

The Future of Science Teacher Education in Tonga

By

Margaret Kuira Vaka-Vivili

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DEDICATION

Dedicated to my sisters Cathy Sharon Yuamai Possiri and Julie Yahumbo Sirimai Kuira

ABSTRACT

The purpose of this research was to explore and document existing policy and practices contributing to the debate of science teacher education in the Pacific. The study took on a pragmatic approach for a mixed research, drawing from the positives of both the qualitative and the quantitative approaches using the *kakala/kakala* research frameworks guiding the methodological framework.

Being a mixed research, the data collection method involved three elements: one-on-one semi-structured interviews with senior Tongan education officials, document analysis and a teacher questionnaire targeting science teachers. All the interviews were conducted in English and recorded using a digital recording device and transcribed by myself as the researcher. All the science teachers who participated in the questionnaire returned a signed consent form to confirm willingness to participate maintaining anonymity.

In order to answer the research question, the study examined the significance of the fibre (*fau*) used in the *kakala* weaving process, extracting from the Kakala/Kakala research frameworks the metaphoric conceptual relevance of the fibre (*fau*) which holds the *kakala* providing it structural support. Hence the conceptualisation that, the three strands of fibre that holds and maintains the education system in Tonga can be attributed to;

(i) strong cultural values, (ii) a clear and definitive education policy framework (Catherwood & Levine, 2004), and high teacher self-efficacy. The self-efficacy of Tongan science teachers is measured for the first time and reported in this study as high to very high on a Likert-type psychometric scale adapted from (Skaalvik & Skaalvik, 2009) to fit the Tongan context. The study also discusses challenges and teacher perceptions of being a science teacher in Tonga and the implications these challenges might pose in future.

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List of Acronyms

| | | |
|------|---|--|
| KRF | - | Kakala Research framework |
| TIOE | - | Tonga Institute of Education |
| MOE | - | Ministry of Education |
| EMIS | - | Educational Management of Information System |
| FWC | - | Free Wesleyan Church |
| FCOT | - | Free Church of Tonga |
| SDA | - | Seventh Day Adventist Church. |
| LDS | - | Church of Jesus Christ for the Latter Day Saints |
| PICs | - | Pacific Island Countries |
| PFFs | - | Project Formulation Frameworks |
| EFA | - | Education for All |
| PRIF | - | Pacific Islands Infrastructure Facility |
| SACE | - | South African Centre for Educational Excellence |

KEY: All words in the Tongan vernacular are *italicised*

CHAPTER 1.0 INTRODUCTION

Overview

This chapter introduces the topic of study by firstly presenting the rationale to the problem. It includes the purpose, significance and background to the study. The background is described in two sections; firstly from a wider Pacific Regional perspective and secondly on the Kingdom of Tonga more specifically.

1.1 Rationale

The issue regarding the future of science education in the Pacific was raised by (Muralidhar (2004)), who emphasised the importance of producing qualified and confident science teachers was revisited by Jokhan (2007). Both were concerned about science teachers' capability of teaching science lessons beyond the use of textbooks to motivate their students. Jokhan (2007) suggested that secondary science teachers in Fiji needed practical skills to accompany their blackboard teaching of science. In doing so, she invited Fijian secondary science teachers to a week-long professional development workshop to learn or refresh their laboratory practical skills to enhance their teaching skills in science. Muralidhar (2004) and Jokhan's (2007) concerns that the teaching of science in Fijian schools might be 'neglected' is supported by Harlen (1992) who had suggested that, scientific 'attitudes' are aspects of behaviour which are 'caught' through the way in which the teacher carries out a scientific activity, rather than taught. Therefore, reiterating the importance to have adequately trained and qualified science teachers in our schools.

In a Global sense, the World Bank (2013) and Mayor (1997) recognise with proponents of science education like, Cook (2013) and Prakash (2014) the importance of science education provided through the school curriculum as playing a key role in Human Resource Development and establishing life-long skills in the student. This emphasises the relevance of the school science curriculum as being vital to the creation of work in the knowledge

economy. This calls for politicians, development agencies, and other interested groups and individuals to be keen on increasing the proportion of secondary school graduates with a greater capacity in science (Muralidhar, 2004).

Currently, it is unclear whether or not the provision of science teachers to deliver the secondary science curriculum in the Pacific supports this objective as there appears to be some neglect in Fiji (Jokhan, 2007), and shortage of teachers, including science in Tokelau (Massey, 2013). This adds to a worldwide concern regarding shortage of science teachers in the last decade, raising another concern that, it is not only the shortage of qualified teachers that mattered, but the quality and quantity of science being taught in the schools that also mattered. However, some argue that the quality and quantity of science being taught is up to the teachers and an adequate number of teachers or the school authorities to establish (Ingersoll, 2001; Mangrubang, 2005).

For Pacific countries, it is crucial to empower future generations to understand the changes taking place in our oceans and produce skilled human resources with scientific knowledge to manage its vast resources for a sustainable future. At a Pacific Ministers of Education meeting in September 2006, Nadi Fiji, the Ministers endorsed the Pacific Education for Sustainable Development Framework, with the 'Think global, act local' adage in which Pacific policy makers were encouraged to adapt their curriculum frameworks to align with the United Nations Decade of Education for Sustainable Development (UN ESD 2005 - 2014). The goal was to take this international vision and translating it into specific goals for the Pacific focussing on priority areas and objectives for action locally, nationally and at regional levels. To implement these policies requires appropriate science teacher education programs (both pre-service and in-service) (UNESCO, 2006).

1.2 Purpose

The purpose of this research was to explore and document existing science teacher education policies and practices together with challenges faced between policy developments and implementation of basic science teacher training and professional

sustainability of science teachers in Tongan secondary schools. The research particularly aimed at investigating who was training as secondary science teachers and factors that sustain practising teachers in their work. That is one of the key challenges faced by policy makers and educators and has long been recognised by UNESCO (Mayor, 1997) and Pacific science education advocates Muralidhar (2004) and Jokhan (2007). The findings of the study will be presented to the Tonga Ministry of Education for future policy planning and implementation surrounding science teacher training and retention of science teachers in its secondary schools.

1.3 Significance

The Pacific is not isolated as its many islands but a part of the global community which is advancing in technological advancements and our children need to be adequately taught to grasp that reality. Hence the importance of having adequately trained science teachers with the necessary assistance provided to them to take on that responsibility. The next section provides the background to the study.

1.4 Background to the study

This section describes and provides the background to the study. It begins with a general introduction to the Pacific region to precede the description of science education in the island Kingdom of Tonga specifically.

1.4.1 Regional Context

The Islands of the Pacific are found in a unique and diverse region of the world's largest ocean. Its member countries have a combined population of about 3.4 million people inhabiting hundreds of islands, scattered over an area equivalent to about 15 percent of the globe's surface (WorldBank, 2013).

Pacific Island nations tend to bind together in regional endeavours as they all share similar challenges of being small in size with limited natural resources, large distances to major markets and vulnerable to exogenous shocks that can affect their growth and leading to a high degree of economic volatility (WorldBank, 2013). This affects the delivery of educational programmes, making ‘building teacher capacity’ as one of its objectives under the Pacific Education for Sustainable Development framework (UNESCO, 2006, p. 5).

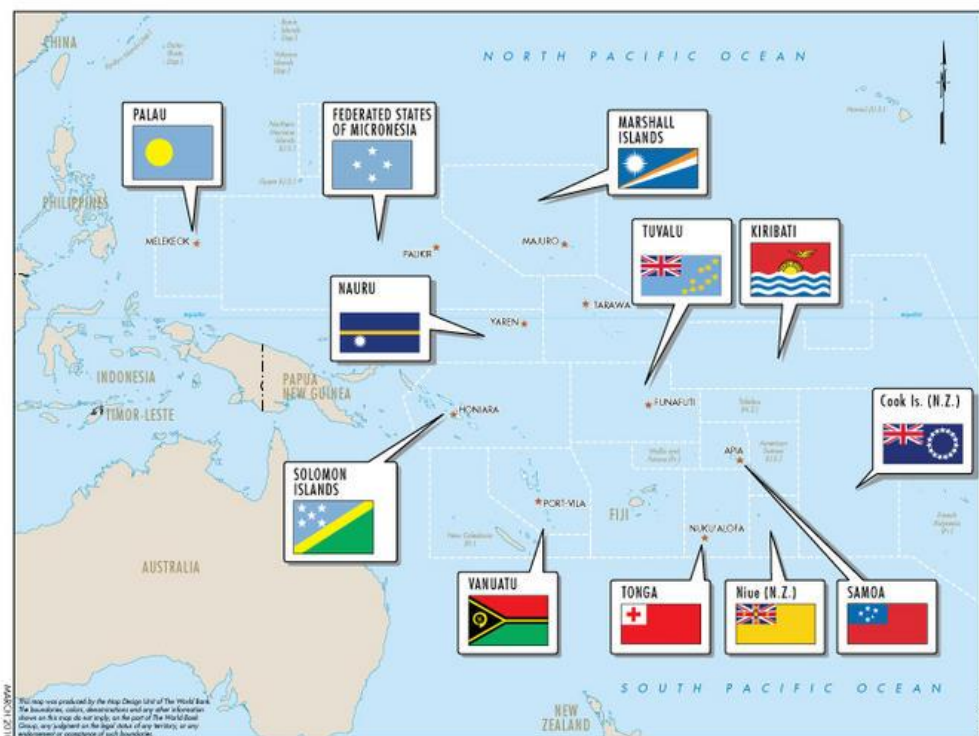


Figure 1.1 Member states of the Pacific Island Countries (PRIF, 2013)

The country in this study is the Kingdom of Tonga; with a high 99 percent adult literacy in the Pacific (Mundi-Index, 2014), and is also one of eight Pacific countries out of the countries in the world with the highest average annual disaster losses (WorldBank, 2013).

In 1992, Senior Pacific educators met at a High Level Consultation meeting, held in Apia, Samoa to set a framework for science education in the Pacific. Muralidhar (2004), reports four issues of concern to all the Pacific states as:

1. What subject strands should be valued and included in the science curriculum; with a focus to emphasise on the relationship between science and everyday life in the Pacific?
2. How pre-service teacher training programmes should be organised to include access to in-service courses, and ways to retain trained science teachers in the teaching work force.
3. Philosophy of Science Education including content delivery and assessment processes.
4. Resource Requirements: Can teachers meet the objective of teaching science using local resources? (Muralidhar, 2004, p. 51).

The meeting then suggested a standing advisory group be created to monitor science education programmes in the region, to monitor all aspects of science education, its goals, content, teaching methods, assessment and cultural appropriateness. This Advisory group was to identify the problems in science education and suggest strategies to address them. They then met in March, 1994 and produced a document which covered six key areas: Curriculum, Teachers, Examinations, Assessment, Resource requirements, Dissemination and use of information by the school and the community (Muralidhar, 2004).

These recommendations were endorsed at the lead up meeting (7th Consultative meeting) in Suva in 1994, followed by a survey of science education in the Pacific Island Countries (PICs). Next was the preparation of the Project Formulation Frameworks (PFFs) for the six components of the programme by educational planners in the PICs, in September, 1994. In May, 1995, a Consultation of Pacific Directors/Secretaries of Education was convened to

obtain reaffirmation of national commitments to a science education initiative for Pacific Island schools. This meeting also reviewed a document called 'Science Education in Pacific Schools (SEPS)'. At the time when (Muralidhar (2004)) wrote this article, he was still waiting to witness further developments and the implementation of this regional project (Muralidhar, 2004).

1.4.3 Development of the Pacific Secondary Science Curriculum

The University of the South Pacific was established as a regional university in 1968 and one of its first commitments was to provide teacher education for the expanding school systems in the region. Many countries were becoming independent and were replacing the expatriate teachers in their schools and needed locally trained teachers and the development of curriculum and assessment processes as priority. This led to the establishment of a Curriculum Development Project based at the USP in the 1970s. Regional educators acted as project consultants to develop curriculum materials for Years seven to ten (Year 7-10) of secondary level. It eventually led to reforms in curricula in their respective countries and saw the establishment of the South Pacific Board of Educational Assessment (SPBEA) in 1980 (Muralidhar, 2004).

SPBEA is a regional body established to administer and monitor senior secondary school qualifications and has been operating successfully for over 30 years. Some countries have now been able to develop their own national form 6 qualifications beginning in 2013, whilst the seventh form qualification will continue to be administered by SPBEA based in Fiji. In 2010, SPBEA moved and merged with the Education Training and Human Development division of the South Pacific Commission (SPC) but in 2012 Tonga weaned itself from the SPBEA family and is currently reliant upon its own staff to develop and administer their own National Form 6 ahead of the other Pacific Island countries (SPC, 2014).

Section 1.4 has presented a brief historical background to the Science curriculum endeavours on a Pacific Regional context. Since this is a case study on Tonga, the next section will provide a background to teacher education in Tongan.

1.5 Research Background – Tonga

This section describes the educational background to the study by describing secondary education and the teacher preparation systems in Tonga.

1.5.1 Education in Tonga

This section will begin with a general introduction on the education sector before discussing secondary education and Post-secondary teacher education specifically.

The education system in Tonga begins with six years of free compulsory basic primary education. They have a high 99 percent adult literacy rate comparable to other countries in the Pacific region(Mundi-Index, 2014). This has been attributed to the dedication of their teachers and other educators within their education systems (Catherwood & Levine, 2004).

Most Tongan students have up to three stages for ‘formal schooling’. The first stage is between the ages of six and 14 years with a compulsory six years of basic free Primary education. The second stage is up to seven years of Secondary education followed by Post-secondary education at varied lengths depending on the course and Professional Institutional requirements. The state runs seven of the 40 secondary schools (including the intermediate sector), three are privately owned while several Church systems run the rest (Maka, 2005). Each of the church systems have their own CEO’s for Education, and are responsible for the delivery of the national secondary education programme, recruitment, remuneration and professional development of their teachers (Thaman, 2014).

The Tongan Ministry of Education Women’s Affair & Culture administers education and endeavours to maintain a uniform secondary school system throughout the Kingdom by ensuring all schools follow the same curriculum and take the same examinations for

accreditation purposes. English is the official language of instruction for secondary schools although it is bilingual mostly in the local Tongan vernacular up to Form 4 level. Most schools offer the traditional academic subjects of English and Tongan (Compulsory Language studies), mathematics, science, history and geography. Non-academic subjects like Tongan craft, woodwork, art, metal work and home economics, music, commercial practice and agriculture are also offered in a few schools (Thaman, 2014). Computer studies is also now offered in many schools in place of shorthand and typing offered in some schools in the past as reported by Thaman (2014).

The next section discusses the education policy framework which provides the foundation on which education and teacher education are set upon.

1.5.2 Educational Policy Framework

The education policy framework of 2004 – 2019 was developed stipulating the following three strategic goals:

Goal 1: “To improve equitable access to and quality of universal basic education for all children in Tonga up to Year 8 (Form 2)” (Catherwood & Levin, 2004 p. 20). This is in line with the UNESCO Education for All policy and the overarching four pillars of education; learning to know, learning to do, learning to live together and learning to be (Satbir, 2014).

Goal 2. “To improve the access to and quality of post-basic education and training to cater for the different abilities and needs of students” (Catherwood & Levine, 2004 p.20).

Goal 3. “To improve the administration of education and training so that the quality of educational performance is enhanced” (Catherwood & Levine, 2004 p.20).

Consistent with the desired policy outcome for Tonga’s school curriculum under section 8.83 of the education policy framework 2004 - 2019, the subjects and programs offered are

geared towards preparing students to live fulfilling lives of high quality, promoting student achievements at a high level, and meets individual and national needs. Section 8.84 of the same policy calls for the curriculum policy issues to include the following:

- (i) the need for review and modernisation of the current curriculum to accommodate latest advances in knowledge and technological advancements;
- (ii) marrying the appropriateness of the Tongan curriculum objectives with the assessment criteria and procedures;
- (iii) maintaining a balance between the extent to which the school curriculum captures the uniqueness of Tongan culture and prepares pupils for life in Tonga, and the extent to which the curriculum enables the development of skills that may be required in a global world; and
- (iv) evaluation of the quality of support provided (resources) to support children's learning by current learning resource providers and systems in Tonga, including current pre-service and in-service teachers (Catherwood & Levine, 2004).

These two desired policy outcomes (section 8.83 and 8.84) are again consistent with the four issues raised by senior Pacific education officials in 1992, as reported by Muralidhar (2004). Tonga has also recently actioned a Cultural mapping, & Planning policy which is described in the next section.

