important role for teachers is to make sure that students are able to understand the concepts that are presented in the school curriculum. These findings show that Timorese science teachers have used several strategies to make these science concepts accessible and understandable for their students. The specific teaching approaches used are discussed next.

Table 6.2
Making Science Concepts Understandable

Teaching strategies	**Words/phrases**	**Number of teachers**
Discussions	We discuss one subtopic When we apply discussion They discuss things before discussing the relevant topic	12
Questioning	I asked back I was asked by students We also questioned them By asking the content of	14
Setting concept in a familiar context	Give a simple example Learning the concept by linking to the local context Make an example	24
Practical work	Experiment Practical work Hands-on activities	14
Demonstrations	Give a demonstration Show to them Show it again to them	16
Field trips	We direct them going to the field Research on the seashore Do direct observation	3
Project work	Split them into groups Group discussions Present the result	9
Kinaesthetic teaching strategy	We move a thing from one place to other I ask students to represent the planets	3
Translating into a different language	Translate it to Tetum Explain in both Tetum and Portuguese It needs to be explained in Tetum Explained in mother tongue	30

Table 6.2 illustrates that Timorese science teachers use nine teaching strategies to make science accessible to students, these are: discussions, questioning, setting concepts in familiar contexts, practical work, demonstrations, field trips, project work, kinaesthetic teaching strategy, and translating into a different language.

6.3.1 Discussions.

One teacher's strategy for making science understandable to students was having discussions. The indicator words/phrases were: *we discuss one subtopic, when we apply discussion, they discuss things,* and *before discussing the relevant topic.*

According to teachers, there were various reasons why they used the discussions strategy**.** Twelve teachers out of 44 were conscious that teaching and learning would be livelier if there was two-way communication. If teachers tend to dominate the classroom, students will find it easy to lose interest and concentration. Hence, involving students through discussions is a strategy to help students to pay attention and keep focused on teachers' talk. As ESA expressed:

> *When we are just lecturing, the students tend to get sleepy, but when we apply discussion, they are involved directly, they share their ideas, and they discuss things that they have_to,… then they conveyed their ideas, and after we can complete it. This is the difference; it makes the classroom more alive. Rather than solely explaining. There is time for the teacher to explain but there should be time for them to speak up.* (ESA, FGI, G7-Baukau, p. 14)

ESA's statement implies that discussions give students a chance to convey their understanding and views. Through discussions, students can learn from their peers. From students' expressions, teachers can detect whether the students have coped with the lessons appropriately. If students have not coped with the learning content as intended, then teachers could add the content that they were missing. ESA's way of teaching seems to be influenced by her perspective on how students learn and how teachers should interact with them. As stated, teaching through discussions means teachers and students share the lesson time equally.

> *There is a time that we teachers do the explanations, but there should be time for the students to speak and give their ideas… so in my lesson time all students*

are seated in groups or a circle. Then I gave them questions for them to discuss. (ESA, FGI, G7-Baukau, p. 15)

From ESA's teaching strategy, it can be seen that she provided two possibilities for students to convey their ideas: one where they could pose their ideas with her as the main facilitator or another where two students could share their ideas with their peers in a small group. The important thing was that they had a chance and courage to speak and share their views about questions that she had given them to be discussed. In short, discussions are a way to stimulate students generating their ideas, communicating them to their peers and developing their understanding.

Another teacher also used the same idea. This was ULA's teaching experience. With ULA's teaching, the discussion teaching strategy was used to provide a chance for students to practise their communication skills with their peers or, one day, in public. ULA expressed this by saying:

> *The discussion is good. Because I always see in my class that mostly the children are so quiet, then they are afraid to come forward, so the discussion method is for them to learn. They get used to coming forward. By doing so, we do not need to tell them anymore, but we can just say who wants, then they will raise their hands and willing to come and talk with courage*. (ULA, FGI, G8-Dili, p. 10)

In ULA's teaching, she applied the discussion strategy to challenge students to voice their thinking and have the courage to give a talk in front of others. This approach can facilitate students to have the courage to express their ideas and also learn from each other.

The discussion that ESA asked her students to engage in was about a geology topic. Her teaching strategy is described:

> *Prior to the lesson on rocks, I asked every student to bring rocks. In class, I asked them to put these at the front of each table. Then, I asked them "In your view are these rocks all the same or different?" Because rocks, even if they look the same, they are in fact different. This allows them to carefully reflect on my question and examine closely the rocks they brought to class… so in my lesson time all students are seated in groups or in a circle. Then I gave them questions to discuss*. (ESA, FGI, G7-Baukau, p.14)

ESA's way of facilitating learning through her discussion strategy provided two significant benefits for learning. First, she tried to create links between the learning topic and students' experience. Asking students to bring rocks that they had found to class means that indeed science is a subject that learn about the world around them. Second, posing discussion questions requiring students to carefully examine the physical form of rocks was a way to encourage students to discuss and find out that rocks are all different and are used differently. In short, the discussion strategy helped students to make sense of a natural phenomenon, and also helped them develop investigation skills.

6.3.2 Questioning.

Furthermore, through discussions, teachers can interact with students by questioning the learning content or other things they consider relevant to the discussed topic. Hence, 14 teachers out of the 44 asked questions as a teaching strategy during the learning process. The indicator words/phrases were: *I asked back, I was asked by students, we also questioned them*, and *by asking the content of.* One example of a teacher's strategy of teaching by utilising questions was:

> *And I asked students if we caught a fish and put it in the terrestrial side would the fish be alive? Then they answer "no." So, I told them that because terrestrial is not fish environment.* (ANT, FGI, G7-Likisa, p. 8)

ANT's teaching strategy showed that even though his question was simple and closed, with only one possible answer, he did not dominate the learning process by giving the information while students passively listened to him talking, but he interacted with students by asking them to choose then he asked what would occur if a fish was placed in a non-watery environment. According to Harlen and Qualter (2004), the question that ANT posed is a closed and simple question. This is because it did not require students to provide a wide range of explanations and personal ideas and it limited them to saying whether the animal would live – yes or no. ANT was the one who then emphasised that aquatic animals would only able to survive in watery conditions.

Another teacher who used questioning as a strategy to facilitate students learning science is MIG. He questioned his students to compare the purity of air in the city and the mountains. Distinct from ANT's teaching strategy, MIG's did not limit his students

in expressing their ideas but he encouraged them to think further and raised various answers to his queries. As he expressed.

> *The things that I did are about the environment and pollution, air pollution, soil pollution, and water pollution. I asked, "have you ever been to Dili?" "Yes, we have." "You could make a comparison between air and oxygen in Dili and in the mountainside, which part is cleaner?" They answer – in the mountains. "Why, what is the reason?" Because in Dili we encounter a lot of smoke, car, motorcycle, cigarettes, so when we breathe, it will cause some effects to our lungs. But in rural area is not, so it does not affect our lungs." Give them a case like this and they understand it and they seek the solution by themselves*. (MIG, FGI, G8-Likisa, p. 14)

From MIG's teaching strategy, he first asked closed questions to focus their attention. That is, they said yes or no to having visited Dili. To those who said yes, he gave another closed question for them to make a decision about which place's air was cleaner. Through open questions such as "why, make a comparison, and what" he invited students to not haphazardly provide answers but stimulated them to think beyond the classroom (Lee & Kinzie, 2012) by reflecting on the existing environment that they experienced personally between the city and the mountainside. MIG's discussion questions could also be categorised as person-centred questions (Harlen & Qualter, 2004), which means open questions that allow students to give their personal ideas freely without being limited to a definite answer. MIG was conscious of instilling problem-solving skills in students. If people inhale directly the smoke of industrial products such as cars and motorcycles, then it will interfere with their health.

6.3.3 Setting concepts in a familiar context.

Another teaching strategy that teachers had used to make science accessible to their students was setting a concept in a familiar context by using a real example. As the theory presented in the students' textbook usually covered a general idea, it became the teacher's role and responsibility to translate the given content for students to understand. An example was carrying out chemical reactions. In developed countries, they might use sophisticated equipment to explain or illustrate the concept, but Timor-Leste cannot provide the same context as developed countries, because the county lacks these resources. This would make it hard for students to see the worth and function of the learning concept. To overcome this situation, 24 of 44 teachers

contextualised the learning concept to students' life experiences. The indicator phrases were: *give a simple example, learning the concept by linking to the local contex*t, *and make an example.* MIG's statement provides one example:

> *For example, about substances and mixtures. We mix the two things, so we have named the mixture. When I entered a class, at the first time I give a simple example, did you ever prepare a coffee? Mixing sugar with coffee or tea? Or preparing milk? What happened there? If we mix the sugar with the coffee, we call what? If the coffee or the sugar is on its own, we call how? There they replied that the coffee was coffee, and sugar is sugar. Once mixed together we call it the mixture. Things that we didn't mix, we name it substance, of the things that we have mixed we known it as a mixture.* (MIG, FGI, G8-Likisa, p. 14)

MIG's teaching strategy illustrates that he brought students to their real world when he taught. By asking students about activities that students do daily in their lives, for example preparing coffee, he invited students to make links to the real context of the concept of substances and mixtures. This strategy helps students to understand better because they are able to see real-life examples of the concept.

Teachers who embrace this teaching strategy are aware that before they put the concept into a familiar context, they themselves have to understand the prescribed concept that they are going to discuss and then identify an appropriate example in ways that match the concept that students are learning. As one of the teachers claimed:

> *Sometimes when we teach, we just make it up from our thought, after reading and understand, oh… it matches with this topic; we just make an example. But we do not follow what is in there. We look at the image. Even it is hard for us; it is important for us to read the topic, subtopic. We will read and understand "oh this means…" but we find it on our own, "oh, this is the example for this."* (IMA, FGI, G8-Baukau, p. 2)

IMA's teaching strategy illustrated how after she read and gained the knowledge, she sought appropriate ways to match the learning concept to make it real for students. In short, teachers did not teach the concept merely by using content given in the textbook, but they were creative in pursuing appropriate ways to put a concept into familiar contexts.

6.3.4 Practical work.

Effective learning occurs when students are involved in what they are learning. Hence, teachers act as facilitators to help and encourage students to construct their own understanding of a concept or theory.

Also, teachers need to find a way to boost students' motivation to be actively involved in the learning process. Practical work is a strategy that teachers can use. By doing practical work or hands-on activities, students are expected to be involved and directly assemble and ultimately prove the concept that they are assigned to learn. Through this involvement, they are able to see how things work or observe a natural phenomenon that exists. It is also a chance for students to develop analytical skills. This study found that 14 Timorese teachers used a practical work strategy when teaching science. The indicator words were: *experiment, practical work,* and *hands-on activities.*

One of the teachers who embraced the strategy expressed this as:

> *The teacher needs to find a way to show these things through experiment. In the case of the volcanoes, we can dig the ground, use some mixture substances to illustrate what is inside a volcano. Show to them that when the mixture of substances interacts, there is an underground activity. If the heat rises continuously, then the activity in the underground structure increases, and one day the heat finds a way to breathe out. Thus, the volcano explodes. Doing this illustration will allow the children to have better a grasp of how a volcanic eruption happens*. (CLE, II, G9-Dili, 7)

In this volcano hands-on activity, the students were directly involved, mixing up some substances to represent the underground activity and make their own discoveries. CLE's teaching strategy and his students' interest to know more about the causes of volcanic eruptions is a reflection of inquiry-based learning (Kuhlthau, Maniotes, & Caspari, 2007). Through simple experiments, students were encouraged to be involved and do the hands-on activity and to act like scientists, for example by doing observations, conducting an experiment, gathering information, and assuming a sense of responsibility to understand the causes of volcanic eruptions, hoping eventually to draw a conclusion. As Kuhlthau et al. (2007) pointed out, inquiry is an approach that emphasises student-centred pedagogy and considers students as independent persons

who actively construct their own ideas and skills as they carry out practical work. They are not the traditionally viewed passive receivers of others' knowledge, and therefore inquiry-based learning is a good approach for developing a science pedagogy (Ling, 1999).

In addition, ITA's decision to do a classroom experiment was driven by her belief that through experiments students were motivated to learn better. As she expressed:

> *When we are just lecturing, students found it hard to understand so the good approach is through a hands-on activity. We asked them to bring materials that they are able to bring. And we teachers provide the rest. Because when we did the experiment, students like it and are willing to know the content further. Even though, they are young, they always have ideas to question something.* (ITA, FGI, G7-Baukau, p. 17)

ITA's statement implies that in fact, students learned better through experiments because they were eager to know more. This means the experimental activities fascinated students to explore the concept. She believed that if schools lacked materials, teachers should manage to find a way to make an experiment happen. Through practical work, it also allowed students to develop inquiry skills to build their own knowledge.