1.5.3 Cultural Mapping, Planning and Policy

Brown (1953), in learning theory defines culture as the class of responses of any hominid individual learned from any other hominid individual. Culture is multi-faceted from anthropological, psychological and sociological points of view are members of some homogenous group that share certain common characteristics giving rise to a 'group nature' co-existing with cross-disciplinary cooperation (Brown, 1953). Culture is also defined as; the attitudes and behaviour of a particular social group that anthropologically places it as the sum total of ways of living built up by a group of human beings and transmitted from one generation to another (Oxford, 2014).

In accordance with the above definitions, these attitudes and behaviours are taught and learnt from other individuals within a homogenous group. Within the context of this study,

the culture (class of responses) of the Tongan people as a homogenous Polynesian group, has been taught and passed on by persons (hominids) from generation to generation (Oxford, 2014), with its unique set of values, traditions and practices in response to certain influences setting it apart as a culture. In other words, culture can be the operating system of a people and has tendencies to impact the participation of children in education (Rosenberg, 2010). A lot is understood through certain practices which are deemed valuable and affect the group as normal or abnormal. For example, in Europe, Lysgard (2013) reports that the implementation of culture-based developmental strategies have been a recent trend in many cities especially for territorial planning and development, even though the definition of culture and the objectives of cultural strategies have been highly contested in public debate.

The Ministry of Education has recently sought to strengthen cultural education by placing culture as an integral part of education and implementing it through its Cultural Mapping, Planning and Policy under the '*Kato alu* framework' (Fua, Tuita, Kanongata'a, & Fuko, 2011). This framework signifies the five areas of importance metaphorically illustrated in the construction of the traditional Tongan gift basket known as the '*Kato alu*' (Figure 1.3).

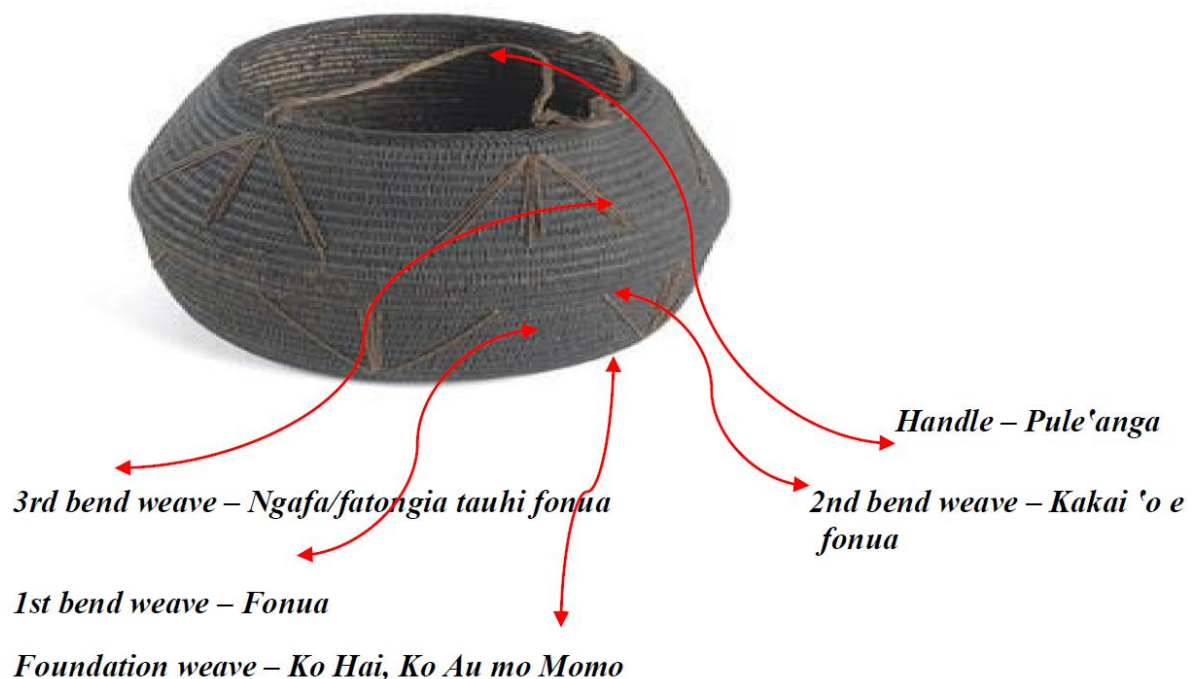


Fig 1.3 The '*kato alu*' – traditional Tongan gift basket (Fua et al., 2011)

The five areas include the following:

1. Foundation weave – *Ko Hai, Ko Au mo Momo* (Who am I and my brother)

The foundation weave signifies the importance of recognising the foundation of one's identity as being Tongan in the sense of:

- * cultural identity through language, values, philosophy and beliefs

- * social cohesion, Faith (Christianity, intangible cultural heritage and protection and enforcement of cultural rights.

2. Outer-wall weave, first bend – *Fonua* (land/country)
3. Outer-wall weave, second bend – *Kakai 'o e fonua* (People)
4. Outer-wall weave, third bend – *Ngafa mo e fatongia tauhi fonua* (Duties and related cultural responsibilities of land-use and care by its inhabitants)
5. Handle of the basket – *Pule'anga* (Government)(Fua et al., 2011).

These aspects are enforced intrinsically and summarised altruistically as, *ofa fonua moe ofa ki hono kakai* and *mateaki li'oa* which translates into an altruistic love of country, love of fellow Tongans cascading to an intrinsic motivation to serve, dispelling self-gain. This is the aspect that makes a Tongan-Tongan and brings forth commitment and dedication in every way to perform to their best for the 'good of Tonga' (Fua et al., 2011). Ensuring that the Tongan culture is taught beginning at Primary school right through to secondary school and at Teachers College ensures that the values and traditions of the people are passed on from generation to generation.

This section has described and explained the cultural mapping and planning policy, the next section will discuss the policy issues and outcomes with regards to teacher supply and demand.

1.5.5 Policy Issues and Desired Outcomes for Teacher Supply and Demand

Under section 8.114 of the Tonga education policy framework 2004 - 2019, the desired policy outcome for Tonga is one that is supported by an adequate supply of competent,

trained, and well-qualified teachers at all levels. A teaching career in Tonga is perceived as an attractive profession, so teachers are motivated to stay and contribute to the education sector. It is recommended that all teaching positions be filled by teachers of quality, and advance planning for teacher supply be undertaken to avoid teacher shortages (Catherwood & Levine, 2004).

Under section 8.115, teacher supply policy issues include more effective forecasting, planning and monitoring of teacher supply. Therefore a necessity exists to verify up-to-date teacher attrition rates and, if so, identify the areas experiencing such, and the reasons for any defined emerging trends. That trend analyses of teacher mobility and past and future teacher loss rates (including teacher retirements) are required and there is a need to develop a robust model for an accurate forecast of teacher supply and demand (Catherwood & Levine, 2004).

Section 8.116 of the Policy outcomes calls for appropriate sources of future teachers needs to be developed. It calls for a review of policy on teacher recruitment and retention, teacher remuneration, and teacher preparation in and beyond Tonga, including annual student intake for training at the Tonga Institute of Education or other providers, thus identifying the need for recruitment of expatriate teachers in the future. It calls for a need to improve the quality of teaching, by ensuring that the existing work force adequately upgrades their skills particularly unqualified teachers. Data and analysis requirements to be carried out and extended to reflect the changes in the secondary curriculum if any, to coincide with the need to provide qualified tutors for expanded vocational and technical education (Catherwood & Levine, 2004).

Finally, section 8.117 stipulates for the availability of qualified teachers as an essential pre-requisite for an effective education system. However, the MOE sees that their conditions of service are not under their direct control but strong evidence is required to influence decisions of the Public Service Commission in that regard. Salaries in Government schools and Non-Government institutions will influence compensation levels however, there is also an increasing international market for qualified teachers in specialised areas thereby making

it essential to monitor the dynamics of this supply and demand equation and how it will affect Tonga (Catherwood & Levine, 2004).

1.5.6 Policy Issues and outcomes on Teacher Quality

Under section 8.124 the desired policy outcome for Tonga is that all teachers be well qualified, trained, committed and competent; able to motivate and encourage all students under their care to learn. That 'teaching' be perceived as an attractive profession one which is held in high regard by the community, and all teaching positions to be filled by teachers of quality. As a way of uplifting the quality issue, section 8.125 calls for key education policy issues to relate to ways of raising the standard of teaching, make improvements to the quality of pre-service and in-service teacher education, and decide whether formal registration of teachers is required in order to maintain standards of quality to ensure public confidence in the profession (Catherwood & Levine, 2004).

Tonga acknowledges that Teacher education is the heart of human resource development in an education system and views quality of teaching under section 8.127 as the single most important factor that relates to the quality of student achievement. By acknowledging that effective learning depends upon effective teaching, it considers improving the quality of teaching to be a significant factor in raising the level of student achievement. It hopes to achieve that under section 8.126; to have a policy on teacher education to be supported by maintaining a core of trained specialists in teacher education at the Tonga Institute of Education to ensure that teacher education specialists are accessible to the various education systems for assistance with in-service delivery, curriculum review and development, and examinations expertise (Catherwood & Levine, 2004).

Section 8.128 calls for the effective preparation and supply of teachers to be fundamental aspects of a well-performing education system. In order for this policy outcome to become reality, the Government has an important role to create the environment in which teachers can be well prepared for their role. The Government recognises that not all teachers would necessarily be trained in the state institution, however, when a small country like Tonga has only one Teacher education institution, the Government has a particular responsibility to

ensure that it is well resourced and supported; that is staffed by well qualified teachers or lecturers, with a sound quality assurance system in place, and to deliver quality programmes (Catherwood & Levine, 2004).

One way the above policy outcome can be realised is to grant the Tonga Institute of Education more autonomy by separating it from the Ministry of Education in a structural and budgetary sense would enable it to operate more effectively in carrying out its core functions under section 8.129. This initiative would assist the college to improve the offerings of in-service training for all teachers in the various education systems. It would enable it to build collegiality, higher status and increased stability of staffing in the institute, and should also lead to efficiencies through increasing administrative savings, since it would be part of the Tonga Institute of Higher Education. Furthermore, an independent Tonga Institute of Education would be able to plan its place and course offerings to match more closely the needs of the various education systems (Catherwood & Levine, 2004).

1.5.7 Science Teacher Education in Tonga

Vision statement: “Faiako ma’a Tonga ki he Tonga” – preparing a holistically Tongan teacher as a professional with all aspects Tongan to teach in Tonga.

The Tonga Institute of Education (TIOE) is the country’s only teacher education institute. It was founded in 1944 providing local teacher education to Tongan teachers and neighbouring countries. TIOE offers a three year Diploma of Education (Secondary) as the core programme that has been developed from the original Teacher’s Certificate, at an undergraduate level. It also offers teachers with other science or science related qualifications the opportunity to upskill with a Graduate Diploma in Teaching and Learning (TIOE, 2004). Since it is a desired policy outcome under section 8.124 to improve the quality of teachers (Catherwood & Levine, 2004), the MOE through TIOE offers 50 spaces each year for this purpose for interested teachers to take this opportunity, paving the way towards full teacher’s registration.

The vision statement for TIOE reads; '*Faiako ma'a Tonga ki he Tonga*', translates into a commitment to prepare; a 'Tongan' teacher to teach Tongan children in Tonga. There is a deeper meaning to that vision statement to a Tongan when he or she reads it in the Tongan language. Apart from preparing a student teacher in their specific subject area, TIOE's vision is to prepare the teacher holistically to understand Tongan cultural ethics and values, and to commit themselves to the task of imparting and sharing their knowledge with the next generation of Tongans as outlined in the *kato alu* framework (Fua et al., 2011).

Over the years, there have been ongoing reviews and improvements in the curriculum, with reviews made in several subject areas including science. In 1995/96, Science received \$NZD25 000.00 in assistance from the Government of New Zealand towards the purchase of science equipment after one such review (Moala, 1995). Recently in 2012, the science laboratory saw renovation and new stock of chemicals funded through the Australian Government's Aid programme (AusAid). TIOE is currently in the last year of the present Diploma of Education programme and rewriting curriculum documents in preparation to begin the new revised Diploma of Education programme in 2015 and towards the Bachelor of Education programme offered locally.

Program Structure

The Diploma of Education (secondary) is an applied professional teacher education programme that integrates theory and practice, enabling a balanced progression of knowledge, understanding and skills throughout the courses that consist of 360 credits and totalling 3600 learning hours to the student. The main structure of the programme consist of Education studies, Core Language Studies (Tongan, English and Tongan culture courses), School Experience and Curriculum Studies make up the major four subjects while Music, or Physical Education and other elective courses make up the fifth major group (TIOE, 2004).

Entry and Selection Criteria to TIOE

Applicants for the Diploma of Education (Secondary) programme must satisfy the following criteria to be admitted:

- i) Pacific Senior Secondary Certificate (PSSC – sixth Form) with a passing total grade score of 14 or less in four subjects and a minimum grade score of 5 in English for entry into the first year of the programme.
 - ii) A South Pacific Form Seven Certificate (SPFSC) results with (B Bursary or better), with a minimum grade score of 5 in PSSC – sixth Form English.
- Or
- successful completion of all USP Science Foundation Courses with a minimum grade score of 5 in PSSC English. Applicants who meet these two criteria enter into the second year of the diploma programme.
 - iii) The third cohort are ‘serving teachers’ with a Class one Teachers Certificate from the former Certificate programme with a minimum of 5 years teaching experience. They would be granted entry into the second year of the three year programme.
 - iv) The fourth cohort of potential students would be those who have completed a two year post-secondary certificate or diploma in Agriculture, Information Technology or another technology related subject/s. They may be granted entry into TIOE to complete a Diploma in Education to pursue a teaching career in their field of expertise (TIOE, 2004).

Selection Process

Preliminary selection is carried out by TIOE upon receiving written applications with the required supporting documentation before an interview with the Principal (or Deputy Principal) and a member of senior Ministry of Education official, following a review and selections finalised before successful applicants are notified in writing (TIOE, 2004).

For degree studies, Tongan students mostly enrol at the University of the South Pacific (USP) to pursue a Bachelor of Education or a Bachelor of Science before becoming teachers. Education systems rely on graduates from USP, until recently Atenisi University (a private University) in Tonga, and scholarship holders who have studied in Australia or New Zealand returning to fill graduate positions. Two churches send their teachers overseas within their own systems and they are; the Church of Jesus Christ for the Latter Day Saints (LDS) to Hawaii's Brigham Young University and the Seventh Day Adventist Church to the Pacific Adventist University in Port Moresby, Papua New Guinea for graduate level qualifications. However, with TIOE offering the New-revised Diploma programme, leading to a Bachelor of Education beginning in 2015, it removes time away overseas and makes degree level studies more accessible with it being offered locally.

On the demand side, there is quite a concern for a perceived shortage in supply of qualified science teachers. Given that science is a compulsory subject up to Fifth Form level in Tongan state schools and some Church-run schools, it is reasonable to assume that the demand for science teachers will also increase as enrolments increase. For example in 2011, Tonga acquired only one graduate Physics teacher from the University of the South Pacific, despite high enrolment numbers into the Bachelor of Education programme three years prior (USP, 2013).

1.6 Study Limitations

Although this study may have a Pacific-wide inclination, the data collected and presented is limited to the Kingdom of Tonga. This study was further limited to science teachers of the main island of the Kingdom of Tonga.

1.7. My Interest in this Project

During my 10 years of teaching science in Tonga, four of those were at the Tonga Institute of Education (TIOE) as a Science Teacher Educator. I came under the impression that there might be a general decline of interest in science among secondary students by the time they reached Fourth Form, and therefore chose not to study science in Fifth Form. Science

teachers appeared to be discouraged because of lack of equipment to carry out practical lessons. A few teachers in the outer islands called for assistance with the instructions for making local calcium carbonate to make lime water for the carbon dioxide test. Those with specialised degree qualifications only took up teaching as a transit option. And most of all, the numbers of science student teacher intakes for training at TIOE dropped to five in one year. These personal experiences motivated me to pursue this research in the hope of making a contribution to the system that has shaped my career in education.

I have presented an introduction to the topic including a background to this study. The next section presents a review of literature on the importance of Science education and the need to balance teacher supply and demand especially of science teachers.

CHAPTER 2.0 LITERATURE REVIEW– (TEU)

Overview

This chapter intends to highlight and review some of the literature on the importance of science education and the issue of demand and supply of science teachers in secondary schools. This review of literature is sourced from international perspectives and contexts but transferable into the Pacific context or developing countries in general.