6.3.5 Demonstrations.

However, practical work needs more materials and time to carry it out. It requires specific time, large quantities of equipment and materials. Sometimes it needs expensive substances and materials. More than that, it also requires extra attention and the capacity of teachers to control the students during the activities. Hence, 16 teachers out of the 44 preferred to use the demonstration strategy in front of students. The indicator words were: *give a demonstration*, *show to them,* and *show it again to them*. An example of this strategy was expressed as:

> *If there is no time to do the experiment, then we can give a demonstration to the students, telling them that this is called this, because the students with this age just think about playing. Therefore, we should have a demonstration so that the student always remembers what we have taught.* (ESA, FGI, G7-Baukau, p. 16)

ESA's statement shows that teachers wanted to show the learning concept in reality either by experiment or demonstration. If an experiment would consume too much time, then teachers could at least arrange some materials to just display or demonstrate the concept to students. This strategy could clarify the concept so that students might be challenged to understand when they just listen or read about it from a textbook. Even though it would not involve students in the activity, ESA believed that through demonstration students would remember the lessons for longer. ESA believed that this strategy helped students to have a better understanding about a concept and helped them to focus on the accompanying learning content.

6.3.6 Field trips.

Another teaching strategy that teachers used to make science understandable to students was conducting a field trip. A field trip is a teaching strategy where teachers organise their students to learn science from nature outside the classroom. This strategy enables students to make connections between the concept and the reality of life. However, due to students' safety when carrying out activities and the time concern, there were only a few teachers who used the strategy. The data analysis shows that only three teachers ever took their students on a field trip. The indicator words were: *we direct them going to field*, *research in the seashore*, and *do direct observation.* One example is:

> *Regarding discussion as I mentioned, when we did the practical work about ecosystem/ecology. We direct students are going to field; we determined the space of study field. They marked the field study and surrounding it with a rope; then they list down things that they found there*. (STA, FGI, G7-Dili, p. 13)

Through a field-trip teaching strategy, STA assigned his students to collect information about living and non-living elements that exist in a certain area. This strategy enables students to have direct participation in the learning process by touching, feeling, observing and completing a task that was assigned to them. In other words, through a field-trip teaching strategy, STA gave students the space and chance to gain and practise ways that scientists work through conducting an investigation and listing or entering data. The field trip that was taken by STA can be an effective method

for encouraging student participation to improve their scientific skills and knowledge directly and independently.

In short, providing and encouraging students to be involved in science activities through experiment and field-trip teaching strategies to gain understanding is a way to advocate that students are the primary author of building and being responsible for their understanding.

6.3.7 Project work.

Teachers' efforts to limit their domination over students' learning were not limited to giving students the opportunity to perform science activities; they also required students to report on some activities that they did. Hence, nine teachers out of 44 used a project-work teaching strategy by splitting their students into small groups and assigning them a project to complete. The indicator phrases were: *split them into groups, group discussion,* and *ask each group make a presentation.* One example of the approach is:

> *Currently, I just did a group discussion with Grade 9 students about environmental impact. It relates to rubbish issues. I gave each group a different title, one group debate this, then present the result and the other does this then present the outcome, they presented about; rubbish, environmental pollution.* (INO, II, G9-Baukau, p. 16).

INO's way of teaching implies that he gave students a sense of responsibility by requiring them to search for information, brainstorm their ideas together, then present the discussion results in front of the class. The strategy seemed to provide a chance for students to practise their communication skills and critical thinking. Finding out the cause and effect of littering the environment challenged students to be critical of the actions and then provide appropriate solutions that, INO hoped, they would embrace in real life.

6.3.8 Kinaesthetic teaching strategy.

Some teachers also embraced a kinaesthetic pedagogical strategy. According to Cheney (2017), kinaesthetic teaching is teaching through movement-based activities whether they be small or large. Data analysis showed that three Timorese teachers had embraced the strategy when explaining science concepts. The indicator phrases were*:*

we move a thing from one place to other, and *I ask students to represent the planets.* One teacher expressed his teaching experience:

> *We are now in Chapter 2, which is about movement, so sometimes we have to practise, as mentioned that for the movement, we move a thing from one place to another place, so we move by moving things from a place to another place. We get each group to come forward, but because there are so many students, then we just have eight students from each group. We ask them to have a try.* (ICO, FGI, G8-Dili, p. 12.)

From ICO's teaching strategy, we can notice that, in teaching science, he was not imparting the concept of movement by lecturing in a traditional learning style, but he physically demonstrated how the concept works. Then he encouraged students to have a try and to perform the concept by themselves. The kinaesthetic proponents claim that it is an important strategy because it can improve memory, attention and general cognitive function (Cheney, 2017).

6.3.9 Translating into a different language.

Another strategy that teachers used to make science understandable to students was translating into a different language. Since the government opted to utilise Portuguese as the instructional language in schools, Timorese teachers needed to learn to use Portuguese so they could translate and have flexibility using different languages. It was hoped this would help students to understand the information that teachers delivered. In schools, learning would be difficult if teachers did not have this translation skill. This is because the curriculum content is only available in Portuguese and the majority of students are not familiar with it. Hence, it becomes the teachers' responsibility to translate and transform the content into students' own language to be understood.

This analysis showed that 30 teachers provided examples of this strategy, but all of them would need to be able to translate the materials. The indicator words/phrases were: *translate it to Tetum, we explain in both Tetum and Portuguese, it needs to be explained in Tetum,* and *explained in mother tongue*. One example of the strategy is expressed:

> *As we know that in Timor, we have two official languages, Tetum and Portuguese. Even book was written in Portuguese, but the important part is*

> *student could understand our intention, an introduction we can do it in Tetum or read in Portuguese then later translate it to Tetum, not whole part but at least we try to make our student understand what we say. But, if they do not get it, then we can explain in mother tongue so that they could understand it*. (MIG, FGI, G8-LIkisa, p. 16)

This statement illustrates that when teaching science teachers kept it flexible when imparting the science concept. Even though the textbook provided concepts in Portuguese teachers needed to be sensitive to their students' language situation. Teachers needed to be conscious of the language in which the content would be understandable for students. In MIG's teaching, he found that his students would understand the talking content if he communicated it in Tetum. But if some students still found it hard to cope with the content, then teachers needed to translate the content into another local language that they used. MIG's teaching strategy showed that he was able to embrace the subject matter and ways of encouraging students to be actively involved in the learning process, by translating the language that inhibited students from learning the science concept.

Timorese teachers realised that they had an obligation to deliver science content in more than one language, and crucially in one of the languages that students would understand. However, there were two aspects that needed to be considered: students' national examinations and teachers' limitations in mastering the learning language, which is Portuguese. Hence it was inevitable that they had to be flexible through the languages when teaching. As VEL experienced:

> *Frequently, we gave notes in Portuguese, particularly for content that giving in national exams. Because in exams there is no questions that ask in Tetum. Therefore, we should teach in Portuguese but if in the middle of lessons, our Portuguese has gone then inevitably we have to explain the lessons in Tetum.* (VEL, FGI, G7-Dili, p. 13)

The statement shows that this teacher had a good judgement of his students. He was concerned about the students' ability to receive the information. Hence, even though he was challenged by the new language demands at school he became flexible, working between the languages to ensure that his talking did help students learn the information that he imparted. Even though they were adjusting the teaching languages

in regular classes there was also a vital demand that they should not ignore: the national examinations. In exams, questions were only given in Portuguese; hence, using other language at school was a way to help students understand the content but preparing them to comprehend the relevant content in Portuguese terms was also mandatory.

6.4 Providing Students with an Awareness of the Nature of Science

Scholars argue that science knowledge is tentative, which means that scientific theories and concepts are not absolute but may change with time. Hence, helping students experience science activities and the process of science is more than allowing them to carry out experiments. But teachers must bring to the classroom scientific attitudes such as the ways in which scientists develop knowledge, for example, scientific skills: how to observe, and how they use models to develop and illustrate concepts (McComas, Clough, & Almazroa, 1998). Although these science teachers had not yet shown that they had embraced the true understanding of nature of science and could mimic the process that scientists perform when developing knowledge, some of them had started to teach the ideas, which paved the way towards an appreciation of how scientists work. The approaches that had been taken can be seen in Table 6.3.

Table 6.3
Providing an Awareness of the Nature of Science

Teaching strategies	Indicators words /phrases	Number of teachers
Showing how to experiment	I show them how to do an experiment How to use it for observation Show them first	3
Scientific inquiry	They observe Questions that they posed will be asked back to them to find the solutions	4
Fostering students' curiosity	The children raised questions why this occurred. I always start [lessons] with a problem	3
Modelling	Draw a model Represent the planets	2

Table 6.3 indicates that 12 Timorese teachers demonstrated some aspects of a strategy to illustrate the nature of science when teaching science. This consisted of four

teaching approaches: showing how to do experiments, scientific inquiry, fostering students' curiosity and modelling.

6.4.1 Showing how to do experiments.

Three science teachers included a nature of science strategy when teaching science to allow students to scientifically explore science according to the nature of science by showing how to do the experiment as an example for students to follow. The indicator words/phrases were: *I show them how to experiment, how to use it for observation,* and *show them first,* as CLE did with his students:

> *I try to do practical work first… then I have to prepare the students into groups one week ahead. Then in my class hour, they just enter the lab then I show them how to do the experiment after they are done, they do some discussion then present it. Following that, they return to class, and I am not to answer their questions but just to share the information about how scientists work in the concern topics*. (CLE, II, G9-Dili, p. 8)

CLE's statement indicates that prior to explaining science concepts to students, he tried to have them do some science activities. Before students explored the activities further, he gave them instructions on how to carry out the experiment. He did not provide students with direct answers to the discussion questions; but he gave them space and clues to let them find the answer for themselves. With CLE's teaching strategy, we could say that he embraced the spirit of scientific inquiry (Abd-El-Khalick et al., 2004) by providing a hook for students to find the answer scientifically through the hands-on activities that they had done.

Another way for teachers to allow students to learn science through the nature of science strategy was to instruct students how to utilise the laboratory apparatus. Hence, ahead of utilising the science tools and equipment, ESA showed her students how to use the equipment properly to prevent them damaging the microscope when they used it. She stated:

> *When we do practical work to identify bacteria, so we use a microscope as a technology, so that the students might be able to detect bacteria and its form which is evolving or tiny things that cannot be seen with naked eyes. Each group learned how to turn on, how to use it for observation, where is the part for observation, where is the button for turning it on. Show them first. In order*

> *not to break it, then we have to show them how to turn it on, then use it and how to zoom it. So, tell them first, then tell them to take something small. They observed worms from the pond*. (ESA, FGI, G7-Baukau, p. 12)

When using the showing-how-to-experiment strategy, ESA was demonstrating practical scientific techniques, before her students carried out their scientific inquiry. Even though she had just learned how to use the microscope recently, she immediately applied it to her teaching. This was because she believed that through using science apparatus, students could explore a microscopic world. By using a microscope, ESA's students could find out that in fact bacteria do exist but due to their small size, we humans find it hard to see them with the naked eye.

6.4.2 Scientific inquiry.

Another way for teachers to use the nature of science-teaching strategy in teaching science was through scientific inquiry. The research findings have shown that an inquiry-teaching strategy is a good way for students to gain new skills, engage critical thinking skills and construct their own knowledge (Carr et al., 1997). This is because it includes hands-on activities and students are encouraged to assemble the activities, seek answers and solve the problems by themselves.

This data analysis showed that four of the teachers had employed this strategy when facilitating students' learning. The indicator phrases were: *they observe,* and *questions that they posed will be asked back to them to find the solutions.* An example statement is:

> *My teaching method so far is that firstly when we get into the classroom, we present content, then make a bit of introduction of practical activities if there is any, then we organise them and split them into groups, then we give an example then they work, but we do not give the answer immediately, they have to explore then make question, they observe, they can make question after the observation before we provide them with the answer we have to give them the opportunity to answer first, allow the groups to answer, their answers are considered whether right or wrong, then summarise*. (ULO, FGI, G8-Dili, p. 15)

ULO's statement shows that during facilitated science lessons he tried not to dominate the learning sessions. Also, he did not position students as passive learners but kept

interacting with his students and provided scaffolding for students so that they could find and build their own knowledge through an exploration of the activities (Abd-El-Khalick et al., 2004). He also motivated students to communicate their findings regardless of the quality of answer that they gave. ULO's teaching strategy reflected scientific inquiry-based teaching and learning, where he encouraged students to act as scientists, by doing experiments, then required them to communicate to their peers the method that they had utilised to draw their conclusions.

6.4.3 Fostering curiosity.

Teachers are no longer the single and unique information source and provider. There are many sources and ways for students to gain information and build their own knowledge based on their own interests. Hence, three teachers advocated fostering students' curiosity when teaching science, rather than positioning them as passive learners. Fostering students' curiosity is a scientific attitude that supports scientific inquiry. The indicators words/phrases were: *the children raised questions, why this occurred,* and *I always start [lessons] with the problem.* An example of this strategy was:

> *Recently I did an activity on the force of gravity. So, we did an experiment on that; then the students collected materials, simple materials. Then we conducted the difference between [friction force] and gravity force. We did the experiment, and each group observed, after that, they asked the question, why rounded paper and flat paper fell differently, one paper fell first then the other paper next, and then we explained.* (ULO, FGI, G8-Dili, p. 15)

ULO's statement indicates that the activity that he did with his students triggered students' curiosity to know more about the effect of things when falling from a certain height. This activity was simple, but it resulted in a significant effect for students when learning science. This is because they used their curiosity to ask and discover how nature works and behaves. The activity also provided them with basic skills to be critical and propose a scientific explanation.