It begins with the importance of science education in secondary schools and the associated policy demands that highlight the need for adequately trained science teachers, before discussing the issues related to the demand and supply equation. The issues of interest being: attraction of students to teacher preparation or training and recruitment and retention of science teachers. Although some general terminology for teacher demand and supply situation is used, the context focus is on science except for the cases where a general reference is made for all teachers.

The next section highlights the importance of Science education as an integral part of secondary education.

2.1 Importance of Science Education

“As a first priority, policy makers should consider what are the educational purposes that science and technology education can best provide for students as they move through the stages of schooling”
(Fensham, 2008, p. 5).

Science education has been considered a key component of the school curriculum in all education systems for a very long time; vital to learning life-long skills and development of children (Mayor, 1997). Science as a universal subject knows no boundaries but provides the discipline of the mind (Prakash, 2014); aimed to stimulate and excite pupils’ curiosity about the various phenomena and events in and all around them, satisfying that curiosity with knowledge (Poisson, 2000).

Secondary education is recognised as a key component, the cornerstone of educational systems worldwide, as it links primary schooling with tertiary education, and the labour

market. Mayor (1997) stresses the importance of science education to achieve sustainable development for all people is through the provision and basis of Education for all. It provides a gateway to many opportunities, destinations and benefits of economic and social development, taking young people where they want to go in life (Cuadra et al., 2005). Science plays a key role in Human Resource Development and the creation of work in the knowledge economy; urging policy makers (government and development agencies) to drive up the proportion of students graduating from secondary school with a greater capacity in science (Muralidhar, 2004).

Since globalisation has now increased the demand for a more sophisticated labour force attuned with the globalized and technologically-driven world, the World Bank (Cuadra et al., 2005) further considers, quality secondary education to be indispensable in creating a bright future for individuals and nations alike. It calls for secondary education systems to be more flexible, relevant and responsive to both local and global needs. In this respect, it urges policy makers and educators to address the twin challenges of increasing access and quality and relevance of secondary education for all young people. Thus understandably, current efforts to address access under the Education for All programme through the drive for universal basic education, should not shelve quality and relevance of all subjects offered at secondary school level (Cuadra et al., 2005).

Tang (2010), agrees with Mayor (1997), about the right to universal access to quality science education as recognised by UNESCO for some time along with recent refinements of the arguments in its favour, however, clarifies that there are many problems associated with access to this basic education and as stated, 'access' alone in itself is a challenge. UNESCO also recognises that while science has come to be an important part of basic education, in many parts of the world it is non-existent especially in primary education. Therefore first of all the place of science for all has to be established first at elementary or primary education before quality basic science education can be achieved. Since secondary science education plays a key role in human development towards social, economic and human capital development of many countries worldwide, practical experiences in science link ideas and engage learners at many levels of their schooling (WorldBank, 2014).

Fensham (2008) reported; the 2007Perth Declaration on Science and Technology Education stood by the importance of science and technology for sustainable, responsible, global development, and the need to bridge the gap between science and technology and the public expressing the need for governments to recognise and address the following four areas:

- (i) Concern at the lack of recognising science education as a vehicle for meeting national educational goals and social and economic needs.
- (ii) There is an observed widespread lack of student interest in current school science and technology education and of its relevance to them
- (iii) There is a shortage of specialist science and technology teachers in many countries
- (iv) To consider current rapid changes taking place in science and technology and their applications must be reflected in the planning and teaching and learning of science and technology (Fensham, 2008, p. 44).

Today's societies have a task to transform secondary education institutions and current schooling practices to align them with the demands of a globalized and technologically driven world (Cuadra et al., 2005; Poisson, 2000). Tang (2010), elaborates that all societies have their own ways to educate young members of their community to ensure that they become full participants in society, and able to contribute and develop it. Often the debate is on what to include and what not to include in the curriculum as relevant. One of the recommendations from the Perth 2007 Declaration on Science and Technological education was: "Policy makers should make the issue of personal and societal interest about science the reference point from which curriculum decisions about learning in science and technology education are made about content, pedagogy, and assessment" (Fensham, 2008, p. 21). The declaration further clarifies that, in the primary years of education, the central curriculum intentions of the science and technology curriculum should be geared towards developing the natural curiosity and creativity of young students. In the secondary years the role of Science and Technology in the students' worlds outside of school (application of science) should play a powerful motivating role. Paralleling these curricular decisions about how science affects them, together with the practices that are informative

about science-based careers to both students and parents need to be developed in school and the wider public in general (Fensham, 2008).

Hence this shifts the need to examine carefully the importance of policy surrounding science teacher education, recruitment and retention of science teachers in secondary schools, as it is through the teachers that these aims would be achieved. In the United Kingdom, Science education is one of the compulsory subjects from the age of five to 16 which has been specified on their Science National Curriculum which covers four strands: Scientific enquiry; Life and living processes; Materials; and Physical processes (UNESCO, 2002).

A smaller developing country like Brunei considers science and technology to be very important for the development and growth of their country and therefore the Ministry of Education has made science a compulsory subject for all primary schools and junior secondary schools; however, students may choose to opt away from science at the senior secondary level (Syed Zin, 1999). In other developing countries the age or year level where secondary science education ends may differ. In Tonga, science is compulsory up to fifth form level (15 year olds) for the government schools while for the Church-run schools science is an optional subject as early as Fourth form (13-14 year olds) (Thaman, 2014).

At the policy level, (Thaman, 2014) calls for a need to systematically evaluate the science and mathematics curricula currently being taught in Tongan secondary schools to establish its relevance and suitability for the future needs of the majority of pupils. If a great number of students were critical of the teaching of mathematics and science, either the teaching is considered 'bad', or the students are considered 'bad', or the curriculum is not suitable for these children. There is a need to investigate student's learning styles and ways teachers could adjust their teaching to meet those needs as science was among three subjects (home economics and mathematics being the other two) which "were singled out by respondents as requiring improved teaching" in Tonga (Thaman, 2014, p. 35).

In summarising, there is no question that secondary science education contributes significantly in human development and therefore, developing countries ought to select carefully the contents of their science curriculum, employ the best practices by ensuring

their qualified teachers are equipped to administer their educational goals. The next section highlights teacher supply and demand in context.

2.2 Contextualising Teacher Supply and Demand

“The teacher supply and demand balance is affected by policy considerations, local labour market conditions, institutional practices and societal attitudes towards teaching” (Cooper & Alvarado, 2006, p. 4)

The teacher supply and demand equation is affected by a set of dynamics that may occur over a period of time often due to certain multifaceted set of events (SACE, 2010). Studies in South Africa by SACE, (2010) describes it as a differentiation of the total number between the ‘inflows and outflows of teachers’ (SACE, 2010, p. 2). SACE (2010), uses the word ‘stock’ to describe the current teaching pool, ‘inflow’ as the national pool, and ‘outflow’ as those leaving the profession. Inflow may constitute new teachers from higher education institutions, untrained teachers or teachers who have been recruited back into the profession after leaving teaching for some time. The ‘outflow’ representing teachers leaving the profession due to: retirement, resignations (attrition), death or temporary absences due to illness or further studies (Boe & Gilford, 1992; SACE, 2010).

Supply factors such as, intakes of new students into teacher education colleges, or graduates out of teacher education colleges, are often affected by other dynamics such as:

- deciding how long they will stay in the profession,
- where to teach (urban or rural school),
- whether to return to teaching (for those who have left teaching for a while) and
- when to retire

Some of these dynamics range from changes in the social conditions influencing increased or decreased enrolments of students and the state of the economy (Cassellius, 2013; Gilford & Tenenbaum, 1990; SACE, 2010). Often policy makers responsible for providing and ensuring an effective public education system have to deal with concerns regarding the supply of qualified teachers to adequately staff their schools. Thus making the topic of actual and potential teacher shortages continuously being discussed (Boe & Gilford, 1992; Cassellius, 2013; Gilford & Tenenbaum, 1990); with Cooper and Alvarado (2006) describing the preparation, recruitment and retention of teachers as a “pipeline that leaks over time”

(Cooper & Alvarado, 2006, p. 1). This is elaborated further by Boe & Gilford (1992) that, trying to balance the teacher supply and demand equation is often difficult when there is a shortage of highly qualified teachers in some teaching assignment at some location. Although a state or country may have the teaching designations on record, there might not be actual teachers acting in those roles. That situation would still throw the system into shortage as the priority hiring practice of teachers would be to first of all ensure there is staff for all classrooms (Boe & Gilford, 1992).

Therefore, Boe & Gilford (1992) summarise the implications of implementing such a policy framework linking teacher training, teacher recruitment and teacher retention faces numerous challenges and urge schools to ensure these conditions are met:

- Align teacher training programmes with;
 - The needs of diverse learners
 - Maintaining content standards
 - And prepare them for the contemporary classrooms.
- Simplify and streamline hiring processes, so that teachers are not discouraged from teaching, particularly the 'hard to staff' schools.
- Ensure that all new teachers participate in quality and mentoring programmes with ongoing professional development.
- Address working conditions so that schools become learning communities for both educators and learners.

Cooper and Alvarado (2006), report that keeping the supply and demand of quality teachers balanced requires a consideration of several factors too, with three major components of teacher demand being: pupil enrolment, policies of pupil-teacher ratio and turnover. Other considerations are; prior commitments to current teachers, available funding and if so, prices that must be paid for various qualities of teachers (Boe & Gilford, 1992). In order to cater for demand, one mechanism often used is to relax qualifications requirements during hiring. There are three ways to this mechanism, which are:

- (i) If a highly qualified applicant is unavailable to fill a certain teaching position, then hire a less qualified person. Usually quality is compromised,

- (II) Hiring experienced teachers with poor competence or
- (III) Hiring qualified teachers out of their field of competence (Boe & Gilford, 1992).

The issue of supply according to Cooper & Alvarado (2006) depends on several factors:

- the number of students graduating from the teacher preparatory programmes
- the proportion of these graduating students who choose to enter teaching,
- the number of teachers licensed through alternative programmes, and
- the number of returnees from a reserve pool including retired teachers.

In order to equilibrate the supply side of the equation, some systems offer financial incentives for teachers to enter into teaching and continue in the profession. If systems are still not able to hire suitable additional staff, then administrators would be looking at increasing the workload of the existing teachers. Typical examples are, increased class sizes and more classes to teach per teacher – both increasing the teacher-student ratio (Boe & Gilford, 1992).

In some Western countries (for example the United Kingdom, Australia, France and Germany), the issue of supply is less of a problem with total number of teachers available, but the issue is with the number of qualified teachers in specific subjects such as mathematics, science, special education and bilingual education in some cases. In other countries (for example Japan, Czech Republic, Portugal, and Hong Kong), the supply of teachers is adequate as Teaching is quite an attractive career which draws enough teachers to replace the ones that leave the system (Cooper & Alvarado, 2006).

This section has described the teacher supply and demand equation in context. The next section will attempt to describe one product of this equation in the context of science education and the components that affect it before addressing some issues with shortages of science teachers specifically in relation to teacher supply and demand.

2.3 Shortage of Science Teachers

The continuing worldwide trend in the shortage of science teachers has influenced a lot of policy decisions over decades. The April 17th, 1954 edition of the Nature magazine reported

shortages of specialist Maths and Science teachers in England then, followed by November 30, 1963 (Nature, 1963). Seventeen years later the same magazine report in their January 17th (1980), a shortage of specialist teachers of mathematics and natural science, particularly physics (Nature, 1980). This led to the concerns over mathematics and science teacher shortages especially in the K-12 or primary and secondary education sectors receiving much publicity in the 1980s making teacher shortage a cyclic concern with history (Ingersoll, 2001; Ingersoll & Perda, 2010). These concerns reached new heights with reports from numerous high-profile organisations including: the National Academy of Sciences (2006), the National Research Council (2002) and the U.S. department of Education (2002). The reports all directly tied the shortage of mathematics and science teachers to the quality of educational performance and in turn to the future well-being of the economy and security of the nation. Throughout the report, the commentators, researchers and reformers used the term ‘shortage’ to any school with staffing problems and trying to find the correct formula for hiring enough teachers to replace those who were leaving or going on retirement (Ingersoll, 2001; Ingersoll & Perda, 2010; Mangrubang, 2005). The most direct and practical way policy makers would use is to make sure there are enough qualified teachers in the school through advertising (Boe & Gilford, 1992).

As stated in section 2.3, there are various reasons why there could be shortages in schools. Apart from the ones highlighted by Cooper & Alvarado (2006) with regards to the supply factor, the following should also be considered:

- High attrition from the teaching profession partly due to insufficient remuneration or poor working conditions
- Increased retirement rate of aged teachers due to an aging workforce
- Increased intake of students from lower level as a result of increased population of that age group for reasons outside of school contexts.
- Continuing decline in teacher-pupil ratios
- Falling enrolments in teacher preparatory programs

- Decreasing interest among women in teaching due to more lucrative opportunities elsewhere, and
- Constriction in the numbers of teachers entering because of the entry-level performance standards being adjusted (Boe & Gilford, 1992).

Most of these trends do not develop or materialise into actual teacher shortage all the time, but with respect to projecting teacher demand and supply specifically for teachers of science, considerations need to be made; especially when considering the importance of science to national goals. For this, discrepant research needs to be done in order to understand their retention patterns in the teaching profession, in order to better assess the potential for shortages (Ingersoll & Perda, 2010). Other information needed is about the sources of supply, migration, reassignment (reshuffling), attrition and re-entry, retirement of teachers in the various disciplines (Boe & Gilford, 1992; Ingersoll, Merrill, & May, 2011).

Science was recently reported as one of the hard-to-fill subjects in Victoria Australia (NEALS, 2012). Another Victorian study showed equal concerns, as a decline was observed as children move into higher levels of secondary and tertiary education in Victoria Australia (Hassan, 2011). Blosser (1983) and Gilford & Tenenbaum (1990), reported Physics and Chemistry shortages to be greater than Biology for the three major disciplines of science in the United States of America.

Studies carried out in Tanzania also revealed these declines (Mabula, 2012). It was recognized that, if science and technology lessons are to be taught effectively, they need to be taught by skilled individuals with expert knowledge in the science disciplines from the lower levels of academic training. This is especially true for many developing countries, despite the many challenges facing teaching and learning of science (Mabula, 2012). Likewise the interest to study science is also following the same pattern as the numbers that are studying science. Educator need to be concerned about this decline of interest in science subjects in these early years of secondary schooling as it is in these years that pupils develop positive attitudes towards the pursuit of science subjects and career choices are formed (Mabula, 2012).

The tiny Pacific Island nation of Tokelau is severely short of qualified teachers prompting their government to set up scholarships for six students currently studying towards a

teaching qualification with one studying for a science degree, at Massey University (Massey, 2013).

While developed countries may be concerned about dropping interest in the subject among children (Hassan, 2011), in developing countries it would be of equal concern as they are faced with huge challenges in delivering the science curriculum effectively, like in the Solomon Islands (Daudau, 2010), Fiji (Jokhan, 2007) and Tanzania (Mabula, 2012). Some of the challenges facing developing countries in teaching a science curriculum effectively are as follows:

- (i) Inadequate teaching facilities;
- (ii) Poor quality of science classroom practice by teachers which reduces the enjoyment and effective learning of science;
- (iii) Serious shortage of competent and qualified teachers;
- (iv) Evidence of students developing negative attitudes to science subjects over the secondary school years;
- (v) A balance in the compulsory subjects at lower levels so that there are enough students who reach senior level with the right kind of science taught for the career path he/she might want to select for the future, and
- (vi) Lack of or no in-service training regardless of many changes that may have been introduced at the Ministry level especially in science teaching strategies (Mabula, 2012).

This section has discussed some issues concerned with science teacher shortages; the following sections will discuss attraction to training or teacher preparation, recruitment and retention of science teachers.

2.4 Attraction of Science Teacher Trainees

“Teachers are primarily attracted to teaching by intrinsic motivation, but extrinsic factors play a major role in retaining them” (Cooper & Alvarado, 2006, p. 17).

There are many multifaceted reasons why people choose the different professions and careers that they are in and teaching is one of them (Maphosa, Bhebhe, & Shumba, 2014). The teaching profession, no matter what the subject, is one that “aligns with both the altruistic and intrinsic notions and a desire to serve society” (Mtika & Gates, 2011), and that desire to serve motivates many because they feel it is important work that “contributes significantly to society” (Cooper & Alvarado, 2006, p. 17).

For many school leavers, it becomes a difficult task as many students would have to consider long term career prospects and job security, influences from family and friends and experts in the area of expertise plus salary considerations (Padaguri, 2011). Studies conducted in Zimbabwe by Maphosa et al. (2014) also found, another motivation to enter teaching as ‘another’ way of earning a degree. In Malawi, Mtika & Gates (2011) reported that, apart from the reasons identified in Zimbabwe, many school leavers went into teaching as a secondary option because they missed out on government scholarship for Universities or as a stepping stone to other career options. Whatever reason or factors; intrinsic, extrinsic, altruistic or a mixture of these, all play an important role to determine the career choice of an individual to enter the teaching profession. The Zimbabwean studies revealed reasons more intrinsic in nature, consistent with personal attributes with positive results associated with being a qualified teacher. The decision to become a teacher is sometimes influenced by close friends and family members (Maphosa et al., 2014).

Studies carried out in Malawi by Mtika & Gates (2011), revealed a range of reasons for entering into teacher training, from:

- a) failure to follow a desired career choice,
- b) a springboard into a career elsewhere,
- c) a means to upgrade a qualification and
- d) teaching as a vocation.

In Papua New Guinea it was found that many high school students with negative pre-training attitudes to teaching as a profession and only a few seemed attracted to teaching; mostly females and those whose parents were also teachers. The same PNG study revealed that more students preferred professions such as law, accounting, engineering, medicine,

agriculture, management, and technical area. Reasons given for disliking teaching included low pay, poor working conditions, and low status (Mundia, 2012). Teaching was reported to be less popular among minority high school students for a number of reasons including negative student experience in school, low status of teachers, and poor pay (Mundia, 2012) and also among pre-service student teachers in Malawi (Mtika & Gates, 2011). Contrary to these research findings, a higher percentage of high school students in Brunei Darussalam wanted to be teachers (due to good pay) than those who weren't interested in teaching. Again teaching appealed more to female high school students than males in Brunei, and was a viable option for junior high school students more often than senior high school students (Mundia, 2012).

Lastly, SACE (2010), reports that individuals consider employment probabilities associated with a profession and the current labour market signals on whether there is a demand for certain skills associated with this profession. Therefore their choices to enter teaching are usually also affected by whether they will stay in the current school or system, for how long, starting wages, their future growth in the profession, non-pecuniary rewards and consideration of all other opportunity costs (SACE, 2010).

2.5 Science Teacher recruitment

The recruitment of teachers is often driven by 'demand'; defined as the number of funded teaching positions that could be filled (Boe & Gilford, 1992). Once hired, the individual enters a teaching force that is again varied in composition which includes; qualifications, subject matter specialty, grade level, ability to teach special needs children, age, race/ethnicity and gender. Having a database could provide the school or education system with vital information to determine the supply of teachers corresponding to demand for the desired characteristics (Boe & Gilford, 1992) including turnover and shortages (Ingersoll, 2001). Usually for science teachers, it is their qualification specialty in one of the three major disciplines of Biology, Chemistry or Physics.

Some countries like the United States have revised their strategies on how to recruit and retain science teachers due to the shortage they faced (Luft, Wong, & Semken, 2011). In the

state of Victoria, Australia, science was reported as among one of the 'hard-to-fill' secondary subjects (NEALS, 2012). While comprehensive studies and projection models of supply and demand factors have been used by various authors (Boe & Gilford, 1992; NEALS, 2012), to predict numbers for the teaching work force. Gilford & Tenenbaum (1990), provides two reasons to be sceptical about improving projection models;

- (i) there is a great variation across school districts and salaries and working conditions that prevent it from being entered into the model in an aggregate manner and
- (ii) while studies may show that the final decision of a teacher to take a job may depend on salaries, the estimation technique has not been fully developed to know the real impact of teachers' career decisions.

School systems use a variety of strategies to recruit applicants for teaching positions. The first step for teacher recruitment is to determine the needs of the school for the coming year. Needs considered include: student enrolments, teacher-student ratio, class sizes, budget, information on internal transfer queues, information on attrition during the school year and information about resignations and retirements. If personnel officials feel that there is a particular shortage, some schools use special incentives such as offering bonuses during recruitment (Gilford & Tenenbaum, 1990).

Gilford & Tenenbaum (1990), report in one such recruitment drive, the officials found among the respondents to advertisements for teaching; the number of Biology applicants to be greater than Chemistry and Physics. The second discovery was that districts that paid higher salaries and attractive working conditions tended to attract many teachers from the nearby areas. The third observation was urban districts that needed more new teachers each year were more likely to use the national recruiting strategy. Geographical areas and preferences tend to influence applications well (Gilford & Tenenbaum, 1990). In South Africa, SACE (2010), found teacher recruitment and locality preferences to have an effect even though salaries were the same nationwide. Furthermore, Gilford & Tenenbaum (1990), found that usually for rural schools, the teachers who were originally from the area tended to go back home and were able to balance some of those staffing needs of the rural schools.

When recruiting, some advertise, while some make trips to job fairs or colleges where they have recruited from in the past. Applications are then screened and decisions made. At

high school level, the principal would delegate the departmental head to choose among the applicants, before their referees are called and the process completed. Subject departmental heads in schools are sometimes involved in the selection process because usually they are responsible to oversee the quality of instruction offered in their department (Gilford & Tenenbaum, 1990).

I have presented some of the factors that affect science teacher recruitment. The next section will present some of the factors affecting science teacher retention.

2.6 Science teacher retention and attrition

The overall changes in teacher supply are affected by factors that make teaching more or less attractive compared with other occupations in the job market. The major source of teacher supply to the system are the new teachers coming in despite continuing teachers making up the bulk (about 90 percent) of the general pool (SACE, 2010) or teacher supply in a year (Gilford & Tenenbaum, 1990).

Teacher attrition in most countries are low except for United Kingdom and the United States where between 30 to 50 percent of teachers leave within the first three to five years of teaching. With the exception of Australia (18 percent for female teachers between the ages of 25 -29) and Hong Kong at 10 percent, Germany, France, Portugal all recorded less than 10 percent (Cooper & Alvarado, 2006), resulting in a low teacher turnover. 'Turnover' is defined as the rate at which a company (school) loses and gains employees (Wikipedia, 2014). Younger teachers tended to have a higher rate of departure and those who remained, tended to 'settle in', and the turnover rates declined mid-career until retirement years (Ingersoll, 2001).

While some states in the United States were looking at ways to recruit and retain their science teachers (Luft et al., 2011), a study of high school science teachers in Tucson Arizona, revealed the contrary. More teachers wanted to stay because they valued recognition as professionals and having autonomy in their classrooms being more important than money (McElroy, 2009). A study by Morgan (1994), found Pacific Adventist teachers

tended to retain their jobs more and rated job satisfaction as more important than financial remuneration.

2.7 Self – Efficacy

Definition

Self-efficacy is a concept that stems from within Albert Bandura's social cognitive theory where he emphasizes that personality is developed from observational learning, social experience and reciprocal determinism (Cherry, 2013). Elaborating further, Cherry (2013) explains that, according to Bandura, a person's attitudes, abilities and cognitive skills comprise what is known as the 'self-system'. This self-system plays a major role on how individuals perceive situations and respond to different situations. Self-efficacy is an important part of the self-system (Cherry, 2013; Geyer, 2014).

Importance of Self-efficacy

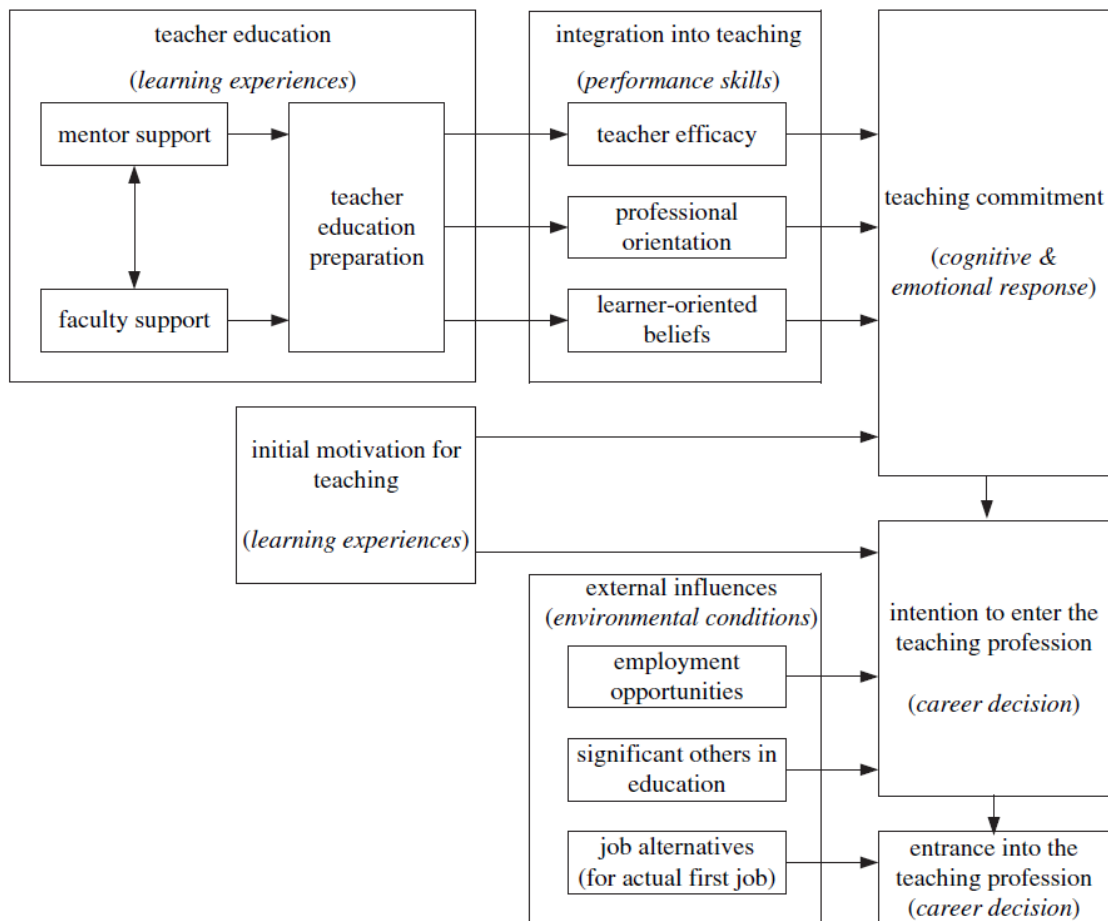
Perceived self-efficacy as a conceptual framework affects thinking processes in the regulation of motivation, action and affective arousal (Bandura, 1989). According to Bandura, self-efficacy influences a lot of social interactions and makes a difference in how people feel, think and act. How humans function, is facilitated by a personal sense of 'control'. A person with a confident 'can do' attitude is a person who believes in being able to cause or conduct a more active and determined life course. People with high self-efficacy choose to perform more challenging tasks and set themselves higher goals and stick to them. The self-efficacy of a person can therefore either impede or motivate them into facing those challenges (Bandura, 1989; Gibbs, 2002). Self-efficacy then becomes that individual's belief in his/her capabilities to effectively organise and execute a course of action required to manage specific situations. These beliefs govern how that individual thinks, feels and behaves, which is an important topic among psychologists and educators because of its impact on everything from psychological states to behaviour to the motivation of an individual to not only do something, but how and why one does it that way (Cherry, 2013).

Teacher Self-efficacy

Self-efficacy is a very powerful predictor of the actions of a teacher under the given circumstances (Gibbs, 2002). There has also been positive correlation between self-efficacy the political skills of networking ability, interpersonal influence, social astuteness and apparent sincerity which are very important attributes to a teacher (Geyer, 2014).

There are four kinds of self-efficacy being important indicators of teacher effectiveness; behavioural, cognitive, emotional and cultural. These can interact and influence control of emotions, behaviour, thinking propelling confidence and capability to teach effectively in the most culturally appropriate manner. It is believed that self-efficacy being the control factor, enables teachers to exercise personal control over their behaviour, thinking and emotions. Effective teachers will believe strongly that they can make a difference in a child's life and much of the time their teaching will reflect their beliefs. It is that 'can do' attitude that drives the self-efficacy of a teacher which is a strong predictor of teacher effectiveness (Gibbs, 2002; Holtz, 2009).

Teacher self-efficacy is built during teacher preparation as shown in Figure 2.1, that teacher efficacy, along with professional efficacy and learner-oriented beliefs are crucial components of teacher education preparation which a teacher integrates into his or her teaching which results to commitment in teaching (Rots, Aelterman, Devos, & Vlerick, 2010).



Note: Italicized words in parentheses indicate the relationship of components of the model to the more general tenets of the Social Learning Theory of Career Decision Making (Mitchell & Krumboltz, 1996).

Figure 2.1 Hypothetical model of factors affecting graduate teachers as they enter the teaching field (Rots et al., 2010).

Some indicators of strong self-efficacy are; greater job satisfaction (Gibbs, 2002; Skaalvik & Skaalvik, 2009), more committed and low absenteeism (Gibbs, 2002). Teachers with high self-efficacy tend to: persist in failure situations (Gibbs, 2002; Tschannen-Moran & Hoy, 2001), take more risk with the curriculum, use new teaching approaches, get better gains in children's achievement and have more motivated students (Gibbs, 2002).

In summarising, when a teacher's role deals with instilling ideas and facilitating in building-on from prior knowledge in young people, self-efficacy is crucial as it provides a strong sense of competence when facilitating cognitive processes and managing situations. When children witness competence and confidence being modelled, it raises their motivation and

self-esteem. In science, this could be demonstrated through practical experimentations, field trips and excursions apart from individual investigative projects.

“ if there is one subject matter that has potential to offer significant returns on investment for both the individual and country concerned, it is unquestionably science education....Reforming science education can impact on the protection of the environment, the population growth rate, personal health and welfare, and the quality of life. It offers the possibility of increased relevance, higher student motivation, reduced per capita costs, improved teacher retention, a large number of overseas study options, and better quality education...”
(Muralidhar, 2004).

I have presented in context the definition of self-efficacy and the importance of self-efficacy as a teacher. The next section presents the policy outcomes for the Tonga national Education Policy Framework relating to the topic of teacher supply and demand propelling this study into the context of this research. The next section summarises all the literature relating to this study and propels the study into the context of this study.

2.8 Summary

This literature review has contextualised the topic and sub-topics of this study utilizing literature mainly sourced from the internet and the Victoria University online library facility. Literature sources have been mainly online articles, thesis, and reports from journals including UNESCO, Pacific Islands Forum Secretariat, SPC & European Union and World Bank reports.

There is no question about the role secondary science education plays in the social, economic, and human capital development of countries around the world. The task before today's societies is to transform secondary classrooms and current schooling practices to align them with the demands of a globalized and technology-driven world, challenging policymakers and educators to address the issues of increasing access, quality and relevance of secondary education for all younger generations.

Gaps Identified:

This literature review has widened two major themes of discussion or gaps which are:

- (i) To be clear at policy level the relevance of science to society and plan its content pathways to be included in the curriculum and ways to implement the teaching of science
- (ii) Assess the Teacher Supply and Demand equation to plan for (i).
- (iii) It may mean revisiting the individual components and carrying out further research into both areas to update policy decisions and implementation.

This research is more inclined towards the second theme by exploring current practices purporting to the relevance of science as a subject in Tongan secondary schools and investigating the processes by which teachers of science are attracted to training, recruited and retained in secondary schools. Firstly, literature around teacher supply and demand and/or components pertaining to science teacher supply and demand in the Pacific is limited. Therefore one of the aims of this research is to contribute to this knowledge gap in education in the Pacific region. Secondly, it will contribute to the debate by assessing whether or not science teachers in Tonga are adequately supported to deliver quality science teaching in its secondary schools. Thirdly, it intends to assess how secondary schools staff their science classes and the impact that this has on the quality of science teaching. Hence, the overall question asked in this research as; to what extent has Tonga been able to attract to train and retain its science teachers?

Research Question:

To what extent has Tonga been able to attract to train and retain its science teachers?

The study will ask; are there enough science teachers being trained or recruited to meet demand for science curricula? In addition, qualitative interviews will be conducted with senior staff in selected secondary schools to assess if there is any relationship between the recruitment strategies and the staffing strategies used by schools and the quality of science teaching staff. What are the science teachers' perceptions about teaching science at the moment and what is their self-efficacy? In order to understand the research question, some of the terms used in the question are defined and clarified as follows.