6.4.4 Modelling.

In science theory, occasionally, some concepts are hard to contextualise in real life. Hence, two teachers provided a model for their students to help them discuss

scientifically the concept of planetary orbiting. The indicator words were: *draw a model,* and *represent the planet.* One of the teachers said:

> *We have a practical manual, we display the simple materials, we draw a model of how to make rotations and translation movements. We explain it to them and draw a model, and later we used the students with one student representing the sun, another representing the moon, and another representing the Earth. So, when [the students being the Earth moves], the students being moon also moves around the planet Earth to show the movement of planets.* (STE, FGI, G8-Dili, p. 16).

STE's statement indicates that when he taught astronomy concepts to students, they were challenged since these form concepts and content are not experienced by humans on Earth. However, he used a modelling strategy by asking students to perform the movements of sky bodies to help them to understand the concept. Scientists also use modelling to explain phenomena. In this way, students were modelling how scientists developed hypotheses and explanations using models.

In the first 3 years of implementing the 3rd cycle curriculum (MoE, 2010a, 2010b), most of the local teachers found it hard to make astronomical concepts visible in schools. However, with the manual provided by MISES, which offered simple ideas and materials, like students being the sun and moon, it was now possible for teachers to help students learn science and demonstrate how scientists used modelling.

6.5. Utilising Learning Strategies

It seems that a teacher's pedagogy is largely influenced by how he or she believes students learn. Some of these Timorese teachers believed that students passively learn information from others. Hence, teachers set up their teaching plans and their strategy was to prepare large amounts of content that they saw as important for students to know. While some teachers thought that students would learn better when provided a chance to rehearse the knowledge, other teachers thought that their students would learn better when the concept was put in the relevant context and linked to prior learning.

The findings of this research indicated that Timorese science teachers largely utilised these three teaching strategies, namely: *preparing a large amount of content,*

rehearsing and applying knowledge, and *making links to students' contexts and prior learning.* Each of these learning strategies is presented and related to a learning theory and teaching approach in Table 6.4.

Table 6.4
Utilising Learning Strategies

Teaching strategies	Category	Indicator words/phrases	Number of teachers
Behaviourist learning approach	Learning of content knowledge (delivered in chunks)	Definitions of those terms Find out in other references My knowledge is in the children's brains, it never loses	12
	Knowledge delivered sequentially	Learning in stages First learn	8
	Rote learning by memorisation	Be able to learn more	10
Cognitivist learning approach	Practising and applying the learning content	Presenting them gifts I gave them a lot of exercises	6
Constructivist learning approach	Recapping previous lessons	Evaluating them about previous knowledge Making questions of the previous topic	6
	Identifying prior knowledge	I conduct students' previous knowledge on the concerned topic Have you ever heard this topic? Example of previous knowledge	5

Table 6.4 depicts three types of teaching strategies that Timorese teachers utilised when teaching students, these are:

- Behaviourist theory-based teaching strategies
- Cognitivist teaching strategies
- Constructivist theory-based learning strategies.

6.5.1 Behaviourist theory-based teaching strategies.

The teachers who used these behaviourist teaching strategies were categorised into three sub-category aspects: learning of content knowledge, knowledge delivered sequentially and rote learning by memorisation.

The teachers who used this behaviourist teaching strategy utilised their specialist strengths to provide a large amount of content knowledge. Data analysis indicated that 12 teachers had used the strategy. The indicator phrases were: *the definition of the terms,* and *find out in others references.*

Teachers who utilised this strategy perceived knowledge as objective, specific, and complete. Therefore, when the new curriculum was designed and structured about a non-specific general topic, it was be a concern for them. As a solution, they kept teaching students using strategies they had found to work. So, ahead of each teaching session, they sought relevant chunks of information that they found incomplete or missing, as NAN explains:

> *In the previous curriculum, it was described clearly about the definition of biology and physics. But in the new system, even the students are ready enrolled in pre-secondary school, but they do not know the definition of those terms. Because in the textbook it does not describe the meaning of it. So, we teachers are the one to find out in other references and gave it to students so that they can also learn about it.* (NAN, FGI, G9-Likisa, p. 6)

This participant lamented the lack of some information in the 3rd cycle curriculum that he considered vital for students to know such as the definitions of the common terms. He clarified his response by comparing it to the previous curriculum where the meaning of the learning terms was given, such as "what is biology?" or "what is physics?" However, as the new curriculum is framed in an integrated and thematic block approach, the meaning of the terms is not required. So, when, he tried to teach the students, they remained confused because of the lack of meaning or definition. Hence, as a solution before he went to teach, he tried to find other references that could provide him and his students with additional information concerning the teaching topic. Teachers who embrace this behaviourist idea believe that knowledge needs to be delivered in chunks and they (the teachers) are the unique sources who can provide rich information to students.

Another way that teachers used to chunk knowledge, as their strategy when teaching science, was a transformation of this knowledge from adults (teachers) to youngsters (students). This was revealed when I questioned them about their science-teaching

objective at school. The indicator words were *my knowledge is in the children's brains.* As VID expressed:

> *For example, my background is physics, so I want to transfer what I know to them, at least they know. Not so much but there is something that I plant in their heads, they have to know. Therefore, started for the beginning, this is my experience, things that they talked on energy, about other content, I know the direction, so I have to take from other references, not much but I put a couple of numbers in order for them to know. Because science evolves, this is my objective; I am planting something in the students' brains so that I might die one day, but my knowledge is in the children's brains, it never loses.* (VID, FGI, G8-Baukau, p. 10).

From VID's statement, we notice that he strongly held a behaviourist view of learning that encourages learning-oriented knowledge transmission of facts and principles (Agarkar & Brock, 2017). This involves teaching students by transferring knowledge from adults, who are considered to have rich information, to young learners who are considered less knowledgeable.

An implication of this belief is that the lessons are presented to provide material for rote learning. Most Timorese teachers were very concerned with the country's national examination. Hence, at school, teachers tried ways to enable students to memorise this knowledge in order to later reproduce it in exams.

In examinations, students were expected to recall their lessons and write these as precisely as possible in their answers. If the students answered slightly differently than had been taught then their marks were reduced. The keywords were *to be able to memorise.* Hence 10 teachers out of 44 had used the approach. An example of a teacher practising this learning strategies is:

> *Then we also need to give a summary to the children in order for them to be able to memorise so that they can answer in the national exam*. (IMA, FGI, G8-Baukau, p. 12)

Another teacher also highlighted this view of learning:

> *I teach in accordance with the content, that relevant to the national exam. I skip things that are not relevant to the national exam, because it is already*

> *difficult for me, would be even more difficult for the students*. (ELO, FGI, G8-Baukau, p. 12).

IMA and ELO's statements indicate that their teaching orientation was to prepare and equip students with content that was relevant for national examinations. Since they found that national examinations were memorisation and multiple-choice driven, at school, they prepared students to focus more on how to master the given content, so they could later reproduce it in the exams. In short, their teaching goal was limited to enabling students to be able to answer national examination questions but did not go beyond this.

Teachers who relied on a behaviourist way of teaching became confused if the content of the subject was not presented sequentially. Eight teachers had used this idea when teaching science. An example of a statement was *first learn or learning in stages.* As DES emphasised:

> *In my opinion, a person should first learn the root, then follow with the trunk, then learn_about the leaves. According to biology, things should go like that, but here, it is the opposite. Starting from the trunk and then the leaves, we do not know the root of it. And also, about the formula, from Grade 7 up to Grade 9, they [students] only learned about the formula of movement, but not the rest of it.* (DES, FGI, G9-Likisa, p. 9)

DES's statement expressed his perception of how the subject should be delivered. He stated that the content of the subject should be presented in an orderly manner, from simple to complex. So, when a teacher taught the subject, they also followed this strategy. However, in the new curriculum, he no longer found the same way of teaching content which caused him confusion. It seemed that the behaviourist teaching approach influenced DES's teaching practice because the behaviourists perceive teaching as an opportunity for students to build their knowledge gradually from a small specific base, which then broadens to a complex array of knowledge (Fosnot & Perry, 1996).

In short, teachers who embraced a behaviourist teaching strategy perceived students as an empty box that passively welcomes and accommodates whole chunks of

knowledge that teachers are eager to provide. Hence, the knowledge that is transferred should be structured sequentially.

6.5.2 Experiments to illustrate theory.

Proponents of behaviourist learning also see learning science as directing students to find facts and principles that already exist in nature and are part of humans' reality. The implication of such teaching strategy for science teaching in the Timorese classroom is that experiments are used to deepen theory or concepts that had been learned ahead of the experiment day.

Hence, two teachers had adjusted their teaching to follow this view: The indicator words/phrases were: *after doing the theory*, and *in experiment just to deepen the theory.* One example of the statement is:

> *Theory in this week, then one day or one hour we use for practicum. Then we have no choice; we should do the experiment. So, after doing the theory. Even the theory studied a week ago, in experiment just to deepen the theory that has learned on that week.* (DES, II, G9-Likisa, p. 6)

DES's statement shows that the practical work was carried out to illustrate the scientific theory rather than being designed and run to discover new things and equip students' curiosity to dig into the secrets of science. It was focused on proving concepts and formula that had been learned earlier. So, this was another behaviourist teaching strategy that was largely used by these teachers.

To conclude, the behaviourist way of teaching and learning was a way that most of the Timorese teachers had been trained and had experienced throughout the formal education system. As a result, most teachers continued to insist on teaching sciences separately because they believed by teaching science (biology, chemistry, and physics) separately, they could focus on one subject and teach a large amount of science content deeply.

6.5.3 Cognitivist theory-based learning strategies.

Another group of teachers believed that students would learn better if students had a chance to reflect on and keep rehearsing the given content. Teachers who applied this strategy were influenced by a cognitivist theory-based teaching strategy. Distinct from the theory of behaviourist learning, the cognitivist theory perceives that the

information that reaches the students will not necessary be accepted by them, but students will actively process, filter and store information that they find worthy for them to possess and this will occur by carrying out exercises related to the information.

The implication of this belief for teachers' teaching is that they design the lessons so that they can practise the activities and get rewarded for doing so. Hence, two teachers out of 44 granted gifts to their students after they completed homework that they assigned them to do. The indicator words/phrase were *presenting them some gifts,* and *I gave them reward.* As one of them expressed:

> *My way to motivate students learning was presenting them some gifts. For those that completed the homework and got most correct, I gave them reward in form of notebook and pens. So that they are diligent to study*. (OSE, FGI, G9-Dili, p. 13)

OSE's statement shows that stimulating students to revisit and complete some task that he had assigned for them was an effort to boost students' passion to study. Hence, he rewarded them with notebooks and pens as a form of supporting activities that they did, completing homework. Granting students a gift is a teaching strategy that reflects a belief in cognitive learning theory.

The cognitivist proponents also perceived that providing students with a chance to reflect upon and rehearse, then apply with exercises, what had been presented to them, is important (Agarkar & Brock, 2017). This is essential as there is an assumption that rehearsing is a way to highlight the learning knowledge and sharpen the memory's ability to hold the knowledge. The statement words/phrases were *I gave them a lot of exercises* [in other words problems to solve]. As VEL practised with his students:

> *We that teach biology, we have a lot of time, so I gave them a lot of exercise, with the main objective is so that when they go to Grade 9, they will be ready to deal/face the national exams. And the second is so that they understand the content better* (VEL, FGI, G7-Dili, p. 10)

VEL's teaching strategy was, after he explained the learning content, to invite students to practise it. For VEL, practising is a chance to prepare students to be able to deal with national examinations. However, if some students remained challenged to cope with the learning materials then he continued to give them another opportunity for better understanding. VEL's teaching strategy is influenced by a belief in cognitivist

learning where the cognitivist perspective emphasises that it is vital to provide a chance and space for learners to internalise the learning topic with practice and sometimes reward.

6.5.4 Constructivist-based learning strategies.

However, some teachers showed that they were moving with the times. They were sensitive to the learning demands of their students and adjusted their teaching strategies as needed. These teachers were aware of constructivist learning theory (Fosnot & Perry, 2005). When believing in behaviourist learning, teachers are keen to transfer concepts and the ideas of experts to students' heads, but the constructivist proponents oppose this view. They argue that learners have their own choice to choose information that they want to learn. If they find the new information worthwhile for them, then they will embrace it for their use. But if they think it is not worthy, then they will let it pass. Therefore, the constructivist perspective suggests that teachers give space to students to build upon their own understanding. As Carr at al. (1997) claimed, "We construct meaning for the world around us from our prior attempts to make sense of it" (p.163). This means learning will be meaningful if the new content or information has strong links with existing context and prior knowledge. Hence, some teachers delivered their teaching based on constructivist-based learning by recapping previous lessons and assessing how far students had learned the previous lessons. The statements words/phrases were: *I evaluated them about previous lessons*.

> *I asked the students "you have learned the internal structures of the Earth; how many are there?" They were confused. Some of them said we have not learned about it. Some confirmed that they have learned it while others said not yet. I kept asking, "Did you learn about types of rocks?" …The students said, "oh yes, we understand, we have learned." Some gave a response while others just kept quiet. At this moment, I evaluated them about previous lessons.* (ITO, II, ST, p. 7)

ITO's statement implies that he was using constructivist learning-theory strategies. Before he taught the "internal structure of the Earth and its external manifestations," he assessed students' knowledge to understand how much the students understood about the concept that had been previously taught by their schoolteacher. This shows that he had considered students' previous knowledge about the topic. He did not teach

students literally, as directed by his teaching supervisor, but he assessed how students should be taught based on his evaluation result. This shows that in his teaching, he was embracing the constructivism learning theory, which means he taught based on what students knew.

Six teachers out of 44 also embraced constructivist learning theory by basing their teaching on students' previous knowledge. Hence, six Timorese teachers included this strategy of identifying prior knowledge when teaching science. The indicators words were: *I conduct students' previous knowledge on the concerned topic, have you ever heard this topic?* and *example of previous knowledge.* One example of the belief in learning is:

> *Before I taught "internal structures of the Earth and its external manifestations" [Grade 9] This topic has relevance to Grade 7 and 8. How I know and assess student knowledge about this? Hence, as I mentioned earlier, in my teaching plan, I conduct students' previous knowledge on the concerned topic.* (ITO, II, ST, p. 8)

ITO's statement implies that he based his teaching on constructivist learning theory. Before he taught the "internal structures of the Earth and its external manifestations" he assessed students' knowledge to understand how much the students understood about the concept that had been previously taught by their school teacher in Grade 8. This shows that he had considered students' previous knowledge about the topic. He did not teach students, as directed by his teaching supervisor, but he assessed students to find out how they should be taught based on his evaluation result. This shows that in his teaching, he considered the constructivist learning theory, which means teachers teach based on what students knew before.

6.6 Summary

This chapter has provided information about how teachers used their pedagogy to overcome the challenges of a lack of texts, equipment, materials and teachers in order to provide a useful learning environment for students.

They relied on sharing information that reflected their views that knowledge could be transferred from teacher to students – a behaviourist view of learning. However, there were signs that some teachers understood that cognitive and constructivist learning

theories could be practised in their pedagogy to make it easier for their students to understand science.

Many teachers believed in the importance of science experimentation and science enquiry and when possible attempted this strategy even if they were limited by time and equipment. When this happened, they carried out a demonstration of the experiment.

An awareness of constructivist learning theory was starting to appear in their practice with their appreciation of using questioning, discussions and group work in order to help students to understand the topic.

CHAPTER 7:

DISCUSSION AND CONCLUSIONS

7.1 Introduction

This research aimed to explore how integrated science has been interpreted and taught in the current *3rd Cycle Science Education Curriculum* in Timor-Leste in order to identify areas for future professional development. The research questions that guided this exploration were:

- How has the vision of an integrated science curriculum been interpreted by Ministry of Education officials and educationalists involved in this curriculum reformation?
- What are the challenges for teachers as they enact the new *3rd Cycle Science Education Curriculum*?
- What pedagogical strategies do teachers use when enacting the *3rd Cycle Science Education Curriculum*?

Answers to the research questions are paid attention to in Sections 7.2–7.4. Section 7.2 comments on the vision that the Ministry of Education officials and educationalists had to translate this vision of curriculum enactment. Section 7.3 reflects on the challenges of curriculum implementation as recounted by teachers, while Section 7.4 considers the significance of the pedagogical strategies employed by these teachers in Timor-Leste. Section 7.5 considers the challenges that teachers face when developing students' scientific literacy. Teachers' science education pedagogy is compared to Cochran et al.'s (1993) model of PCKg in order to estimate the level of PCKg they identify in their responses. Also, in this section, is a discussion of how the perpetuation of the colonial educational legacy can partly explain the issues of language and the view of learning held by teachers. Implications for professional development are discussed in Section 7.6 and in Section 7.7 future directions for research are identified. Section 7.8 discusses the limitations of this research. Section 7.9 presents a summary and concluding statement.

7.2 Translation of a Vision

To answer the first research question, it appeared that the Timor-Leste government viewed education as one of the fundamental pillars for eradicating poverty and re-

building their country (RDTL, 2002). Science was seen as one of the subject areas that was central in this process (MoE, 2010b). Consequently, the vision of the *3rd Cycle Science Education Curriculum* was to create a scientifically literate Timor-Leste workforce who could successfully compete in the international labour market. This aim is similar to countries that are reforming their curriculum when preparing for this millennium era. For example scholars who reported on these curriculum development include China (Wei (2009), Singapore (Lam et al., 2013), Indonesia (Prihantoro, 2015) and South Africa (Naidoo, 2010). This aligns with Vieira and Tenreiro-Vieira's (2016) view that a curriculum should provide access to scientific literacy for all students. In addition the notion that educated citizens are an economic resource to be cultivated is similar to that held by Indonesian educators (Abbott, 2017), and can be regarded as an ongoing legacy of their occupation. As part of this new curriculum, skills were identified for students to develop, such as being able to think scientifically and the development of competencies, to achieve this outcome (MoE, 2010b). These skills are referred to as transversal competencies because they can be integrated across all curriculum areas.

In Shah's paper entitled, *Timor-Leste ten years on: Reconstructing curriculum for the future,* he states that as Timor-Leste turns to building its political and economic independence, curriculum reformation is seen as a mechanism that could re-establish "public confidence and participation in an educational system" that is appropriate at this time of developing independence (2009, p. 2). He further argues that while many consider (including the government and donors) this curriculum reform as a crucial part of Timor-Leste's independence, he is still unsure if this curriculum reform has truly contributed in building the country after years of occupation and war.

In another paper, Shah (2014) raises an important pedagogical question in the title of the article: *Learner-centered pedagogy in post-conflict Timor-Leste: For the benefit of the learner or the learned?* Shah (2014) argues that an understanding of curriculum design and implementation in Timorese education essentially needs to be anchored within critical discourses about "colonial and neo-colonial influences" (p. 58). He suggests that educational policy makers need to be aware that imported ideas and expertise may not always the answer for the colonized country. Consequently the policy makers who are influential in terms of the design and enactment of the new

curriculum need to be able to see how this vision of a 21st century curriculum aligns with the overall vision of Timor-Leste in terms of achieving "full" educational independence. Because indeed, as Shah (2014) affirms, we need to reflect on who is benefitting from our classroom pedagogies that are promoted during this curriculum reform.

It seemed that Timor-Leste Ministry officials still held aspects of this colonial vision and they contracted a group of Portuguese scholars to develop a curriculum that would realise a curriculum that aspired to scientific literacy for the new millennium (FM, II, p. 4). This 'borrowing' of educational ideas without considering Timor-Leste conditions was a continuation of past practices (Shah & Quinn, 2014). But in doing this, the Portuguese-designed curriculum then reflected a contemporary view of science education, rather than representing the needs identified by the Ministry officials for Timor-Leste's future. These Portuguese authors also developed textbooks and teaching materials to align with this contemporary curriculum.

Timor-Leste Ministry officials were then responsible for its translation into a classroom pedagogy. However, a barrier to a contemporary pedagogy was that these officials perceived the outcome of a contemporary curriculum to be knowledge acquisition to equip students to enter the international level market. They had a view of the spiral, thematically-organised curriculum that was content based, where all content had to be taught sequentially. In fact, this sequential view aligned with the previous curriculum and did not reflect the pedagogy needed to teach content thematically where the concepts are continuously revisited. Furthermore, this view of a fragmented implementation where content was foremost did not take into account the need to use contexts that were relevant for Timor-Leste students.

It seemed that these Ministry officials believed that as the underpinning spiral structure of the curriculum had been shared with educationalists and teachers, they would be able to implement the *3rd Cycle Science Education Curriculum* using an integrated thematic approach within this spiral structure. Additionally, these Ministry officials believed that once the curriculum documents had been released, all teachers would have access to the document itself and the associated teacher materials and textbooks. They were unaware that many teachers had not physically touched either the curriculum or the resources.

Whilst Timorese Ministry officials translated the curriculum in terms of content, the teachers' narratives (see chapter 5) showed that this was not enough to contextualise the new curriculum in Timor-Leste. In other words, it was difficult to realise the goal of scientific literacy because links were not made to connect science to the Timor-Leste students' everyday lives.

Thus, whilst other countries such as China (Wei, 2009), South Africa (Naidoo, 2010) and Singapore (Lam et al, 2013) were assimilating curriculum reform with the goal of aligning to a western pedagogy, and (un)consciously perpetuating colonization, Timor-Leste Ministry officials were seeing the new curriculum as a means of advancing independence and democracy in the country. However, this may have been a drastic move considering that there may be more important dimensions of everyday life that need attention such as rediscovering and asserting Timor-Leste values and identity amongst Timorese students and teachers than relying on a radical transformation of the curriculum (Shah, 2014).

The role of the educationalists was to support teachers to enact this contemporary curriculum. Even though they acknowledged the new *3rd Cycle Science Education Curriculum* was different, they did not model this vision of teaching in a thematic, integrated manner that reflected a constructivist theory of knowing – that reflected how people learnt (Baviskar, Hartle, & Whitney, 2009). Instead they focused on upskilling teachers' content knowledge in areas with which they were unfamiliar. In this way, they continued to base the teacher training on separate subject disciplines such as biology, physics and chemistry that provided a subliminal message for professional developers that a behaviourist view of learning required such information to be delivered as packages of information (Ninnes, 2013). This resulted in a contradiction between the curriculum vision and its implementation. The vision was of a constructivist-informed curriculum document, but it was described and explained without reference to how the teacher would gain the skills and knowledge to implement this visionary document. Instead teachers were given professional development as packages of knowledge in a behaviourist manner. This meant that that teachers gained a vague idea of this new curriculum and developed a view of the importance of gaining specialised knowledge from subject-specific trainers who would deliver information transmissively.

7.3 Facing the Challenges of Curriculum Implementation

There were four general questions asked of the teacher participants. These asked them to focus on their understanding of the curriculum document and its overall aims. Then they were asked about the challenges of implementing the *3rd Cycle Science Education Curriculum* and what materials they found relevant. These general questions enabled the researcher to identify the specific challenges that these teachers faced.

One of the challenges these teachers faced was they had a strong underpinning belief that content needed to be delivered in a step-by-step method to enable students to master scientific concepts. This belief in a behaviourist way of teaching was also supported by their belief that the curriculum was content driven and organised to deliver conceptual understanding. Such beliefs echoed education practices followed under the Indonesian regime (Ninnes, 2013; Shah, 2009, Shah, 2013). This belief is supported by a textbook style that provide science information in a sequential way. Kanginan (2000) is an Indonesian physics textbook writer that presents information in this manner and is used by teachers and students in Timor-Leste. Such a style of text and teaching reinforces as Mansour (2013) describes as a determinist way of learning.

Because these teachers had been teaching within their specialisms when they were required to develop lessons that reflected more than one discipline it seemed that they believed they lacked a deep understanding of the scientific concepts that provided the foundation for that discipline (Ninnes, 2013). Consequently teachers who were trained in physics teaching felt unconfident in teaching a topic that had a biological or geological focus. This meant they were keen to be given the content quickly so they could plan an integrated unit as proposed. This belief that such information was necessary meant that they urged a professional development focus that was content driven.

Another challenge related to the way that training in the complex curriculum structure was provided by Portuguese and Brazilian curriculum specialists; however, this training only lasted two weeks and involved a representative teacher from each municipality. Training of the classroom teachers relied on a trickle-down model that

used the municipal trainers to deliver understanding of this new curriculum in one week.

There have been critiques about the professional development of teachers on enacting curriculum reform as being tokenistic (Garii, 2006) when such shallow professional development means that teachers revert back to their accustomed style when under pressure. For example in Australia, Ferguson-Patrick, Reynolds, and Macqueen (2018) reported on such a professional development programme going through the appearance of helping teachers realising this new curriculum but noting that because teacher pedagogical change takes time, there was little significant change in their pedagogy. Therefore, this report underscores the significance of providing in-depth and continuing professional development sessions for teachers (Anderson, 2015) in order for them to develop a belief that would resonate the intent and purpose of scientific literacy as espoused in the Timor-Leste curriculum document (MoE, 2010a & 2010b).

Moreover, Mansour (1999) maintains that teachers' confidence will either augment or work against teacher belief. Thus teachers' professional training needs to pay attention to teacher belief about effective pedagogy. This attention and acknowledgement of their views is important before engaging on strategies to build their confidence. These tasks need attention by professional developers before attempts are made to change teacher practice. Consequently when teachers are required to enact the new science curriculum time needs to be spent unpacking their beliefs about learning, teaching and an understanding of curriculum design before any changes can occur (Lowe & Appleton, 2014). This focus on finding out teachers' views would then affirm Pajares (1992) research that claims that science teachers' beliefs are dynamic and are influenced by their changing understanding about how knowledge is socially constructed and learnt. Such changes can emerge from teachers' professional development training when teacher belief is attended to and time is spent showing teachers alternative pedagogies.