Definition of Terms

Attract: To be able to draw and maintain sufficient student intakes annually to train and supply Tongan secondary schools with science teachers.

Train: Learning to become teachers of the subject hence, to attain a qualification to become a teacher of the science subject.

Retain: The ability of schools to staff and maintain the required (sufficient) numbers of science teachers to deliver the science curriculum to secondary pupils.

Sub –Research Questions

The following questions were raised to serve as the basis of enquiry into the problem as sub-research questions:

1. How has Tonga been able to attract and train its science teachers?
2. How has Tonga been able to recruit and retain its secondary science teachers?
3. What is the self-efficacy of Tongan science teachers and how do they feel about their work?

This Chapter has presented a review of literature on the importance of science in a school curriculum. It has also visited the issues of demand and supply of science teachers in secondary schools highlighting the need to be wary of the process by which students are attracted to training as science teachers, recruitment and retention of these teachers in a school system. It has also identified some of the gaps in literature on this issue especially for the Pacific Island nations especially Tonga posing the research question and the sub-research questions which guided this study.

The next Chapter presents the methodology used in obtaining the data for this research.

CHAPTER 3.0 METHODOLOGICAL FRAMEWORK - *TEU mo TOLI*

Introduction

This chapter begins with an outline of the methodological framework used for collecting the data in three parts. The first defines and describes the theoretical framework of the study (section 3.1) presenting the research paradigm, followed by a description of the research framework - the Kakala Framework clarifying definitions and meanings in the Tongan cultural context. The second part (section 3.3) presents the research process where the strategies that are defined in the research framework were utilised used to achieve the objective. Thirdly the data analysis methodology is presented in section 3.4, explaining how the data collected were integrated.

3.1 Research Paradigm

Pragmatism – as a paradigm for mixed research

A Research paradigm is defined as “a perspective about research held by a community of researchers based on a shared set of assumptions, concepts, values and practices” (Johnson & Christensen, 2008 p.33). It is an accepted model or pattern as an interpretive framework, guided by beliefs and world views stemming from assumptions and feelings about the real world around us and how it should be studied and understood (Feilzer, 2010; Johnson & Christensen, 2008).

There are three major research paradigms; qualitative, quantitative and the mixed research approaches. Pure qualitative research relies on the data collection techniques being non-numerical using words and pictures, while it is the opposite for quantitative research where numerical data is involved. This case study chose a pragmatic position to combine certain aspects of the two paradigms into a ‘mixed research’ to best find answers to the research question (Johnson & Christensen, 2008).

Pragmatism is a deconstructive paradigm that advocates the use of mixed methods in research and “sidesteps the contentious issues” (Feilzer, 2010 p. 8) and focuses instead on

what works in solving practical problems in the real world. Pragmatism extracts the necessary positive aspects of both qualitative and quantitative methods and uses a combination of both concepts to understand the world fully, particularly regarding the research questions under investigation. In doing so, it avoids the 'narrow-angle lens' and 'paradigm wars' between qualitative and quantitative paradigms (Feilzer, 2010; Johnson & Christensen, 2008).

A mixed research therefore "involves the mixing of qualitative and quantitative research methods" placing it on a continuum as shown in Figure 3.1(Johnson & Christensen, 2008).

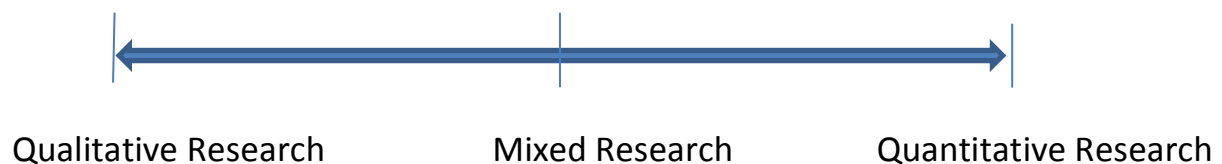


Figure 3.1 Research Continuum (Johnson & Christensen, 2008)

The exact mixture is dependent upon the guiding research framework, the research questions and the situational and practical issues facing the researcher (Johnson & Christensen, 2008).

The next section describes the research framework used in this study.

3.2 Research Framework

3.2.1 The Kakala Framework

The research framework that guided this research was the Kakala framework by Konai Helu Thaman (Thaman, 2010). The *Kakala* is a Tongan metaphoric representation of Thaman's (2010), philosophy of teaching and research in education. She describes the kakala in the Tongan cultural context as a lei woven with a collection of fragrant flowers, leaves and other plant material that have been woven into a garland to wear on a special occasion or present as a gift to a special person. Before the *kakala* is made, the weaver gives great thought in deciding the type of lei and the type of flowers or plant matter to be used. Choice flowers are then carefully picked or collected and intricately and skilfully woven together with the use of local fibre (*fau*) providing the support base into which the elements can be skilfully placed to form a beautiful piece of wearable flower arrangement. As mentioned, a *kahoa kakala (lei)* is worn on special occasions or ceremonies and is of great significance as most times, the weaver gives it away (Thaman, 2010).

Thaman (2010), used this metaphor to typify education especially the teaching and learning process as, *ako* (schooling), *poto* (learned) *mo* (and) *ilo* (the appropriate use of acquired knowledge and understanding). The kakala framework in a research sense uses the concepts of: **toli** (gathering), **tui** (weaving) and **luva** (presentation) translating into: **toli** (data collection), **tui** (analysis of the data) and **luva** the presentation of research findings (Thaman, 2010).

Recently, there has been an addition to this three part research framework to bring its research orientation into a 6 part process to compliment **toli**, **tui** and **luva** with **malie** and **mafana** by Taufe'ulungaki, Johanson-Fua, Manu'atu and Takapautolo into the Kakala Research framework (KRF). Thaman's *Kakalaframework* of *toli*, *tui* and *luva*, now includes **teu** (preparation) to precede *toli* (collection) and **malie** (relevance) and **mafana** (application) to follow *luva* respectively. The rationale to the addition is; KRF acknowledges that mental preparation and planning precedes flower collection when making a *kahoa kakala (lei)*, therefore places **teu** (preparation) before *toli* (collection). KRF maintains *toli*, *tui* and *luva* as it is but adds another two steps **malie** (relevance) and **mafana** (application) after that making it a six part process (Chiu, 2011; TESP, 2014).

The next section presents the definitions and descriptions of these terms in both the cultural context drawing parallels of its significance on a research context.

3.2.2 Conceptualization of terms

This section presents the definitions of the terms used and contextualization of the terms from cultural fact into its educational research significance as presented in the Kakala/Kakala Research Frameworks.

***Teu* - Prepatation**

During *teu*, the weaver of the garland decides on the structure and details of the lei especially the type of flowers to be used. After deciding on the components and structure, he or she prepares for flower collection or gathering. Preparation also includes making sure there is local fibre (*fau*), with which the lei will be woven, holding the flowers in place and providing embodiment to the lei.

In research contexts; at the preparatory stage of the study, the research paradigm is decided upon, the methodology to be used and research instruments to use for data collection. It sets the stage as to what impact the final report will have when presented.

For the purpose of this study, selecting science teacher education focusing on Tongan Science teachers as research participants sets the preamble – the *teu* stage. By choosing a case study approach as a methodological framework also confirms the *teu* stage.

***Toli* – Picking/Collection**

In the traditional setting, flowers can be collected in three ways;

- (i) freshly fallen flowers are freely and readily available to be picked up by hand,
- (ii) flowers still attached to the main plant can be picked by hand
- (iii) using a stick or tool to detach the flowers off the stem or to get to the harder to reach areas of a tree.

In the research context it is the data collection process. The information required is collected with the use of the chosen methods and tools. The flowers that have fallen to the ground, represents information that is available via the internet or written documents. The flowers that need to be picked by hand, or with the assistance of a tool such as a stick represents all other data collection techniques either by way of interviews, questionnaire or other. In this research, all three ways were used to gather the information needed for the case study.

Tui – weaving/sewing

The process in which, the gathered flowers are woven into a garland. *Tui* is a simultaneous work of the mind and the hand where the collected flowers are skilfully woven together onto a support fibre (*fau*) that holds the flowers in place, arranged beautifully as the weaver had mentally pre-conceived. The *fau* (fibre) plays a very significant role in the making of the lei - it provides a structure, an embodiment of the *kahoa kakala* or lei.

In the research context, *tui* becomes the data analysis process, when the information collected is grouped into themes or relationships drawn together to produce generalizable findings or overall viewpoints. It is a dual process of arranging data as well as drawing meaning and understanding from the collected data to be presented.

Luva- Presentation

During special occasions and ceremonies, garlands of kakala can be presented as gifts honouring a recipient or distinguished guest. This process is called *luva*.

In the research context, the findings of the study would either be presented as tested and relevant data or an overall report be made available to the relevant bodies or for public consumption.

Malie - Relevance

The recipient feels honoured and appreciates wearing the garland enjoying the sweet perfume or fragrance the flowers release.

In the research context, it is anticipated that a research report or statement of findings will present the recipient with valuable or relevant information which can be used to their advantage.

Mafana- Application

In the cultural context, the wearing of the garland sets the individual apart as having prominence. Prominent persons initiate change and transform communities. At times it boosts one's self-confidence to sometimes step out of their seats to put on a simple dance; it provides a sense of empowerment.

In the research context, when the findings and recommendations are presented, it would be entirely up to the receiving body to digest it and act upon its implications and recommendations for improvement or sustainability.

This section has described the definition of terms in context and drawn the parallels of the *Kakala/Kakala* Research Framework with the cultural essence to educational research application. I have defined the research frameworks that guided this case study. In the next section I will provide the conceptual framework underpinning this case study in detail.

3.2.3 Conceptual Framework – *Koe fau, koe no'o anga ia o e kakala*

Placing the role of the fibre (*fau*) in context

The conceptual framework for the case study drew from the *kakala/KRF* the function and relevance of the fibre (*fau*) in the *kakala* weaving process. The fibre (*fau*) used in lei (*kahoa kakala*) making comes from the inner bark the *Hibiscus tiliaceus* tree, commonly known as the beach hibiscus (Whistler, 1992). Its primary role is in holding the flowers together when woven, and secondly gives structure to the *kahoa kakala* - without it the flowers wouldn't form a pattern or structure. Other uses for this fibre are: making fishing lines when twisted together, nets, mats and ropes. A basic *kahoa/kakala*, can be made by interweaving pieces of fibre and carefully placing the choice flowers in the required sequence to create the wearable lei.

When considering the research question and drawing from the understanding of the metaphorical concept of the *kakala* framework is the question; what holds the *kakala* together as a mastery piece of creation that is valued? It can be answered in the local vernacular as; *koe fau, koe no'o anga ia o e kakala* - the fibre (*fau*) holds the flowers in place and provides structure and strength to the lei. Therefore it seemed appropriate to use the first four steps of the 6 part KRF leaving the last two steps of *malie* and *mafana* to the education governing and monitoring bodies and the Government of Tonga.

In order to answer the research question, the role of the fibre (*fau*) was unpacked into three components by asking the following three questions:

1. What holds a society/ethnic group of people together?
2. What holds an education system together?
3. What holds and makes up the ethics of a teacher?

(i) Culture

The first is the culture of the Tongan people, the source of their strength that enables them to thrive. The Ministry of Education itself is abbreviated MEWAC which stands for Ministry of Education, Women and Culture. Tonga is a Christian country and Faith encompasses the culture of the people; therefore, culture includes faith as a Christian nation.

Ensuring that 'Tongan culture' is taught from Primary school right through to secondary school and at Teachers College ensures that the values and traditions of the people are passed on from generation to generation. The vision statement of the Tonga Institute of Education to train teachers in all aspects including the culture aspects further reaffirms this policy. Culture becomes a piece of *fau* (fibre) upon and with which the flowers (education and development of its people) can be woven with into a fine *kakala* (lei).

(ii) Educational Policy Framework

When formal schooling is organised and controlled by governments, education stakeholders must make sense of the policy approaches within which to operate. Therefore, when key decisions are made relating to the interpretation and implementation of policy directives, there is understanding when combining stakeholders personal values, perceptions, context and resources (Jones & SpringerLink, 2013).

In the context of this research, there is one clear secondary education policy framework which is controlled and monitored by the Ministry of Education Women and Culture. Although the various Church systems operate under their faith-related ethical framework, they all observe and operate within the statutes of the MOE.

(iii) Self-Efficacy of the Science Teacher

This research focused particularly on science teachers; to explore and understand the inner strength that motivates the conviction of how good and confident they feel about themselves with their daily routines. This is important because some tasks can be quite challenging, especially in the Islands of the Pacific where science resources are limited. With Bandura's concept of self-efficacy (Bandura, 1989) in mind, I set out with the belief that their **self-efficacy** is the fibre (*fau*) that empowers them with the confidence to do what they do, although light and porous, yet flexible and strong enough to weave and hold a *kakala (lei)* together. The self-efficacy of Tongan science teachers is measured for the first time in this study and is presented in Chapter 4.0.

This section has described the research framework and the conceptual framework upon which the case study was based. It has presented the *Kakala/Kakala* research frameworks upon which the conceptual framework of the '*fau*' was drawn upon. As the *fau* binds and holds the flowers together, the culture also holds one aspect (one strand) of behaviours of the teaching and learning processes in the classroom. At the same time, the second strand is the educational policy framework that defines the overall objectives of the system. The *fau* also represents the policy guidelines of an education system on what it aims to achieve. Thirdly, at a personal level, the *fau* represents the self-efficacy of a science teacher. The following section describes the research process.

As the *fau* is not rigid, but light and porous, so too are the three strands of culture, education policy and the self-efficacy of the teacher. All three can be intertwined to weave a great science teaching and learning strategy (*kahoa kakala*) for Tonga.

3.3 Research Process

This section describes the research instruments and processes used to collect data in this study. It also provides explanations on how the data were treated and analysed.

Site and Location

This study was conducted in Nuku'alofa, the capital of the Kingdom of Tonga. The final analysis and interpretation of data were carried out at Karori campus of Victoria University of Wellington.

Research Instruments

As a *kahoa kakala* is woven by intertwining pieces of fibre (*fau*), three pieces were chosen for this case study; internet search and document analysis, semi-structured interviews and teacher questionnaire mixing both qualitative and quantitative data collection methods conducted simultaneously. Therefore, data collection utilised the following three instruments simultaneously: semi-structured one-on-one interviews as described in section 3.3.1, document analysis including internet search described in 3.3.2 and teacher questionnaire in section 3.3.3.

3.3.1 One-on-one Interviews

This section details how the one-on-one interviews were carried out for part of the qualitative data gathering. Interviews were conducted in a semi-structured manner with three CEO's of Education two representatives of CEO's and seven principals of Secondary and Tertiary schools and colleges. The semi-structured format was ideal as it allowed the informant to speak, while the researcher listened, enabling the researcher to ask questions for confirmation or clarification of specific ideas during the conversation. The interview schedules used in this study are presented in appendices 12 and 13.

Voice Recordings

All interviews were conducted 95 percent in English and five percent in Tongan, exclusively with the informants and recorded using a digital voice recorder to be transcribed.

Transcribing

The voice recordings were transcribed and summarised by myself as the researcher as all translations were made during the interview by the interviewees. The instances where a Tongan term was used for emphasis were translated explained in English during the interview.

3.3.2 Document Analysis

The internet was the main source of much of the background and demographic information for Tonga. Student enrolments and graduates data were made available by records administration staff of the Tonga Institute of Education and the University of the South Pacific in Suva, Fiji. The Ministry of Education's Educational Management and Information Service unit (EMIS) provided the data on the number of teachers in Tonga and relevant bio-data information.

The next section describes the third research tool – the Teacher Questionnaire and how it was administered.

3.3.3 Teacher Questionnaire

The teacher questionnaire (Appendix 6) targeted science teacher populations from both state-run and Church-run secondary schools in Tonga. Seven out of the nine invited schools participated. The questionnaire utilised a mixed approach of both qualitative and quantitative aspects interwoven into one research tool.

The first aim was to collect factual background information of their bio-data, teaching experience and retention in their present schools. The second aim of the questionnaire was to enable them to share their thoughts and perceptions through open-ended questioning. The key elements were particularly rewards and challenges faced as teachers of science in Tonga. The data collected using this aspect, were treated qualitatively.

The third aim was to carry out a self-efficacy test of our participants to understand more about their self-confidence in teaching under the present circumstances and explore their

thought process regarding factors that affected their teaching career. The data collected on the self-efficacy test were treated quantitatively.