Tsai's research (2002) when interviewing science teachers about their beliefs about the development of scientific knowledge and its teaching has been affirmed in this research. For example, over half of these teachers had a 'traditional' belief about teaching science where learning science is the acquisition of knowledge from credible

sources. Timor-Leste teachers demonstrated that they felt most comfortable when they were able to source knowledge from a text and found ways to transmit information to students when they could not provide their students with texts (see section 6.2)

The use of the Portuguese language as the vehicle of instruction also presented a challenge. Because many of these teachers received their undergraduate degrees in Indonesia (da Costa Sarmento, 2013), it was difficult for them to translate their scientific understandings from Indonesian to Portuguese, especially since they were unfamiliar with Portuguese language. To further complicate this situation, while the language of instruction was Portuguese, teachers needed to translate the material into Tetum and other local languages for their students to comprehend the material. This finding reflects Cardoso's (2012) identification of language instruction being a challenge. Also, it substantiates Quinn's (2013) assertion that in a multilingual situation, *which* language is used for instruction becomes a focus, rather than *how* to use the language to teach.

Furthermore, the use of Portuguese language was side-stepped by officials and not commonly used in wider society (da Costa Sarmento, 2013; Quinn, 2013). Instead, the use of Timor-Leste local dialects was promoted. However, unlike other subject areas, there was no specialist science Portuguese language course provided in teacher-training courses. Teachers in Timor-Leste were not confident to be able to switch between languages when explaining science concepts and the ability to 'code switch' (Quinn, 2013) was even more important when they were required to manage a pedagogy that asked students to critique science-based solutions as part of the development of scientific literacy. For example teachers translating science concepts from Portuguese in a text into Tetum (or other mother tongue) when explaining to students before their classroom discussion and critique.

Capacity building of teachers to enact the new curriculum also comes from ensuring that the necessary resources are in place (Lowe & Appleton, 2014). Resources posed another challenge and were uppermost in these teachers' minds. This challenge included their physical surroundings in the form of buildings, furniture and provision of laboratories. These physical limitations meant that teachers were expected to teach large classes in small temporary buildings that often did not have sound-proof walls and the furniture was either lacking or inappropriate for teaching contemporary

science. Identification of this challenge shows little improvement since Cardoso's (2012) findings about the lack of physical resources.

Access to physical resources such as science equipment and textbooks was limited. For example, more specialised equipment, such as microscopes and measuring devices, which are needed for scientific inquiry, was in short supply. Perhaps in the Timorese context, equipment written about in Portuguese texts (e.g. computers and microscopes) are not relevant for village-living Timorese students. This thesis has shown that many of the references in the text are not appropriate for these students (see section 5.5). This finding echoes those of Gabrielson et al. (2011) and Soares (2011).

As noted in section 5.5 that described the resource challenges where more than 60 students are packed in a small classroom, learning is hampered by a lack of facilities. It could be that Timor-Leste does not have the capacity for such curriculum reformation. Instead perhaps professional development needs to focus on a pedagogy that uses local resources and more importantly provides space and time for teachers to develop a self-belief that local examples provide an appropriate context for learning science concepts. Furthermore an incremental development of an appropriate pedagogy will enable teachers to work towards scientific literacy for Timor-Leste rather than the international stage for everyone.

Copies of textbooks were also limited and the norm seemed to be one textbook for the teacher and the whole class. As mentioned, science textbooks were inherited from Indonesian scholars and were dominated with a determinist learning approach for teachers to follow. This situation was rectified when a new curriculum textbook was developed with a constructivism pedagogy approach. However because the curriculum was new to the country, there was very limited time for teachers to understand these underpinning goals. A lack of resources both texts and science made more difficult its implementation.

Textbook organisation and content presented a particular challenge for these teachers, given the limited content in previous textbooks (Soares, 2011). While the textbook does provide a framework for the constructivist pedagogy needed for delivering a spiral curriculum with the content organised in blocks of themes, the themes were not

relevant to Timor-Leste society. Additionally, the contexts provided were inappropriate.

Other structural features in these textbooks seemed to promote anxiety for teachers, for example the posing of provocative questions that were used to encourage students to discuss issues where there was no "correct" answer because the focus was on the discussion, providing clues or leading students towards an answer, rather than gaining a correct answer through asking closed questions (Quinn, 2013). This type of discussion aimed to develop students' scientific literacy.

The textbooks also gave an opportunity for teachers and students to be involved in a constructivist pedagogy where they reflected on what they had learned, sometimes using concept maps and, at other times, with the request to think about what they were capable of solving or how the material linked to science, technology, society and the environment. However, these teachers seemed to be confused as they believed these questions modelled examination questions.

Another pedagogical strategy found in the textbooks was the authors providing international examples that the teachers and students could use to compare with their own context. The textbook authors expected that the activities linked to these examples would require a high level of interpretation and comparison to the situation in Timor-Leste, but they did not provide sufficient details about the Timor-Leste examples to enable such higher order thinking.

The final challenge was the national assessment system. On the one hand, textbooks provided opportunities for students to contribute and take part in their learning in a constructivist manner, such as making observations, writing up scientific inquiries and document analyses – all examples of opportunities for self-evaluation (see Section 5.7). However, the national assessment system gave a different message. It was one of content learning, reflecting a behaviourist approach to learning. Evaluation of learning in this way revealed the Ministry of Education's lack of confidence in science teachers' pedagogy (JAN, II). They believed that a national examination system could not only assess students' knowledge but also audit teachers' practice. Likewise, these teachers felt their efforts are unappreciated when they saw lower ability students being

rewarded with higher marks, and more able students with a good understanding gaining lower marks.

Furthermore, Ministry officials did not seem to trust teachers' ability to mark this examination objectively (JAN, II). Due to this lack of trust, the national examination was mechanically marked in order to obtain consistent results, further reinforcing the emphasis on the delivery of content knowledge to be able to answer multiple-choice questions. Consequently, this assessment system seemed like a lottery.

Lowe and Appleton (2014) maintain that national tests are intertwined with curriculum reform and national tests should support the agenda of a global curriculum reform. Freire (2000) in his *Pedagogy of the Oppressed* strongly critiques a banking system of education where students are seen only as receivers of knowledge. He argues that this form of education is a form of oppression that uses knowledge as a means of subjugating people with a particular ideology. Unfortunately, the nature of the national assessment tests in Timor-Leste promotes a banking system of education. In section 5.7 Timorese teachers argue that the national tests reinforce memorisation where students are not challenged to critically engage with critical questions and the subject matter in general.

Thus, because of the nature of the national assessment tests, these teachers acknowledged that they encouraged their students to memorise and rehearse the content in preparation for the national examination. And whilst they were aware that this mode of education did not improve the critical thinking of their students, they continued to use this pedagogy, since their achievement as teachers, students, and schools were measured by the result of this national examination. In effect, the national exam promoted a behaviourist learning approach (Agakar & Brock, 2017). While a few teachers have demonstrated the emergence of constructivist learning strategies (see section 6.5.4) their response to reflection, the central component of constructivist learning, was absent. It must be noted that these reflective questions were provided in the text but they were ignored by these teachers as they were not seen as modelling examination questions (see section 5.7).

This research shows that teachers were aware of this disjunction between the requirements of the curriculum and what was asked of students in the national exams.

They implied from their stories that if Ministry officials want the successful enactment of the new curriculum, then they must look at the national assessment tests as well. In section 5.7 they noted that this standardized assessment contradicts what the new curriculum wants to promote and achieve – that is critical citizens that are able to compete to the demands of a globally scientific community as desires by the country leaders (RDTL, 2002). Unfortunately, as the teachers commented, a memorization-based and multiple choice form of an examination defies this purpose.

Shah (2009) also argues that it is challenging to shift teachers' traditional ways of teaching to adapt a modern curriculum and indeed this argument is acknowledged by the teachers. If students' (and indirectly teachers') intellectual achievements are measured by national assessment tests that actually maintain and promote a traditional behaviourist teaching approach, then it becomes doubly challenging for teachers to enact the proposed teaching pedagogies of the new curriculum. Therefore, a successful enactment of the new curriculum calls for a review of this national assessment tests because indeed, curriculum reform and national assessments impact on each other (Lowe & Appleton, 2014).

7.4 Pedagogical Strategies Employed

To overcome the challenges faced by these teachers when implementing the *3rd Cycle Science Education Curriculum*, they used a range of pedagogical strategies to assist their students learn science. Knowledge transmission from teacher to student was the dominant strategy used and this transmission was imposed by the lack of learning resources within the education sector. Consequently, teachers were the filter of knowledge learned by providing notes and/or summaries that determined the concepts learned. In some situations, the teacher filter was impermeable when they decided to omit particular concepts because they either lacked understanding or thought it to be unsuitable. However, this approach perpetuates a banking system of education, where students do not learn how to think critically (Freire, 2000), one of the transversal competencies required in the *3rd Cycle Science Education Curriculum* (MoE, 2012b).

The prevalence of note taking can also be explained in that parents expected to see these notes as evidence of both learning and their child's attendance at school. This

emphasis on checking the notes reinforced these teachers' use of transmissive teaching strategies (Agarkar & Brock, 2017).

However the range of pedagogies that teachers attempted indicated that these teachers were aware that students needed to be involved in their learning and a requirement for rote learning would not suffice. It appeared that some teachers were working towards a personal constructivist pedagogy (Gilbert, 2018) where they wanted their students to mimic their own strategies for knowledge development as they undertook professional development with their colleagues when recognising their need to develop their pedagogy . These participant teachers wanted their students to develop a sound understanding of scientific concepts and it was apparent that some of them used strategies to involve their students in their learning. This is evidence of these teachers adopting a student-centred approach (Shah, 2014) that was promoted in this new curriculum (MoE, 2010b). Furthermore, this student involvement hinted at a constructivist pedagogy as students became active in their learning (Bell, 2005; Osborne & Wittrock, 1983). For example, these teachers posed questions to stimulate discussions because they wanted to reduce the dominance of teacher talk. Also, they made use of contexts with which students were familiar, but, at times, this proved difficult as the examples given in the textbook were foreign to a Timor-Leste context. Again, this hint at the use of a constructivist pedagogy as setting learning in contexts relevant to learners is a central tenet (Carr et al., 1997).

The importance of practical work for learning in science was well understood by these teachers but they were restricted by a lack of scientific equipment and laboratories. Consequently, practical work tended to 'follow a recipe' or be a teacher demonstration. Additionally, because of the emphasis on knowledge transmission, these teachers felt there was insufficient time for practical work, further curtailing its implementation in classrooms. Field trips were even more infrequent because of their perceived time demands. However, project work was more popular, and some teachers organised their students into groups to problem solve, for example rubbish issues. Kinaesthetic learning was also a strategy employed in response to the limited resources. These findings are indicators of an embryonic constructivist pedagogical approach (Bell, 2005) to the enactment of this curriculum.

The critical issue faced by these teachers when helping students to understand scientific concepts was that they had to be able to translate conceptual material into many different languages, for example from Portuguese to Tetum to the mother tongue and then back again, which are examples of these teachers employing code switching (Quinn, 2013). This finding substantiates Quinn's assertion that the use of code switching could increase student engagement and interactions, thus improving learning.

Their teaching about the nature of science seemed to focus on transmission of scientific techniques, and, in the best cases, the way in which a scientific inquiry was carried out. Also, they viewed models as explanatory rather than as a way to develop scientific hypotheses or to analyse data. In this way, aspects related to the nature of science reflected a teacher-centred pedagogy that is commonly found in Timor-Leste classrooms (Shah, 2011).

It appeared that these teachers' views of learning determined the strategies that they used. For example, a behaviourist view of learning was unconsciously promoted with their aim of knowledge transmission when these teachers recounted their successful teaching strategies. Teachers encouraged their students to memorise and rehearse this content in preparation for the national examination, evidence of a cognitivist learning approach (Agarkar & Brock, 2017).

This research demonstrated that these teachers seemed to be promoting a personal constructivist pedagogy where they were facilitating a classroom environment that promoted individuals constructing their own intellectual understanding of scientific concepts (Gilbert, 2018). There were aspects of a constructivist pedagogy where individual elements were promoted such as the identification of prior knowledge. This showed that teachers were aware that a secure development of conceptual understanding needed to be built on students' previous understanding. Occasionally teachers were able to challenge their students' understanding by providing them with scientific explanations that challenged their present understanding. However for effective learning the establishment of cognitive dissonance required students to be able to discuss their previous understanding with their peers. As this did not occur it was apparent that these teachers had not embarked on a social constructivist pedagogy (Gilbert, 2018).

It must be acknowledged that as Baviskar et al. (2009) comments that a constructivist pedagogy is difficult to implement as a learning experience needs not just one of the elements of constructivist learning but all of them. That is eliciting prior knowledge, creating cognitive dissonance, applying knowledge with feedback and reflection on learning must be experienced by the learner. However for this process to be successful teachers need to have the level of pedagogical skill and knowledge to apply these elements in a way that is appropriate at the time. This level of pedagogical skill requires teachers to be sophisticated to realise that there is no specific formula to use.

This research shows that it was apparent that these teachers were still at an early stage of being aware of such constructivist learning strategies for, when provided with reflective questions in the textbook that could have stimulated discussion and reflection on learning, the teachers in this research perceived them as a model of examination questions. Consequently reflection, a central component of constructivist learning, was not recognised and at worst, avoided by these teachers.