The data analysis method used to analyse the questionnaire was mixed analysis(Johnson & Christensen, 2008).

Research participants

Three groups of participants were involved in the study. The first group comprised of senior education officials and representatives from the CEO's offices of secondary education providers; the second group comprised of secondary and tertiary college principals. Both of these two groups were interviewed. The third group were the science teachers from seven invited secondary schools. All participants (Table 3.1), consented by signing and returning the consent form either before an interview or along with the questionnaire.

Table 3.1 Research Participants and Type of Research Tool Used.

| Participant Groups | Research Method and Data Collection tool used | Total Number |
|---------------------------|---|---------------------|
| Senior Education Official | Qualitative - Interview | 3 |
| *CEO's Representative | Qualitative – Interview | 2 |
| Principals | Qualitative - Interview | 7 |
| Science Teachers | Mixed (Qualitative and Quantitative) - Questionnaire | 30 |
| Total | | 40 |

Key: CEO – Chief Executive Officer, SEO – Senior Education Official

Research Sample

As stated the participants were all willing, who consented by filling the consent form either before the interview or completing a teacher questionnaire. The number of questionnaires

distributed per school depended on the size of the school, purposefully targeting science teachers. There was no coding of schools or identifiers used maintaining the anonymous nature of this data collection method. The research sample was therefore, 10 senior education officials (interviewed) and 30 science teachers who returned their completed questionnaire scripts providing a total of 40 as the research sample. The following sections describe how the data were collected and analysed.

Data Collection & Storage method

Preliminary meetings were held with participating Principals to arrange interview times and confirm total number of science teachers in the school before the questionnaires were released. All the interviews were conducted as described in section 3.3.1. After the teachers had completed the questionnaires, the scripts were returned in a sealed envelope that was provided. Out of the 65 questionnaires distributed, 30 (46 percent) returned completed, from which the findings are drawn. The completed scripts were then analysed as described in the next section.

3.4 Data Analysis Method

This section describes the data analysis method used in this mixed research. This method was chosen because the conceptual framework stemmed off a mixed research paradigm, collecting quantitative and qualitative data within the same study (Johnson & Christensen, 2008). Due to the mixed nature, both quantitative and qualitative data were reduced and displayed using tables and charts.

Qualitative Data Analysis

The qualitative aspect involved categorizing the data into themes and treating it as mono data before integrating (Johnson & Christensen, 2008).

Interview transcriptions were analysed qualitatively for patterns and themes in the responses to the interview questions. Documents were also analysed by classifying and categorising separating quantitative data to be treated as such.

Quantitative Data Analysis

Categorising and coding were necessary for the analysis of data collected through document analysis. These findings were reduced and tabulated into themes before graphs were drawn. The responses to parts 3 & 4 of the questionnaire involved a Likert-type psychometric test (*Appendix 6*) and hence required scoring for further analysis. Responses were allocated a score before being consolidated using spreadsheet and charts drawn. The following sections describe how the questionnaire scripts were categorized, coded and scored for further analysis.

Categorizing

The completed questionnaire scripts were firstly categorized into three major groups according to their years of teaching experience as; junior, senior and senior management.

- (i) Junior - those who had been teaching for up to three years (0 - 3 years).
- (ii) Senior - those who had been teaching between four to 15 years (4 - 15 years).
- (iii) Senior management - those who had been teaching for 16 years and over (16 + years).

Coding

The questionnaire scripts were randomly coded chronologically from a mixed pile after categorizing into the three groups as follows. The code T001 was given to the first script that was picked up from the first group (0-3 years) until the last script on that group was coded, the next number went to the first script from the second group (4-15 years), until the last script of the third group (16+ years) was allocated the number T030 before analysis.

There was no coding of schools or name tags associated with any individual however, the designated codes presented in Table 3.2, was for data analysis purposes only. Senior education officials were coded as 'SEO', CEO's representatives as 'CR', principals as 'P' and teachers as 'T'.

Table 3.2 List of Participant and designated codes

| Participant Groups | Research Method and Data Collection tool used | Designated code | Total Number |
|---------------------------------|---|---------------------|--------------|
| Senior Education Official (CEO) | Qualitative - Interview | SEO1, SEO2 and SEO3 | 3 |
| CEO's Representative | Qualitative - Interview | *CR1, and *CR2 | 2 |
| Principals | Qualitative - Interview | *CR1, and *CR2 | 7 |
| Science Teachers | Mixed - Questionnaire | T001 – T030 | 30 |
| Total | | | 40 |

**Note: CR1 and CR2 are identified as such for anonymity but among the P group.*

Scoring for the Self-efficacy Psychometric test

This Likert-type psychometric scale as a test tool was adapted from (Skaalvik & Skaalvik, 2009; Wikipedia, 2013) to fit the Tongan context in this study.

Parts three & four of the questionnaire involved this test component which required scoring during analysis. For part three, each response was awarded a Likert score between one and four (1, 2, 3 or 4) for the responses. This was because participants were given four options too select from for agreement; while for part four, participants were scored out of five (1, 2, 3, 4 or 5) for each selection before being tallied up because the questions here involved five options for selection. The greater the mean was for each of the questions, the greater the self-confidence and self-efficacy of the science teacher.

Analysis of the Self-efficacy test

Part three of the questionnaire consisted of 24 questions, 3 questions each relating to 6 themes: Instruction, Adapting to individual needs, Motivating students, Keeping discipline or managing student behaviour, Cooperating with colleagues and parents and Coping with

changes and challenges. These Likert items were adapted to fit the Tongan context and consisted of four options to select from: Very confidently which carried a score of 4, Quite confidently = 3, A little confidently = 2 and Not so confidently =1. A 4 point scale is used to test their teaching confidence avoiding the middle option of being unsure. It was to test whether they are confident in carrying out their teaching duties and tasks with confidence or not. The mean scores were calculated, consolidated and plotted against the 6 themes (Figure 4.9) using Microsoft excel. The mean scores were further grouped for testing the statistical validity.

The second aspect of their self-efficacy was their thought process in relation to a couple of factors; Time, Discipline, Autonomy, Supervisory support, Co-operating with colleagues and Parents and External Control. This part of the test involved questioning around their thought process in relation to the above themes. The second set of Likert items consisted of 18 questions on a five point scale (questionnaire part 4). Teachers were asked to indicate whether they, Strongly Agree, Agree, Neither agree nor disagree, Disagree or Strongly Disagree. Here the measure of their agreements to the various situations would involve a great deal of thinking about the presented situations and therefore may not translate into immediate action, but is evidently there. Therefore a five point scale was chosen for this part with a total score out of 5 for each question:

5 = Strongly agree, 4 = Agree, 3 Neither, 2 = Disagree and 1 = Strongly Disagree.

The mean scores were consolidated for each of the three categories and were plotted against each theme (Figure 4.10). The mean scores were also grouped for testing the statistical validity.

Statistical Validity

Statistical validity was tested using two-sample t-test to examine whether the responses given by the three groups were different from one another as the sample size was small. This was done by comparing two group means as two samples as the variances of two normal distributions to calculate a probability or *pValue* using Microsoft excel (Investopedia, 2014).

A Null Hypothesis was stated as: There is no difference in the responses of the three groups of teachers between each other. The rejection region for the t statistic or significance value α was chosen as 0.05.

When $p < 0.05$ = Reject H_0 and when $p > 0.05$ accept the alternative H_a .

3.5 Ethical Issues

All care was taken to abide by the Victoria University Human Ethics Policy requirements and guidelines under Ethics application SEPI/2013/67 RM 20310.

Tonga also has its own code of ethics, for which a separate application was made to the Ministry of Education and the Prime Ministers Department. Approval was granted under the Tongan Cabinet Decision No.410 for the fieldwork to begin.

Being a very small country with a very close-knit community, all considerations were given when interviewing the participants as not to reveal the names or identity of the participants. No names have been mentioned but individuals are only referred to their generic titles. Professional care was taken during the interviews and discourse with former superiors and colleagues during the course of data collection.

3.6 Limitations

All the data collected and presented are based from discussions and interviews carried out with senior education officials and principals of both state and church-run education systems in Tonga. The teachers' perceptions and ideas generated are from only 30 willing participants from the 65 questionnaires that were issued to Tongatapu schools. The limited time I had in the kingdom didn't allow for more interviews as data collection was immediately after cyclone Isaac struck the Islands, therefore preventing me from reaching schools in the outer Islands also for a larger sample size.

Even though there are 22 secondary schools and 18 intermediate schools, the intermediate schools were not included in the study in order to maintain consistency.

The adaptation of the self-efficacy test was only to test teacher self-confidence and the themes tested although the Norwegian test by Skalvik & Skalvik (2004) tested for more variables for example Teacher burn out and job satisfaction which were not tested here. The Likert-type scale developed was also an adaptation to fit the context of Tonga. There was no item to item comparative analysis for the statistical validity as the scope of the study did not warrant it. Future researchers could modify or improve on it to suit their purposes.

The findings of the study are presented in Chapter 4.0.

CHAPTER 4.0 ANALYSIS AND PRESENTATION OF FINDINGS –*TUI*

Overview

The data presented in this chapter is weaving (*tui*) of three data collection techniques which have been described in chapter 3.0. *Tui* begins by presenting a summary of interviews with the CEOs of secondary education providers in Tonga at the policy level for preliminary findings in section 4.1. This is followed by the summary of the interview with the Principal of Tonga Institute of Education (TIOE) in section 4.2 before presenting the results of some document analysis of enrolments and graduate patterns at the TIOE and the University of the South Pacific (USP) in section 4.3. The summary of the interviews with the Principals of secondary schools are then presented in section 4.4 before returning to document analysis and analysis of data collected through the teacher questionnaire in this weaving (*tui*) process in section 4.5. The teacher questionnaire surveyed the participant's bio-data, teacher perceptions and self-efficacy. Section 4.6 reports on Tonga's current science teachers explored through the questionnaire while section 4.7 presents Teachers' perceptions. The results of the self-efficacy test are presented in section 4.8 before the summary of all the findings in section 4.9.

4.1 Summary of Interviews with CEO's of Education

Secondary Education Policy

The CEO of Education in Tonga confirmed during the interview that the MOE is the guardian and administers the one education programme in Tonga and all systems comply with the Tonga national education policy. This policy incorporates all aspects in all compulsory school-age levels in Tonga as discussed. All subjects come under the one secondary education policy and Church-run schools systems that partner with the government in delivering secondary education are expected to operate under the national policy in this regard; except for Biblical instructions which is delivered according to each Christian denominational values and principles. Three other SEO's also confirmed that since their education system is faith-based, the Bible is the ultimate doctrine taught, and at the same

time, endeavour to meet all MOE's requirements in terms of standards. Tonga is a Christian country and Faith is part of the people's culture, so it automatically translates across into education as the Minister for Education summed it as; "everything in education in Tonga is centred on the Tongan culture" (*Interview SEO3*).

Recruitment and staffing

The recruitment of science teachers into Tongan secondary schools is mainly from the Tonga Institute of Education for diploma graduates and the University of the South Pacific in Suva Fiji for a Bachelor's degree or higher degree. Other institutions that Tongans have gained their basic science degrees and or higher degrees from are in Australia, New Zealand, USA and Papua New Guinea. Atenisi University in Tonga has recently produced some Bachelor of Science graduates who are currently employed as science teachers. All the CEO's expressed that no advertisements are made overseas for expatriate teachers due to financial constraints, therefore limiting recruitments to Tonga among Tongans who would understand their country's economic situation and be content with their salary.

Three CEO's explained that, expatriates who have been hired by their schools were either accompanying spouses or volunteers. All schools have ex-student groups overseas who are in close liaisons with the schools and sometimes secure teachers through private arrangements. Two CEO's explained how their church has a scheme called 'friends of the church' programme to assist these schools fill a vacancy during times of acute teacher shortage.

The Ministry of Education advertises its posts through the Education Gazette and Ministry's website and most church-run schools do not advertise but, rely on open applications from interested individuals or reshuffling of teachers within their own systems to cover for a shortage. All the CEO's expressed a shortage of science teachers at the moment. The Ministry of Education had recently (2012/2013) done a major reshuffling of teachers to cater for the new Sixth and Seventh Form for Niuatoputapu High School (in one of the Northern most Islands in the kingdom) which ideally needs at least three degree holders in Biology, Chemistry and Physics to effectively deliver the programme. That means a couple of other schools losing a qualified science teacher to Niuatoputapu. One of the church systems currently has one science teacher away on further studies, while another just had one

teacher return from overseas studies, but still does not have a full science team and the school is still looking for a qualified physics teacher.

Retention of Teachers

Science teachers in Tonga tend to be retained in teaching longer because of limited employment opportunities in the sciences outside of teaching. All the CEO's expressed they will retain science teachers in a particular school for as long as they can, but if another school within the system is in need, they will release that individual. One of the biggest challenges was when a science teacher wished to leave. They explained that it is tough but nothing much can be done if they wished to leave for a better opportunity elsewhere.

One CEO put it as; "one of the biggest challenges is attracting science teachers is 'retention'. Science teachers can never perform to their full capacity if we do not equip them. No science teacher wants to come to a school where there is limited to no equipment to begin with, however when they come, we really appreciate having them" (*Interview CR2*). In order to retain them, the system is constantly looking at ways to provide the necessary equipment to assist them in their work or provide other incentives such as scholarships or time for them to do further studies. That way they improve their individual capacities to fully utilize their potential and we can have their full commitment to the school in return. Most return from studies and stay with the system, but some leave for better salary elsewhere. This CEO further added; "When our most qualified teachers leave, it affects us as a system, but considering Tonga as a whole, at least we have contributed to this person's training so that the country will gain, one way or another" (*InterviewCR2*).

Challenges Faced

The biggest challenge expressed by all the CEO's was capturing the interest of the students to do science in school. One Director pointed out that, the question we should be asking now should be; "what is the attraction of students and student teachers away from science instead of to science?"

The technological advancements worldwide have now pushed more and more students to take computing and Information Technology and away from the mainstream sciences. Employment opportunities have also influenced the career paths of many students to opt

for Business and Commerce instead of science. Science oriented employment opportunities in Tonga are limited to nursing and teaching at sixth form level. Unless students complete seventh form and make the required grades, then they go overseas to train as doctors or engineers. Science is not as popular nowadays as it used to be, the trend is now in business and commerce as people need to get a job to sustain their livelihoods.

This Director emphasised that we should be seriously asking this question now and reverse that trend as they need to “learn how to learn” through enquiry learning which science provides. There is a great need to lift the motivation of students in science in order to lift their grades in the external examinations also to meet the required grades for further opportunities. When asked if they were satisfied with the performance of their students so far, they replied, No, with two of them actually saying, “There is never a yes to that question, there is always room for improvement” (*Interview SEO1*).

One director expressed dissatisfaction over the popularity of the subject at senior levels (sixth and seventh form) and suggested science to be made a compulsory subject countrywide up to fifth form along with English, Tongan and Mathematics. The CEO stated, “When students are given the opportunity to opt away from science as early as third and fourth form, it limits their ability to enter into a science oriented career with a sound all rounded educational background” (*Interview CR2*).

Another CEO said, “Students do not want to learn the hard way anymore, they want the easy way out of things and rather not do science because they know it is hard work” (*Interview SEO2*).

The second challenge was getting teachers to lift the attraction of science by being “creative and innovative enough to engage and encourage student’s learning in science through improvised practical demonstrations”. CEO’s expressed that the practical component of science needs an uplift avoiding “blackboard practical classes” which one CEO claimed to have witnessed. In such cases, only a small fraction of children are able to follow what the teacher is doing on the blackboard. The majority of the children need to see experiments being done and get a hands-on experience (*Interview SEO2*). Interviewee P7 agreed by expressing that it would be an injustice to the science teachers if they are not provided the correct equipment to fully utilise the expert knowledge that they have. They have to be

better able to transfer some of their own motivation across to the child and get them interested in doing science through adequate and enough practical demonstrations.

However, this CR2 felt, “the teachers need not to be blamed for it. They are doing their best and some do take the children outside of the classroom and go that extra mile to be innovative in their teaching given the circumstances that they are under with limited resources. So the challenge for some of the Church systems is to be able to acquire chemicals and scientific equipment, or even new science laboratory facilities to better assist their teachers. That way if their work is made a little more exciting, there would be greater job satisfaction and willingness to stay.” “No science teacher wants to come to a school where there is limited to no equipment to begin with, however when they come, we really appreciate having them” (Interviewee P4).

Professional Development

Professional development of teachers with the Ministry of Education as well as some of the Church systems came with demand and needs to meet that demand. If there is a need in one subject area, then professional development focus shifts to the subject concerned until that need has been met.

Currently the Ministry of Education has just entered into a professional development programme with Auckland University’s Liggins Institute to run the “learn science programme” with its science teachers. For one Church system, further training works on a subject rotation basis every year. However, there are also weekly professional development sessions organised and carried out by the senior management team of each school for most schools, with departmental meetings with their team leader and colleagues. One CEO wasn’t aware of any professional development of science teachers at the time of interview, being new to the post. One sentiment expressed by all is “the need to revive the science teacher association”, which seemed to have gone into dormant mode for a number of years now. All four CEO’s recognised that the subject association provided a great support base for teachers and new graduates out in the schools. They expressed that the science teacher association needs to be revived.

Quality of Science Teachers

Qualification and teaching ability stood out to be the two most desired among education directors. Teachers must be able to plan their work according to the curriculum and calendar year and have the initiative to go out and look for resources to assist in the children's learning. Science is a practical subject and it must not be taught on the blackboard. They viewed an effective teacher to be "one that can meet between 90 -100 percent of a child's learning need in a way that is practical oriented and consistent for each learning style".

All the directors interviewed expressed there is a great need for qualified specialised science teachers (in the three major domains of science, yet the following statement was made on a number of occasions; "however, we make do with what we have" (*Interview SEO1*). One expressed that, qualification is currently not necessarily the priority, but "experience and commitment, to be able to connect with students to guide and capture their interest in the subject material is desired"(*Interview SEO3*). Another expressed that the "passion for teaching science needs to be uplifted"(*Interview SEO2*). This may be partly due to the challenge of adequately equipping and facilitating the school science laboratories.

Importance of Science

Directors were asked to place the importance of science in their schools on a scale of 1-5 (1 being the least important to 5 being the most important). The responses received were; 3, 4, (4 ½ - 5) and 5. They recognised the importance of science in their school systems as high to very high.

The director who placed science at 3 provided the following explanation; being a church school, Biblical studies which encompasses their belief system (faith) came first followed by language, science, social science and math. Language (both English & Tongan) came second because everyone needs to learn how to communicate, and Science is third, at number 3 because students needed to 'learn how to learn'. Learning through enquiry learning by practising, testing and learn to ask and answer questions through practical science lessons and research (*Interviewee SEO1*).

The directors who placed science between four and five acknowledged that science promotes enquiry learning, and expressed its importance as a lot more is learnt through hands-on experience (practical component of science). They acknowledged that science opened up a lot more career windows than the other subjects. “Taking science enables a child to explore further and choose a career path not only in the three major domains of Physics, Chemistry, Biology, but Geography, Agriculture, Health science, and Marine sciences or skill based sciences including computing, electricity and electronics and building and plumbing”. This CEO continued saying, “because of the way science is taught – it promotes enquiry learning and research”. This school is currently promoting a special library component where students learn how to seek information using the library (CR2).

Section 4.2 presents how students are attracted to study at the Tonga Institute of Education.

4.2 Attraction of Students for Teacher Training

Vision Statement and Educational Framework

All students who enter the Tonga Institute of Education come under the one vision statement and educational framework of the college which reads; *‘Faiako ma’a Tonga, ki he Tonga’*. *‘Faiako ma’a Tonga’* is a holistic preparation of a student teacher with all aspects of teaching Tongan children in Tongan schools.

Professional Development and Quality

All teaching staff have attained Master’s qualification. As professional development of lecturers at the teacher’s college, all non-masters holders were awarded scholarships in 2009 – 2010 to upgrade to a Master’s degree and have all completed. The college is now in its third year of transition into the New Revised Diploma programme leading onto the new Bachelor of Education set to be offered beginning in 2015. Teaching staff are currently rewriting their courses in preparation for that new development. Two of the current science lecturers have participated in a number of professional development workshops overseas and have returned motivated with positive feedbacks.

However, the college is still unable to fully staff its Science department with a degree holder in each of the 3 science disciplines. Recently a staff member had to be recalled to the secondary division to take up a senior post on one of the outer islands. That move disadvantaged the college to being short staffed. It is hoped that in future, staffing requirements and arrangements of the secondary and tertiary divisions be dealt with separately to avoid a repeat of this problem.

In the meantime, the college further ensures quality by making sure that no Diploma holder becomes an associate teacher for its students when they are on practicum. All associate teachers must at least be a degree holder in one of the three major disciplines of science. Although that was arranged, student teachers were still not able to improvise and teach a practical oriented science, but were copying straight off the book onto the blackboard for the children to copy into their notebooks. The Principal estimates about 80% of the time, it has to do with the school, whether they do not have equipment or it is the school culture and associate teachers are not being helpful enough.

The Science department has recently seen an upgrade of its laboratory facilities and acquired some new chemicals, with the assistance of AusAid and the Ministry of Education. With the improved facilities, the science department opened its doors to the wider school community encouraging senior secondary science teachers to bring their students to the college and use the laboratory facilities for some practical classes and project work. Some schools have taken this offer very positively and have utilized this generosity.

Choosing to be a Teacher in Tonga

There is no career or recruitment programme for secondary schools or the churches for teacher training. Teaching is one of the careers that sits in the higher income bracket in Tonga, so that in itself provides the attraction for more students to apply to train and become a teacher. The Institute receives students based on their own interest and choices for the three entry pathways. The biggest challenge for the college in terms of student intake has been science. The number of new students who enrolled had been low compared to other subject areas. Chemistry has been the most challenging with student-lecturer motivation being quite a challenge. However in contrast, science has somewhat

fared better in terms of passes compared to some other subjects, maybe because of the attention the students get from lecturers because of such small numbers.

The Principal's thoughts were consistent with that of *SEO2*, that it might be a reflection of what is available in the job market, with many secondary students choosing IT and computer studies over teaching. *Interviewee CR2* however, thought it could also be a reflection of the number of students at secondary school taking science as an option and achieving the required grades to meet the college's entry requirements.

The next section explores new student enrolments at the Tonga Institute of Education by examining enrolment records of new student enrolments in science between the years 2006 – 2011.

TIOE Student Teacher Enrolments in Science

The Tonga Institute of Education (TIOE) is one of the two institutions that offer teacher education to Tongans. TIOE offers the diploma programme while the University of the South Pacific offers the degree programmes; Bachelor of Education and Bachelor of Science in Biology, Chemistry or Physics. Records showed new student enrolments were under 15 between the years 2006 -2011 for Tonga Institute of Education (Figure 4.1).

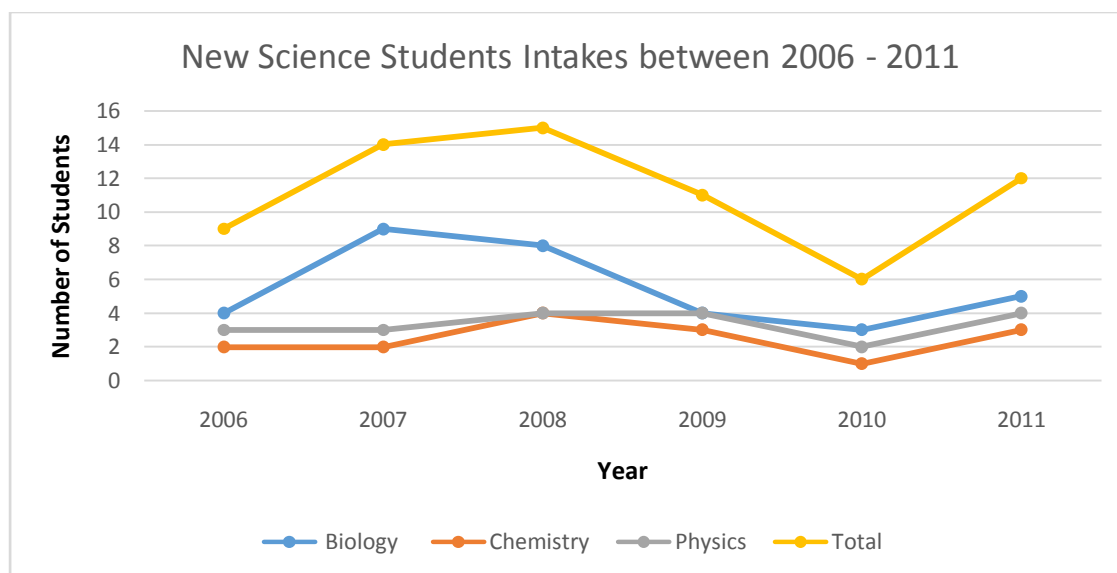


Figure 4.1 TIOE New Student Enrolments between 2006– 2011(TIOE, 2013)

The highest student intake of new student teachers was in 2008, with 15 and the lowest in 2010 with six. Biology was the most selected discipline while Chemistry the least, as confirmed by the Principal (Figure 4.1). Enrolment records at the University of the South Pacific were also examined for the years between 2006 and 2011 (Table 4.1).

Table 4.1 Total New enrolments to TIOE and USP for the Diploma in Education, Bachelor in Education and Bachelor of Science programmes between 2006 and 2011.

| Year | Diploma of Education at TIOE | Bachelor of Education (USP) | Bachelor of Science (USP) | Total enrolled into Education/Science |
|-------|------------------------------------|-----------------------------------|---------------------------------|---|
| 2006 | 9 | 0 | 32 | 41 |
| 2007 | 14 | 0 | 34 | 48 |
| 2008 | 15 | 0 | 35 | 50 |
| 2009 | 11 | 2 | 42 | 55 |
| 2010 | 6 | 5 | 58 | 69 |
| 2011 | 12 | 6 | 59 | 77 |
| Total | 67 | 13 | 260 | 340 |

Key: USP – University of the South Pacific; TIOE – Tonga Institute of Education

A total of 67 new students enrolled for the Diploma of Education programme, while 13 and 260 new enrolments for the Bachelor of Education and Bachelor of Science programmes respectively between 2006 and 2011. There were no new enrolments in 2006 - 2008 for the latter two programmes (Table 4.1).

New enrolments to both institutions almost doubled when combined from 41 in 2006 to 77 in 2011 (Table 4.1). There were no new enrolments for the Bachelor of Education programme from 2006 to 2008 but, the Bachelor of Science programme showed increases throughout in new enrolments for that period (Table 4.1).

The number of students who graduated from these programmes was also investigated and the results are presented in the next section.

Number of Science Teacher Graduates

The highest number of science teacher graduates from the Tonga Institute of Education was recorded in 2006 and 2009 with 14 and 15 respectively, while 2010 recorded 10 and less than 10 in the other years (Table 4.2).

Table 4.2 Total Number of Science Graduates from TIOE 2006 -2011

| Year | Total Number graduated | Biology | Chemistry | Physics |
|------------------------|-------------------------------|----------------|------------------|----------------|
| 2006 | 14 | 5 | 3 | 6 |
| 2007 | 6 | 2 | 1 | 3 |
| 2008 | 9 | 3 | 3 | 3 |
| 2009 | 15 | 6 | 4 | 5 |
| 2010 | 10 | 4 | 5 | 1 |
| 2011 | 7 | 2 | 3 | 2 |
| Total Graduated | 61 | 22 | 19 | 20 |

(TIOE, 2013)

Over the six years studied, TIOE produced 61 new Diploma graduates; 22 Biology, 19 Chemistry and 20 Physics in total. Figure 4.2 shows a comparison of new enrolments and graduates for the years studied (2006, 2009).

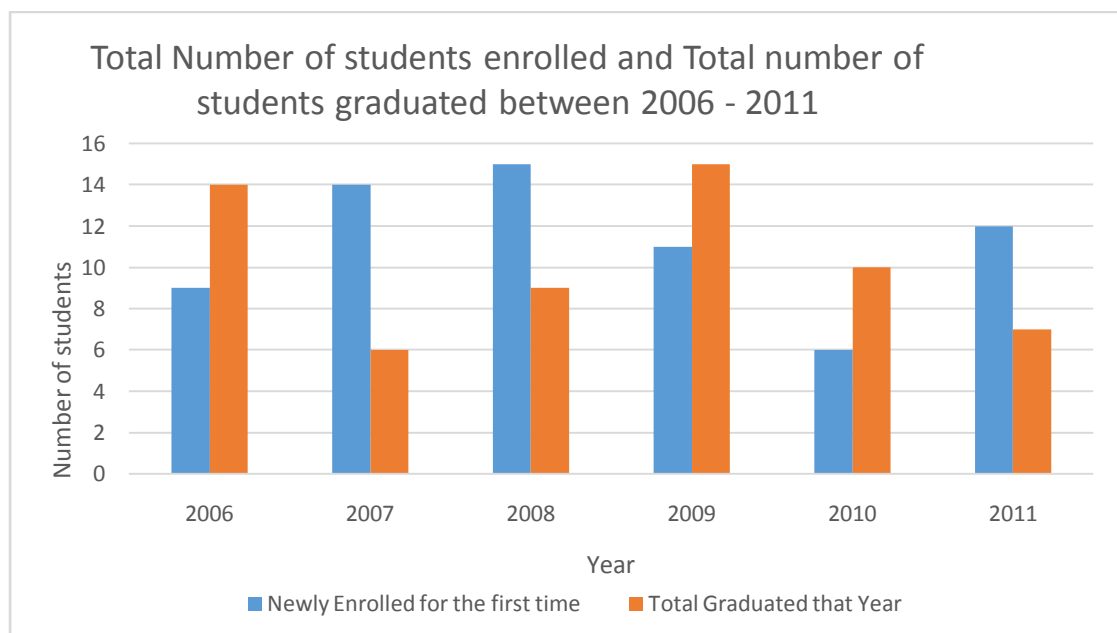


Figure 4.2 TIOE New Enrolments and Graduates for 2006 – 2011(TIOE, 2013)

According to figure 4.2, 2006, 2009 and 2010 were the years with more graduates than enrolments. This may have been due to the four different entry pathways, allowing students for one, two or three year Diploma programmes, depending on their entry qualifications. Repeating students may also have completed their programmes contributing to this difference. The graduating class in a given year would have first enrolled at least three to four years before the graduating year for the most common entry pathways because new teachers were required to teach for a year after completing formal training before they can graduate with their diploma. However, over the six year period there were 68 new enrolments and 61 graduated with a Diploma in Education.

The University of the South Pacific's enrolments and awards register was also examined for the number of Tongan students who graduated with either a Bachelor of Education or a

Bachelor of Science degree between 2006 and 2011. Table 4.3 presents the information for the Bachelor of Education programme.

Table 4.3 **USP Enrolments and Graduates in the Bachelor of Education Programme**

| Year | Total Number of New Enrolments | Science Discipline Elected to study | Total Number graduated | Science Discipline graduated with |
|-------|-----------------------------------|--|---------------------------|--------------------------------------|
| 2006 | 0 | | 1 | Physics |
| 2007 | 0 | - | 0 | - |
| 2008 | 0 | - | 0 | - |
| 2009 | 2 | Physics X2 | 0 | - |
| 2010 | 5 | Biology X3 Physics X2 | 0 | - |
| 2011 | 6 | Biology X4 Chemistry X1 Physics X1 | 1 | Physics |
| Total | 13 | - | 2 | - |

(USP, 2013)

By 2011, 13 new students had enrolled into the programme from 2009 onwards, with 2 graduating with Physics during the 6 years studied.

The second cohort from where Tonga acquired its specialist science teachers was from those that acquired a science degree majoring in one or two of the three disciplines of Biology, Chemistry or Physics, without an education component. According to Table 4.4, by 2011, 22 Tongans had acquired science degrees under this programme despite a higher enrolment number compared to the Diploma in Education and the Bachelor of Education programmes within the same years. One explanation for the low turn-over from the Bachelor of Education programme could be because some individuals, especially practising teachers study part-time or extramurally (*Interviewee P3*). Table 4.4 does not differentiate those with a previous qualification in Education or other, as not all science graduates that return to Tonga go into teaching. On the other hand, some may be established teachers of science upgrading to a degree.

Table 4.4 **USP Enrolments and Graduates for the Bachelor of Science programme**

| Year | Total Number Enrolled | Total Number graduated | Science Discipline graduated with |
|-------|-----------------------|------------------------|--|
| 2006 | 32 | 6 | Biology/Chemistry X2 Biology/Geography Chemistry Chemistry/Mathematics Physics/Mathematics |
| 2007 | 34 | 2 | Chemistry/Biology X2 |
| 2008 | 35 | 3 | Biology/Chemistry X2 Chemistry/Mathematics |
| 2009 | 42 | 1 | Biology/Food & Nutrition |
| 2010 | 58 | 4 | Biology/Chemistry Chemistry/Biology Physics Physics/Mathematics |
| 2011 | 59 | 6 | Biology/Chemistry X3 Biology/Mathematics Chemistry/Physics Physics/Chemistry |
| Total | 260 | 22 | - |

(USP, 2013)

In order to gauge a better understanding of the science teachers' working conditions and relationships with the school administrations, the Principals were also interviewed. The following is the summary of the interview transcripts.