7.5. Considering the Challenges

Developing scientific literacy.

The new curriculum not only was structured from a constructivist perspective it had aspirations that its implementation would foster student-centred learning (MoE, 2010b). These goals of a constructivist- informed pedagogy were identified in the guide for teachers (MoE, 2010b, p.4). Such an inspirational view of curriculum is based on learning science that is a tandem of personal and social constructivist learning strategies (Skamp, 2018) provides great potential for the future of science education in Timor-Leste. When the goal of scientific literacy is added, it would be expected that students would be able to reflect on their understanding by giving feedback about how this scientific view of an issue could apply in a local context. For example how knowledge of rocks could help them discuss the issue of building materials that would be accessible in the country. In fact no such discussion occurred when one participant teacher described their lesson planning.

Instead these teachers seemed to have a Vision I view of scientific literacy (Roberts, 2007) which was content focused and aimed to equip Timor-Leste students to compete on the international arena in educational and scientific communities. Rather than a

Vision II view of scientific literacy which can be identified as one of the goals of the *3rd Cycle Science Education Curriculum* where scientifically literate citizens are able to use scientific concepts to justify their position and decision making about an issue that is important in Timor-Leste society. The challenge is that neither the Ministry officials, the educationalists nor the teachers seem to be aware of how such a vision could be implemented let alone what scientific literacy meant. When asked directly, no participants were familiar with this term. In this way, the Ministry officials, educationalists and teachers were disconnected from this vision of scientific literacy that had been imposed by the Portuguese curriculum authors.

Aikenhead and Ogawa (2007) went further, identifying a Vision III view of scientific literacy. This view is less Eurocentric in that it incorporates indigenous traditional science knowledge. Such a view would have been ideal for Timor-Leste as it would further contextualise science education by incorporating traditional knowledge. For example, when learning about astronomy not only could Timor-Leste students learn scientific knowledge about the solar system, they could also learn Timorese views and strategies for time keeping using the position of the sun and hearing animal sounds. Incorporating this Vision III would mean that students would develop a richer understanding and there would be potential for using contexts that reflected their traditional knowledge and life in future teaching resources. Such an attempt to look traditional knowledge from a variety of countries was attempted in the text book- however the links to Timor-Leste were not made when examples of cultural explanations of astronomy were provided with photos and explanations.

Some of these teachers were beginning to contextualise science learning for their students. This emerging use could reflect a beginning understanding of Vision II scientific literacy, which involves a teacher's ability to contextualise the scientific concepts so students can see the relevance of science to their lives. Contextualisation often requires teachers being able to make connections horizontally, or integrate understandings across scientific disciplines in a curriculum, and vertically between levels of increasing complexity. However, because these teachers were reluctant to leave their subject specialisations, making connections across the scientific disciplines was difficult to achieve. Furthermore, because they did not understand about the spiral curriculum and re-visiting of topics, they tended to teach knowledge in chunks,

negating the vertical connections. And, because these teachers were preoccupied with knowledge transmission, there was no space given to the pedagogy required for teachers to develop students' ability to discuss issues in depth or to critically analyse the many dimensions found in complex science-based societal issues.

Analysing teachers' science education pedagogy.

Models of pedagogical content knowledge (PCK) are useful for analysing teachers' pedagogies in order to identify their strengths and weaknesses. Cochran et al.'s (1993) model was identified in Chapter 2 as having potential for such analysis. It was chosen as it has the potential for identifying how a teacher's PCKg is developing. Moreover because this model is underpinned by constructivist learning theory it can provide a vehicle for explaining how teachers are actively building their pedagogical experience from this common basis of a constructive learning-informed curriculum. It was anticipated that this PCKg model could be used to identify the focus of these teachers' pedagogy and where professional development might need attention. Consequently it was anticipated that a newly trained teacher would not have the same dimensions and shape as an experienced teacher who was conversant with constructivist learning and pedagogy.

Cochran et al.'s (1993) model identifies four domains of knowledge that a teacher integrates as they teach, resulting in their pedagogical content knowing (PCKg). A representation of their model is shown in Figure 7.1.

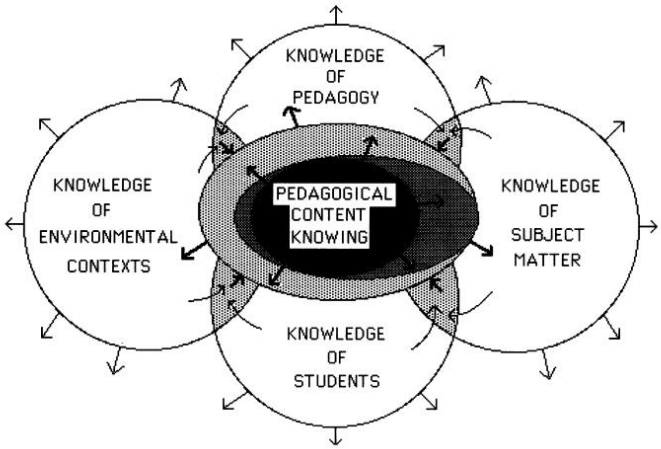

Figure 7.1. A development model of pedagogical content knowing (PCKg) as a framework for teaching (Cochran et al., 1993, p. 267).

Using Cochran et al.'s (1993) model, these teachers' PCKg can be represented diagrammatically as follows in Figure 7.2.

For example, the findings showed that these teachers had a strong knowledge of their students and their particular needs, for example in the way that these teachers could translate scientific concepts into multiple languages. Also, according to these findings, teachers had strong knowledge of the environmental contexts in which they taught. Even though they faced many challenges, teachers were able to draw on their environmental context knowledge to help learning. For example, a lack of scientific equipment was overcome through their use of local materials for measurement and creating simple experiments that illustrated scientific concepts such as motion through the example of students walking to school.

However, while these teachers had a deep knowledge of their particular discipline, most did not believe that they held sufficient subject matter knowledge across all of four science disciplines required to teach the spiral curriculum in an integrated manner. Their belief in the importance of content knowledge meant that their pedagogy was behaviourist in that it focused on transmitting knowledge to their students. The national assessment system reinforced a knowledge transmission approach. Consequently, the expression of their pedagogy was constrained and opportunities for constructivist learning were limited.

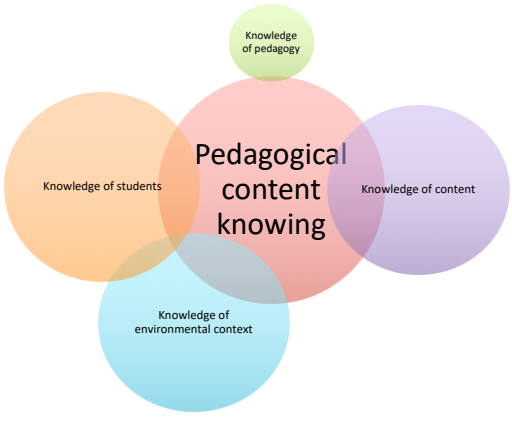

Figure 7.2. Diagram showing Timor-Leste science education teachers' expression of PCKg.

Figure 7.2 reflects the findings of this thesis that specialist discipline subject matter knowledge of these teachers was strong. Their knowledge domains of students and

environmental context showed they were very aware of the educational milieu in which this curriculum was being enacted. The representation of their knowledge of pedagogy domain is the smallest because the findings showed that these teachers were focused on knowledge transmission, rather than a constructivist pedagogy that could realise the curriculum demands for integration, which leads to scientific literacy.

Another component of this model is that it has the capacity to show how teachers have incorporated knowledge of their students into their PCKg. Thus, the merged areas could indicate some interaction between the components. In the theoretical model (Figure 7.1) there are areas of blurring that would demonstrate that integration had occurred and it could be difficult to differentiate between the separate components. Such a blurring Cochran et al. (1993) refers to as "simultaneous integration" (p.267). It was not apparent that these teachers had achieved such blurring as their attempts at integration was limited to two disciplines rather than integrating disciplines when an examination of a scientifically based issue could provide the structure for development of scientific literacy (Roberts, 2007). Instead they were aware that integration was required but had only made small steps towards such integration. This lack of progress could be because these teachers' knowledge of pedagogy was limited, hence. pedagogy was seen as separate and inconsequential to the most important pedagogical activity – that is acquisition of content.

What is lacking in Figure 7.2 are the arrows that show the direction of growth of pedagogical content knowing (PCKg). In the theoretical figure (Figure 7.1), it was anticipated that the dark area would change shape according to the direction of the arrows – so that blurred areas would converge and become dark and opaque. This dark area would indicate that a teacher's pedagogy would encompass all areas of knowing they considered important. Consequently this PCKg would be incorporated into a teacher's implicit belief about how science should be taught. Such PCKg could be thought of as a teacher's practical knowledge which is their view of their professional role as a science teacher (van Driel, Beijard & Verloop; 2001).

At this stage of science education in Timor-Leste Figure 7.2 interprets the findings that these teachers' PCKg was still strongly focussed on a behaviourist view of learning where knowledge acquisition was dominant and this behaviourist approach to learning

meant that a constructivist interpretation of the curriculum and its implement was at a very early stage.

However what is of significance is that this research has portrayed through Figure 7.2 the relative importance that Timorese teachers consider important when delivering this curriculum. That is how Timorese teachers believe students learn and in particular the attributes of each learning style. In order for teachers to develop PCKg it is important that Timor-Leste teachers experience PCKg in action so they are able to translate these developing teaching strategies into their classrooms and reflect on the difficulties and advantages to their colleagues during their expanding PCKg.

7.5.3 Perpetuation of the colonial educational legacy.

The findings of this thesis have shown how all of the groups of people involved in the writing, professional and resource development and enactment of this curriculum had differing perceptions of its goals. Even though Timor-Leste Ministry of Education officials in conjunction with UNICEF had a vision for the *3rd Cycle Science Education Curriculum*, because of colonisation and the conflict, there was a lack of expertise in Timor-Leste to develop this curriculum. There was also the belief that the Tetum language did not have the capacity for educational instruction, leading to the adoption of Portuguese as the instructional language (da Costa Sarmento, 2012). Consequently, these officials looked to Portuguese curriculum writers for assistance (Shah & Quinn, 2014). But these curriculum writers produced a curriculum that reflected modern views of science education with sophisticated pedagogy, which involved a critical application of scientific literacy.

Furthermore, this curriculum does not reflect a Timor-Leste context (Shah & Quinn, 2014) making enactment of scientific literacy difficult for Timor-Leste teachers and students to achieve. As Shah (2014) observes any curriculum development and professional development discussion needs to be accompanied with opportunities to discuss the colonial influences that are influencing this implementation. Such an examination of teachers' views and educationalists' beliefs could identify the issues that return teachers to a behaviourist teaching style.

Based on the curriculum requirements, textbooks were developed for Timor-Leste teachers and students by Portuguese academics. But these textbooks set up two major

disconnections. First, the textbooks reflected a strong constructivist pedagogy that required reflection, discussion, inquiry and practical investigation. It also required that teachers be co-constructors of knowledge alongside their students. However, because these teachers employed a behaviourist approach, they failed to recognise the constructivist foundations of the pedagogical strategies provided in the textbooks, and ignored them. For example, the reflective questions provided did not have an obvious answer and could have made the teachers feel insecure about their ability to transmit the required knowledge. Accordingly, they dismissed this central component of constructivist pedagogy.

Secondly, these textbooks used contexts that were more relevant to developed-world countries, for example trains, bridges and airplanes. The setting of learning in a relevant context is key to constructivist learning (Osborne & Wittrock, 1983), and, as a result, another disconnection was set up for these Timor-Leste teachers and students. These teachers then had to search for alternative contexts that were relevant for their students, for example when studying geological activity by finding rocks that were particular to Timor-Leste.

These disconnections reflect a colonial imposition of this curriculum. Firstly, the Portuguese curriculum developers produced a curriculum that was not sensitive to the Timor-Leste context, resulting in disconnection. The textbooks produced to enact the curriculum served to perpetuate the disconnections. This situation was exacerbated when Portuguese Brazilian trainers had only two weeks to train the Timor-Leste municipal teacher trainers to not only show how scientific concepts could be integrated but also the constructivist pedagogy needed for such integration. These overseas trainers then directed the municipal teacher trainers to carry out professional development with other teachers in their municipality within the space of one week. When the municipal teacher trainers expressed disquiet about the integration of scientific concepts, their concerns were dismissed.

Finally teachers tend to revert to a teaching style they are familiar with. Consequently the colonial view of learning as promoted during the Indonesian occupation still linger in classrooms and when students are subjected to an examination system that promotes the acquisition of knowledge. The behaviourist learning belief still lingers in Timorese classrooms (Agakar & Brock, 2012).

7.6 Implications for Teacher Professional Development in Timor-Leste

What is very evident is that teacher belief has a strong influence not only on professional development uptake but also on the interpretation of pertinent pedagogy (Anderson, 2015; Lowe & Appleton, 2014). The literature provided information that a teacher's belief in an effective pedagogy can be complex and contradictory (Bryan, 2003). This contradiction was seen to be the case with the way in which professional development was delivered to teachers – where content knowledge was promoted over pedagogy – and once more imparted through didactic teaching.

This pedagogical focus reflected Timor-Leste teachers' a strong belief that they needed more resources and knowledge development to improve their pedagogical content knowledge. However, these findings showed that knowledge development should not be a priority. Instead teachers needed to be convinced that a pedagogy focused on developing students' ability to be actively involved in their learning should be at the forefront of future professional development if it was to mirror the vision of this curriculum implementation (MoE, 2010b).

The findings show that instead of focusing on knowledge development, professional development should have attempted to show teachers the merits of constructivist learning (Bell, 2005). This can only occur by asking teachers about their views of learning and only then can they be challenged. When teachers develop a belief that a constructivist learning approach will increase the capacity of their students to learn more deeply than just the replication of knowledge when answering the national examinations, perhaps they will be persuaded away from a behaviourist approach to learning. Consequently, the focus of professional development should first be on showing teachers that a constructivist pedagogy will provide teachers with the skills to progress towards integrated contextualised learning.

Furthermore, teaching training programmes need to model constructivist pedagogy to enable teachers to take part in this approach to learning and experience the process first-hand. For example identifying their prior knowledge about learning, creating a situation where they are challenged about their pedagogical beliefs during a learning situation (cognitive dissonance); applying this new pedagogical insight into a new

learning experience; and providing opportunities to reflect on this learning process (Baviskar et al., 2009). During such a process, they can experience new strategies and skills, then reflect on their efficacy for learning, and how these can be implemented in their own classrooms.

Added to this, such professional development programmes need to develop teachers' understandings of the big scientific concepts that are horizontally connected across the four scientific disciplines in this curriculum. Such understanding goes beyond separate discipline knowledge, such as biological knowledge of photosynthesis, to understanding big scientific concepts such as energy conversion in photosynthesis, motion, exothermic reactions and earthquakes. In this way teachers could develop this conceptual understanding horizontally across this integrated curriculum.

As a result, this type of programme would grow these teachers' domains of knowledge of pedagogy and knowledge of subject matter.

However, such aspirations are not possible without cooperation with the national assessment organisers. While this method of examination dominates, teachers are forced to perpetuate a reliance on such a behaviourist pedagogy.

7.7 Future Directions for Research

This research is highly specific as it is only relevant to the Timor-Leste context. Accordingly, future research needs to focus on developing, trialling and evaluating professional development programmes for teachers as outlined in Section 7.6. Such educational research could provide bottom-up data to inform ongoing professional development programmes and curriculum development. This research could then contribute to developing an emancipatory curriculum relevant to Timor-Leste students rather than one imposed by a colonial power (Freire, 2000).

7.8 Limitations of this Research

The opportunities for interviewing the curriculum writers were limited because they were based in Portugal. Consequently, data about the curriculum structure and intent could only be gained by analysis of the curriculum document, rather than asking the authors directly.

Also, the sample of participant teachers was limited to teachers who had been exposed to some professional development. Consequently, only teachers from the Dili, Baukau and Likisa municipalities were interviewed. In other words, no data were collected from teachers in other areas who had not been exposed to some preliminary training about the new curriculum document.

Language was an issue in the collection and analysis of data for this researcher, as she needed to conduct the interviews in Tatum and then translate them into English. During the process of translating data from one language to another, nuances of meaning can be lost as well as in the subsequent analysis.

7.9 Concluding Statement

This chapter highlights the vision of 21st-century education to introduce scientific literacy as a mechanism to improve the decision making of Timor-Leste citizens. In this way it was hoped that this understanding would not only enable them to make science-based decisions but also equip them with a level of understanding to compete on the international job market. In the context of Timor-Leste, this is a significant vision considering how it just recently gained its independence and is doing its best to stand on its own as a modern nation.

Timor-Leste Ministry officials supported this move but appeared unaware of the difficulties for teachers in locating curriculum information. However, as discussed earlier, the contemporary view of science education that was aligned to the vision of the 3rd cycle curriculum was not aligned with these Ministry officials' and educationalists' awareness of the spiral curriculum that required returning to scientific concepts during a student's educational career. Seemingly both the Ministry officials and educationalists failed to consider the relevance of context when teaching science to Timorese students.

A huge pedagogical challenge to the realisation of scientific literacy was the adherence to the belief that effective learning was underpinned by a behaviourist pedagogy that focused on knowledge transfer. This apparent lack of teachers' understanding of an appropriate pedagogy to teach the 3rd curriculum was made even more challenging in that the training was conducted in a very limited time in Portuguese as the media of instruction. Consequently, the issue of language as it relates to teachers' training and

students' understanding of science education is a significant barrier to fully realising the vision of the 21st-century education for Timor-Leste.

Other challenges for teachers were resources and the national assessment examinations that reinforced the importance of content knowledge rather than the vision of the 3rd cycle curriculum to develop scientific literacy and ultimately to teach students to critique science-based solutions in that they were appropriate for Timor-Leste. The *3rd Cycle Science Education Curriculum* and associated textbook encourage a constructivist pedagogy where students are actively engaged in classroom learning. However, at present, because of the national assessment programme, teachers believe that a behaviourist pedagogy prepares their students for this national exam.

Yet, given these challenges, these teachers have developed pedagogical strategies to overcome the barriers to their students learning science. At the time when interviewed, their pedagogical strategies were more focused on the behavioural transfer of knowledge, but there were indications that teachers were beginning to develop some constructivist pedagogical strategies.

While the goal of the new curriculum could be helpful to the Timorese context, it also perpetuates a colonial legacy of education. The writers of the curriculum, Portuguese and Brazilian scholars, reflected modern views of science education with complex pedagogy, which involved a critical application of scientific literacy. And, as argued in Shah and Quinn (2014), the new curriculum did not consider the Timorese context, which not only made its implementation difficult but also the achievement of scientific literacy a challenge for Timor-Leste teachers and students.

This research has shown how important it is for teachers to understand how students learn science and be able to translate this information into an appropriate pedagogy. Consequently, their PCKg needs attention so that teachers have the opportunity to trial different pedagogical strategies with their students, reflect on their pedagogical beliefs and have some input into a national assessment system that can assess this ultimate goal of science education in Timor-Leste – that is scientific literacy.

As a concluding statement, I return to the aim of this research to explore how integrated science has been interpreted and enacted in the current *3rd Cycle Science Education Curriculum* in Timor-Leste in order to identify areas for future professional

development. The research findings showed that there were misunderstandings between the curriculum designers and its users. The curriculum was intended to develop students with scientific literacy skills; however, its users have not been able to translate their pedagogy into the goal envisioned for this new country: to become a modern society that approaches science-based problems with a criticality to determine how solutions could be developed that are appropriate for their society.

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APPENDIX A – List of Participants Involved in Study

No.	Type of Participant	Sex	Code	Other Details	
	Focus Group Interview Teachers			Municipality	Year Level Taught
1		F	ESA	Baucau	Grade 7
2		M	ETO		
3		M	OAO		
4		F	ITA		
5		M	GOS		
6		M	DOM		
					Grade 8
7		F	IMA		
8		F	INA		
9		M	ELO		
10		F	NHA		
11		M	VID		
					Grade 9
11		M	DIO		
12		M	CIO		
13		M	IXO		
14		M	INO		
				Dili	Grade 7
15		M	VEL		
16		M	DEL		
17		M	EAS		
18		M	NIO		
19		M	NTO		
20		M	STA		
					Grade 8
21		M	ULO		
22		F	MBE		

23		F	ULA		
24		M	ICO		
25		M	STE		
					Grade 9
26		M	PIN		
27		M	FLO		
28		M	OSE		
29		F	ARI		
30		M	IDO		
				Likisa	Grade 7
31		M	NIO		
32		M	BER		
33		M	ANT		
34		M	LIO		
35		M	TIN		
36		F	LAU		
37		M	LOR		Grade 8
38		F	MIR		
39		F	AVI		
40		M	MIG		
					Grade 9
41		M	ONI		
42		F	ARO		
43		M	NAN		
44		M	MAL		
	Individual Interview Teachers	**Sex**	**CODE**		
1		M	VEL		
2		M	MIG		
3		M	ETO		
4		M	INO		
5		M	NAN		
6		F	ARI		
7		M	OSE		

8		F	LAU		
	STUDENT TEACHERS				
		Sex	**Code**		
1		M	ITO		
2		F	FAT		
3		M	JOA		
EDUCATIONALISTS					
		Sex	**Code**		
1		M	VIO		
2		F	MIN		
MINISTRY of EDUCATION OFFICIALS					
		Sex	**Code**		
1	MOE 1	M	JAN		
2	MOE 2	M	FM		
3	MOE 3	M	ASP		
EDUCATIONALIST TEACHER TRAINING ORGANISATION					
	MISES				

APPENDIX B – List of Questions for Ministry of Education Officials

Research questions

Semi-structured interview questions: Ministry of Education Officials
Question focus: **How is the goal of scientific literacy reflected in the curriculum materials?** **How do educational officials interpret and express the concept of scientific literacy?**
1. Tell me about the reformation of the curriculum for the 3rd cycle of basic education? 2. What does the government expect to achieve from this new curriculum? 3. What are the specific goals for science education? 4. How do you ensure that these aims/goals could be achieved in classrooms? 5. Tell me what specific knowledge and skills the government expects students to achieve from this curriculum? 6. Tell me about the content that is covered in the new curriculum document? 7. How was the content determined? 8. How is the content appropriate to Timor-Leste? Give me some examples of when this content is very appropriate and when it is less appropriate? Why has this occurred? 9. How do you access the curriculum documents? Do you have the documents in your place/office? 10. How do schools, teachers and students access these documents? How you ensure that they do have access?

Semi-structured interview questions: Ministry of Education National Examiner
Question focus: **How is the goal of scientific literacy reflected in national exam?**
1. Tell me about the reformation of the curriculum for the 3rd cycle of basic education? 2. What does the government expect to achieve from this new curriculum? 3. What are the goals for science education? 4. Tell me some specific knowledge and skills that the government expects students have to gained from this curriculum. 5. Why have you decided on a national exam for science within basic education? 6. Tell me who designs and how you design and prepare the national exams for basic education? 7. What aspects do you consider when designing the national exam?

8. What aspect of science education do you want to measure?
9. Do you have guidelines/ procedures to measure the output of science learning in Timor-Leste? If so please explain them for me.

APPENDIX C – List of Questions for Educationalists

Research questions

Semi structured interview questions: Educationalists
Question focus: **How is the goal of scientific literacy reflected in the curriculum materials?** **How do teacher educators interpret and express the concept of scientific literacy for teachers during in-service training?**
General questions about the curriculum 1. How do you access the recent curriculum document? 2. What parts of the document do you emphasise when you are training teachers? Why? 3. How do you use the curriculum when training teachers? **Questions about scientific literacy** 1. What do you understand about scientific literacy? *I believe that scientific literacy is when students are able to use science to help them make decisions.* 2. What part of the curriculum refers to this idea? How do you explain this idea to teachers? 3. What examples of scientific literacy do you use with teachers? 4. Comment on the curriculum's role in supporting your training of teachers about scientific literacy? **Questions about the text books and teaching resources** 1. Describe your access to science textbooks and the teaching guidelines? If you can access them - are they helpful for your training of teachers? How do they help you? 2. Tell me about the content of these books. Tell me about the sections that relate to Timor-Leste context, life and cultures? 3. Do you find any content (including figures) that are not not found in Timor-Leste? Tell me more about this. What difficulties do you find when the examples are not relevant for Timor-Leste teachers you are training? **4.** What do you do in these circumstances? How you use these examples that are foreign to Timorese teachers? **Science integration for fostering scientific literacy** ***I know that in new curriculum it was emphasised that we need to teach science in integrated way.*** 1. Tell me what goals do you want to achieve by using this approach? 2. What aspects do you emphasise in your training to achieve this goal? 3. What I mean by this is what content and experiments have you used experiments in this way? 4. Tell me about the teaching strategies that you use to help teachers to foster scientific literacy for their classes?

5. What aspects of science teaching do you consider important when you are training teachers?
6. How do you organise and plan for teacher training components?
7. What types of preparation do you do before your training sessions? Tell me more about it?
8. What do you emphasise in the training of teachers? How do you do this?

APPENDIX D – List of Questions for Individual Interviews with Science Teachers

Research questions

Semi structured interview questions: Science Teachers (Individual Interview)
Question focus: **How do teachers understand and interpret the goal of scientific literacy in the curriculum?**
General questions about the curriculum 1. How do you access the recent curriculum document? 2. What parts of the curriculum document do you find useful? 3. What parts of the curriculum document do you think are important for your planning? 4. How do you use the curriculum document when you are planning for your teaching? **Questions about teaching of science** 1. What is your goal for teaching science? 2. Tell me about the successful/favourite teaching strategies that you use? 3. Tell me why you think they are successful and/or why they are your favourite? 4. How do you make your lessons relevant for your students? 5. Tell me about the examples you use that makes them relevant for your students. 6. Tell me about a science topic that you have taught recently? 7. What was the general goal for this topic - what did you want to achieve from this topic? 8. Tell me how you organise your plan for teaching? Do you do any preparation before starting a class? Could you tell me more about it? 9. How did you link a science topic to the school and exam requirements? **10.** With this example what part of the curriculum did you link it with? **Questions about /teaching resources- textbook** 1. Do you have science textbooks and some teaching guidelines? If yes are they helpful for your teaching? How do they help you? 2. Tell me about the content of these books. Tell me about the sections that relate to Timor-Leste context, life and cultures? 3. Do you find any content (including figures) that are not found in Timor-Leste? Tell me more about this. What difficulties do you find when the examples are not relevant for Timor-Leste students? 4. What do you do in these circumstances? How you use those non-contextual examples – drawings, pictures and written examples. **Questions about scientific literacy**

1. What do you understand about scientific literacy?

I believe that scientific literacy is when students are able to use science to help them make decisions.

2. When have you used science to help you make a decision?
3. What situations have you encountered in your teaching that have helped your students make science-based decisions?

Teaching for promoting/fostering scientific literacy.

1. Tell me about promoting class discussions with your class. What topic was this? How did help the discussion? What science-based issues did your students raise?
2. When did you find your students really interested in science? What made them interested?
3. Tell me about using resources that come from students' lives to teach science. For example, - students reading the newspaper or food labels that are found at the food market?

APPENDIX E –

List of Questions for Individual Interviews with Student Teachers

Research questions

Semi structured interview questions: Final-year student teachers

Question focus:
How do student teachers understand and interpret the goal of scientific literacy in the curriculum?

General questions about the curriculum

1. How do you access the recent curriculum document?
2. What parts of the curriculum document do you find useful?
3. What parts of the curriculum document do you think are important for your planning?
4. How do you use the curriculum when you are planning for your teaching?

Questions about your teaching of science when you are on teaching practice

1. What is your goal for teaching science?
2. Tell me about a science topic that you have taught recently?
3. Tell me about the general goal for this topic - what did you want to achieve from this session.
4. Tell me how you organised your teaching plan? What preparation do you do before teaching? Tell me more about it.
5. How did you link this topic to the school and exam requirements?
6. What part of the curriculum did you link it with?

Questions about the science teaching strategies you have learned and used this year

1. Tell me about a teaching strategy that you really enjoyed using? Why was it enjoyable?
2. How do you find out about students' circumstances? Their life experience and context for teaching science?
3. Give me some examples from real life that you use to help students understand the science concepts.

Questions about the text books and teaching resources

1. Do you have access to science textbooks and teaching guidelines? If so are they helpful for your teaching? How do they help you?
2. Tell me about the content of these books. Tell me about the sections that relate to Timor-Leste context, life and cultures.
3. Do you find any content (including figures) that do not relate to Timorese life? Tell me more about this. What difficulties do you find when the examples are not relevant for Timor-Leste students?
4. What do you do in these circumstances? How you use those non-contextual examples?

Questions about scientific literacy

1. What do you understand about scientific literacy?

I believe that scientific literacy is when students are able to use science to help them make decisions.

2. What experiences have you encountered when you have used science to help you make a decision?
3. What situations have you encountered in your teaching that have helped your students make science-based decisions?

Teaching for promoting/fostering scientific literacy.

1. Tell me about promoting class discussions with your class. What topic was this? How did help the discussion ? What science based issues did your students raise?
2. When did you find your students really interested in science? What made them interested?
3. Tell me about using resources that come from students' lives to teach science. For example, - students reading the newspaper or food labels that are found at the food market?

APPENDIX F

List of Questions for Focus Group Interviews with Science Teachers

Research questions

Focus Group Interview Questions: Science Teachers
Question focus: **How do teachers understand and interpret the goal of scientific literacy in the curriculum?**
General questions about the curriculum – *you may wish to share some ideas about the curriculum* **1.** What are the issues about accessing and using the curriculum document? **2.** Share the ways in which you use the curriculum for your planning? **3.** What do you like about the new curriculum document? 4. What do you find difficult about the new curriculum document? **Questions about teaching science – *you may wish to share with the group about your experiences of the teaching of science.*** 1. What are your goals for teaching science. 2. Share with the group an example of a teaching strategy that made science interesting for your students. 3. Share with the group a teaching strategy you used to make your lessons relevant for your students 4. Tell us about the issues of resources in science. 5. What are the issues about your text books. 6. What other resources do you access for yourself? For students? **Questions about scientific literacy** 1. What do you understand about scientific literacy? 2. Share your experiences about when you have used science to make a decision. **Questions about your teaching to promote/foster scientific literacy** 1. Share with the group how you encourage class discussions about science issues.

2. Share with the group how you have linked the science topic with everyday situations that your students encounter.
3. Share with the group how you could or have used local resources to discuss science-based issues - for example food labels or articles in the newspaper.

APPENDIX G – Information Sheet for Ministry of Education Officials

SCHOOL OF CURRICULUM AND PEDAGOGY
Te Kura o te Matauranga me te Ako

Epsom Campus
Gate 3, 74 Epsom Ave
Auckland, 1023, New Zealand
T +64 9 373 7999
W www.education.auckland.ac.nz
The University of Auckland
Private Bag 92601
Symonds Street
Auckland 1135
New Zealand

PARTICIPANT INFORMATION SHEET
(Education Bureaucrats)

Project Title: How scientific literacy is perceived and interpreted in Timor-Leste science education
Researchers: Teresinha Soares, Associate Professor Bev France, Dr Ritesh Shah and Dr Sally Birdsall

Project description
My name is Teresinha Soares and I am currently studying for a Doctor of Philosophy degree in Education at the Faculty of Education and Social Work at the University of Auckland. I have three supervisors overseeing my project – Associate Professor Bev France, Dr Ritesh Shah and Dr Sally Birdsall, all of whom work in the Faculty of Education and Social Work at the University of Auckland.

My research project is exploring how scientific literacy is expressed, understood and interpreted in the current 3rd Cycle Basic Education Curriculum in Timor-Leste. As a result of my research, I am hoping that my findings will inform science teachers' professional learning for an integrated programme that will promote scientific literacy in Timor-Leste.

What you will be asked to do:
I would like to conduct an individual interview with you that will take approximately 60 minutes of your time. Your participation is voluntary and you can withdraw your contribution at any time up to two weeks after our interview. Our interview will take place at a time and place that is convenient for you. The Director-General of Pre-School, Basic and Recurrent Education is supporting my research and has given an undertaking that your decision to participate or not will have no effect on your employment status or relationship with the Ministry.

The interview will be audio-recorded. You can stop the audio-recording at any time or refuse to answer any question. Your audio-recording will be transcribed by a transcriber who has signed a confidentiality agreement. The transcript will be returned to you for editing. You will have two weeks to make any changes and return the transcript to me. After that, I will assume that you are happy with what you have said.

Confidentiality
If you decide to take part in my research, I would like you to nominate a pseudonym. When I report my research I will use this pseudonym to protect your identity. Also, any identifying features of your institution will be disguised. However, because of the size of the education community in Timor-Leste, it might be possible for someone to recognise your comments.

Data storage/retention/destruction/future use
All of your data will be securely stored at the University of Auckland. The hard copy data will be kept in a locked cupboard. The electronic data will be kept on a password protected computer, backed up and then stored on the university's server. After six years, all data will be destroyed. The hard copy data will be placed in a secured recycling bin and the electronic data permanently erased from the computer's hard disk.

Your data will be used in my doctoral thesis, at conference presentations and in published journals. You will be supplied with a report at the conclusion of my research.

If you have any questions, please contact me, my supervisors or Head of School. Our contact details are below:

Teresinha Soares – email: tsoa864@aucklanduni.ac.nz (in New Zealand); teresoares75@gmail.com (in Timor-Leste)
Associate Professor Bev France (supervisor) – email: b.france@auckland.ac.nz; phone: +64 9 6238899 extn 48439.
Dr Ritesh Shah (supervisor) – email: r.shah@auckland.ac.nz; phone: +64 9 6238899 extn 46356
Dr Sally Birdsall (supervisor) – email: s.birdsall@auckland.ac.nz; phone: +64 9 6238899 extn 48458.
Associate Professor Helen Hedges (Head of School) – email: h.hedges@auckland.ac.nz; phone: +64 9 6238899 extn 48606.

What do I do now?
If you decide to take part in my research, please sign the attached consent form, place it in the envelope provided and put it in the box that will be left in the secretary's office. I will collect it from there.

For any queries regarding ethical concerns you may contact the Chair, the University of Auckland Human Participants Ethics Commitee, the University of Auckland, Office of the Vice Chancellor, Private Bag 92019, Auckland 1142. Tel (09) 373-7599 ext 83711, email ro-ethics@auckland.ac.nz.

Approved by the University of Auckland Human Participants Ethics Committee on 09 March 2017 for three years. Reference number 018618.

APPENDIX H – Teacher's Focus Group Discussion Consent Form

EDUCATION AND SOCIAL WORK

SCHOOL OF CURRICULUM AND PEDAGOGY
Te Kura o te Matauranga me te Ako

Epsom Campus
Gate 3, 74 Epsom Ave
Auckland, 1023, New Zealand
T +64 9 373 7999
W www.education.auckland.ac.nz
The University of Auckland
Private Bag 92601
Symonds Street
Auckland 1135
New Zealand

CONSENT FORM
(Teacher – Focus Group Interview)

THIS FORM WILL BE HELD FOR A PERIOD OF SIX YEARS

Project Title: How scientific literacy is perceived and interpreted in Timor-Leste science education
Researchers: Teresinha Soares, Associate Professor Bev France, Dr Ritesh Shah and Dr Sally Birdsall

I have read the Participant Information Sheet, have understood the nature of the research and why I have been asked to take part in this research. I have had the opportunity to ask questions and have them answered to my satisfaction.

I agree to take part in a focus group interview with the researcher.

I agree for the focus group interview to be audio-recorded.

I undertake to keep what is said in the focus group interview confidential to those in the group and not discuss what was said with people not in the group.

- I understand that:
  My participation in the focus group interview is voluntary.
- The District Education Director has given an assurance that my decision to take part or not take part will have no effect on my employment status with my school.
- I will take part in a focus group interview that will last approximately 60 minutes with four to five other teachers who teach the same year level as me.
- The District Education Director has given permission for the interview to take place at the District Education office at a time convenient for everyone involved.
- During the focus group interview I can refuse to answer any questions and/or leave the interview at any time but the audio-recorder cannot be stopped.
- The audio-recording will be transcribed by a transcriber who has signed a confidentiality agreement.

- Because the interview is conducted in a group, I cannot withdraw my contributions or edit the transcript because it would affect the flow of the conversation.
- I will receive $10 from the researcher and be provided with refreshments at the meeting and interview.
- My identity will be protected through the use of a pseudonym that I will nominate in the space below.
- Any distinguishing features of my school will be disguised.
- Because of the size of the Timorese education community, it might be possible for someone to recognise my comments.
- Data will be used in the researcher's doctoral thesis, conference presentations and journal publications.
- All data will be securely stored at the University of Auckland in a locked cupboard, on a password protected computer and on the university's server.
- After six years, all data will be completely destroyed.
- I will receive a research report at the conclusion of this research using my contact details provided below.

Name:

_____

Signature: _____Date: _____

Nominated Pseudonym:

_____

Contact Details:

_____

_____

_

APPROVED BY THE UNIVERSITY OF AUCKLAND HUMAN PARTICIPANTS ETHICS COMMITTEE on 09 March 2017 for three years. Reference Number 018618.

APPENDIX I – Letter of Assurance from Director-General of Education, Timor-Leste

REPÚBLICA DEMOCRÁTICA DE TIMOR-LESTE
MINISTÉRIO DA EDUCAÇÃO
DIREÇÃO GERAL DA PRE ESCOLAR, ENSINO BÁSICO E RECORRENTE
Rua Villa Verde Dili Timor-Leste

Ref.: 034 /DGEPEBR/ME/III/207

To: Teresinha A. Soares
Ph.D. student at University of Auckland

Subject: request authorization for Ph.D. study research in Basic Education Schools in Timor-Leste

Dear Teresinha,

Referring to your letter dated 18 January 2017 requesting for an authorization to conduct studies as part of your Ph.D. program on Scientific Literacy in Basic Education in Timor-Leste, I believe that such research is important not only for the completion of your Ph.D. study but most importantly will benefit and contribute to the development of science literacy in the 3rd cycle of Basic Education in Timor-Leste.

Thereto, you are welcome to conduct the research in Basic Education in Timor-Leste as you planned for.

In our part, the Office of Director-General of pre-school, Basic and Recurrent Education will make necessary arrangement to ensure collaboration from different relevant National and Municipal Education Directorates including Basic Education establishment to you. But as Director-General, I reasure the participants that their decision to be part of the research , or not, will have no effect on their employment status or relationship with the Ministry of Education.

The Ministry of Education in Dili appreciates very much and expect to see you on a successful study in Timor-Leste.

Dili, March 2nd, 2017

MINISTÉRIO DA EDUCAÇÃO RDTL REPÚBLICA DEMOCRÁTICA DE TIMOR-LESTE HONRA, PÁTRIA E POVO

Cidálio Leite,
Director-General