4.3 Summary of Interviews from participating Principals

Interviews were conducted with five principals of Tongan secondary schools targeting information around the recruitment, professional development and quality of science teachers and their retention in their respective schools.

Recruitment of Teachers

All principals interviewed said that each school principal has a positive influence over the recruitment of teachers in their respective schools although the Ministry of Education or the Church Education offices gives the final word. Sometimes when there is a greater need elsewhere, teachers get reshuffled and principals may not get the teachers of their choice, but a principal may ask for certain teachers if he or she wishes to. One principal answered; "I understand the need of the Ministry, so I work with what I am given" (P2).

Professional Development

Weekly Professional development sessions are run with the teachers of all subjects by the school management team. Apart from that it is up to each Head of Science department to organise meetings and work with his or her team on curriculum matters or other.

Some diploma holders are studying extramurally to upgrade to a degree, so time is allocated to them (by way of a lesser teaching load), to commit to their studies. Those with a Bachelor of Science degree without an Education component are also given the opportunity to gain that qualification through the Tonga Institute of Education's 1 year Diploma in Teaching, programme.

Quality of Teachers

All the Principals interviewed expressed a desire to have all their teachers with at least a Bachelor's degree for the specialist subjects of Biology, Chemistry and Physics with an Education component. The views expressed were much the same as the CEO's of education. They expressed, although that is a wish, they are happy to work with a diploma holder, as long as he or she is "committed and able to translate the curriculum requirement in a much simple easy enough to attract the interest of the child in the subject" (P5).

Another setback on the quality of science being taught at the moment is the lack of adequate laboratory facilities to assist the teachers to perform to their full capacities. Most of the principals said that the overall morale of science teachers has declined over the years, and there is a big need to uplift it. When asked how they can improve the overall quality of teaching and learning in science; the unanimously inclination was around the need to

improve laboratory facilities and restore the science teachers association where teachers used to collaborate, share and learn from each other.

When asked if they were happy with the overall performances of their senior students in science; one principal felt satisfied, as that is the best they can produce with the type of facilities that they have. The rest replied 'No' and that there was more that could have been done to improve that result. One Principal who was also doing the interview on behalf of the Church CEO for Education felt, more could be done at the policy level with the Ministry of Education to make science a compulsory subject nationwide at least up to Fifth level by saying; "Science opens up a lot more career windows for the child, as it encompasses 'life-long learning' skills through enquiry learning. The children are missing out on a lot by opting away from science at 3rd form and 4th form level" (P7). This Principal would also like to see more students choosing to study science at senior levels (6th and 7th form).

Retention

Principals can ask for specific teachers to remain during staffing meetings with divisional heads, however, if the individual teacher wishes to leave for other reasons, such as a new career or migrate overseas, there is nothing much to be done. That would be a sad loss to the school, and the education system as a whole. In order to improve working conditions and attract them to stay on, some of the principals are currently liaising with ex-students overseas (Australia, USA and New Zealand) to fundraise and purchase much needed chemicals and laboratory equipment.

One Principal said "I cannot provide them with monetary incentives to retain them, but I can do my best to go out and borrow chemicals and laboratory equipment from other schools, for them to use to make their classes a little more interesting" (P4). This principal went on to report that, the school's ex-students community in New Zealand has just put a container of school materials together to be shipped to Tonga. There was some agreement between Interviewees P4 and P7 that it would be an injustice to the science teachers if they are not provided the correct equipment to fully utilise the expert knowledge that they have. They have to be better able to transfer some of their own motivation across to the child and get them interested in doing science through adequate and enough practical demonstrations. Two principals voiced that, when their most qualified teachers leave, it affects the system, it

affects them considerably, however tend to accept it cultural altruism as a country and 'good' of the country. They develop a sense of satisfaction of having contributed to an individual's training so that the country will benefit one way or another (Interviewee SEO1, SEO2, P5, P6).

The following sections focus on Tonga's current science teachers. Section 4.6 presents the bio-data including teaching experience and retention patterns of Tonga's current science teachers collected and analysed through document analysis from the Ministry of Education's existing records and a teacher questionnaire.

4.4 Tonga's Current Science Teachers

Bio-data

The first attempt in seeking the bio-data of the science teachers in Tonga was by studying documents held at the Education Management Information Service (EMIS) - a division within the Ministry of Education that attempts to maintain relevant information about all the teachers in Tongan schools, including their qualification details as presented in Table 4.5(Tonga, 2014).

Table 4.5 Estimated total Number of Science Teachers in Tonga as of January, 2010.

| Education System | Number of Science Teachers | Teachers with a Bachelor's Degree or higher. |
|---|----------------------------|--|
| Government | 128 | 27 |
| Free Wesleyan Church | No data | 14 * |
| Catholic Church | No data | 4* |
| Seventh Day Adventist | 4 | 2* |
| Tailulu | 8 | 1 |
| Tokaikolo | 4 | 2* |
| Church of Jesus Christ of the Latter Day Saints (LDS) | 14 | 20 |
| Total | More than 158 | More than 70 |
| | | More than 44.3 % |

*Key * Incomplete data(Tonga, 2014)*

While information from EMIS covered all the schools in Tonga, it was also found to be inconclusive on the exact numbers of science teachers in the country. The qualification credentials of some teachers were missing; for example the teachers' specialist science discipline studied and subjects teaching. The data studied was last updated in January of 2010.

Therefore a research sample was convenient in order to glean more information relating to current teachers' bio-data and related information examined through the teacher questionnaire as presented in the following sections.

Age range of Participants

The questionnaire gathered bio-data information of the informants. Figure 4.3 shows that 80 percent of the participants were aged between 26 and 44 years of age.

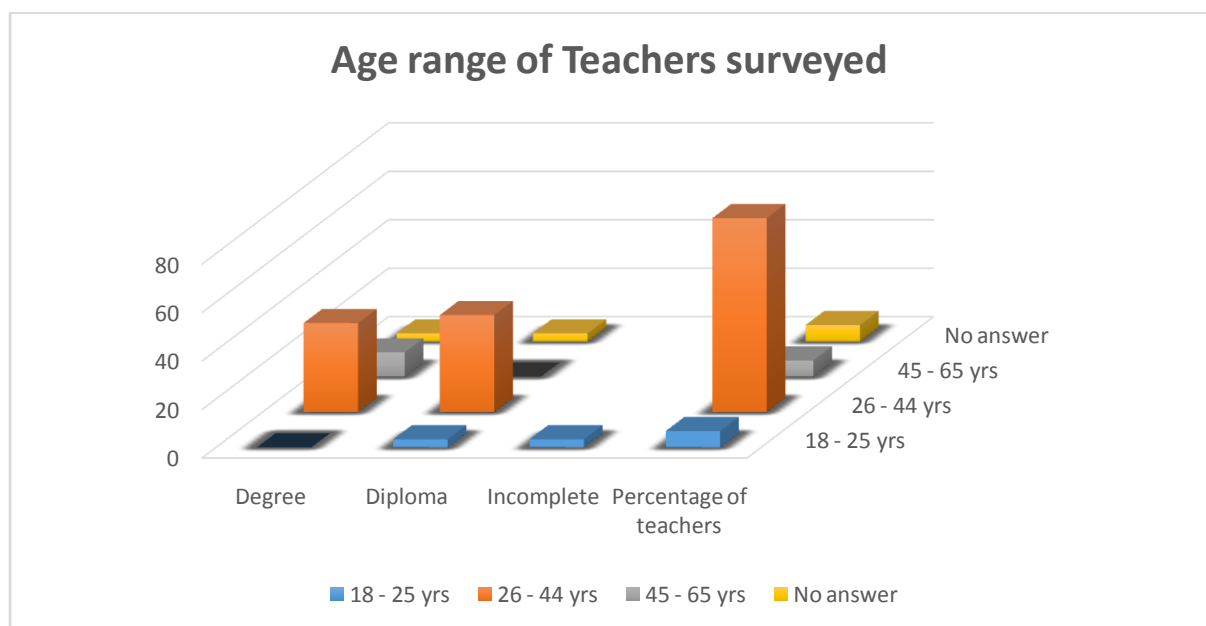


Figure 4.3 showing the age range of the participants.

There were almost equal numbers of diploma (40 percent) and degree holders (37 percent), three percent of this particular age group didn't answer that question. The remaining 20 percent were aged below 25 or over 45 years of age. 40 percent of the participants were male and 60 percent were female although gender was not an aspect of categorising as the

study was specific to science teachers regardless of gender. The education and qualification of the participants is presented in the next section.

Education and Qualification of Participants

The participants had a range of qualifications from a one year Diploma in Teaching, two or three year Diploma in Education, Bachelor's degree and post-graduate qualifications that may have taken three to four years of study and up to six years for the post-graduate qualification. Table 4.6 presents a summary of the qualifications of the participants including the science content studied within the qualification.

Table 4.6 Summary of Participants' Qualification and Science Content studied.

| Qualification | Science content studied | Number of Teachers |
|--|------------------------------------|--------------------|
| Diploma in Teaching | Integrated General Science/Biology | 4 |
| Diploma in Education | Chemistry | 1 |
| | Physics | 2 |
| | Biology/Chemistry | 3 |
| | Physics/Chemistry | 1 |
| | Biology/Agriculture/IT | 1 |
| | Not stated/Incomplete | 2 |
| Incomplete Diploma | Biology | 1 |
| Bachelor of Science with no Education | Chemistry/Biology | 1 |
| | Physics/Math | 1 |
| | Biology | 1 |
| Bachelor of Science with Education | Chemistry/Biology | 4 |
| | Chemistry | 1 |
| | Chemistry/Physics | 1 |
| Bachelor of Education majoring in a Science core | Geography | 1 |
| | Physics | 1 |
| | Chemistry | 1 |
| Bachelor of Arts with Science Education | General Science | 1 |
| | Psychology/Biology | 1 |
| Master of Science | Physics | 1 |
| Total incomplete/Not stated | - | 3 |
| Total Diploma holders | - | 12 |
| Total degree holders (and higher) | - | 15 |
| Total Number of Science Teachers surveyed | - | 30 |

The science teachers surveyed held either a Diploma in Education or Diploma in Teaching, a Bachelor of Education or a Bachelor of Science majoring with or without the education component. Those with a Bachelor's degree in Education, Arts, or Science specialised in one or two of the science domains. There was one participant who held a Master of Science in Physics and there were three who either held incomplete qualifications or didn't state it on the questionnaire.

The science content studied by our participants was then pooled from which figure 4.4 was derived.

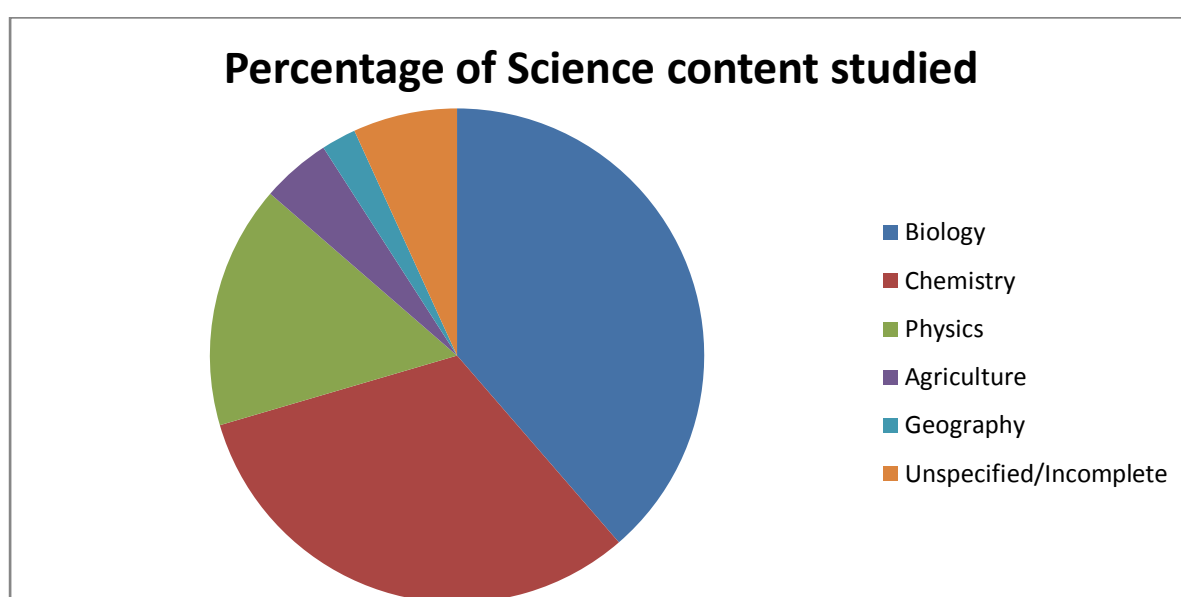


Figure 4.4 Science content studied among teachers surveyed.

Biology was the most common subject studied by teachers within qualifications (38.6 percent) followed by Chemistry (31.8 percent) and Physics (15.9 percent). The participants that attained their teaching qualifications through the one year Diploma in Teaching programme, would previously have had studied Agriculture.

Teaching Experience

The teaching experience of the participants was established at 63 percent with up to six years of experience out of which 16.7 percent have taught for one to three years (1-3) and 47 percent for four to six (4-6) years; while 37 percent of the participants had more than

seven years of teaching experience; 3.3 percent with 7-10 years; 23.3 percent with 11-15 years and 34 percent with more than 11 years (Figure 4.5).

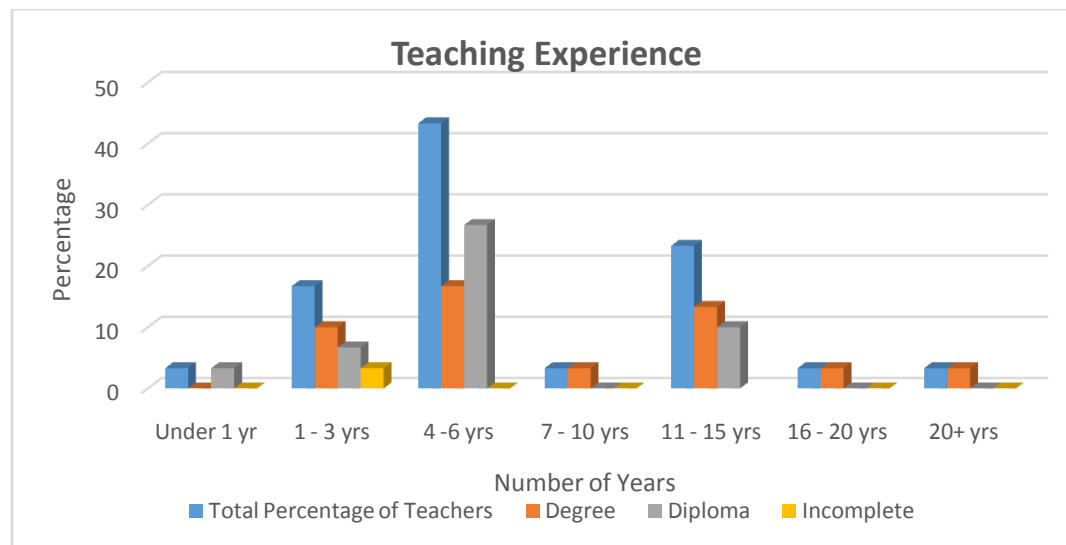


Figure 4.5 Teaching Experience.

The next section presents the patterns of retention of science teachers in their present schools.

Retention

Sixty percent of the participants had been teaching in their present school for as long as they have been teaching, while 36.7 percent had been subjected to reshuffling. The other 6.7 percent had been either teaching for less than one year or provided no response to that question.

All the teachers with up to three years of teaching experience had been teaching in their present school, while seven out of 13 teachers with four to six years of experience were retained for the same period of time. The next biggest group retained was those with 11 to 15 years of teaching experience with six out of seven teachers in that group retained in their present school for their entire teaching career.

However out of the two teachers who had been teaching in the same school between seven to 10 years, both are degree holders; one with 11 to 15 years of teaching experience while the other had 20+ years (Figure 4.6).

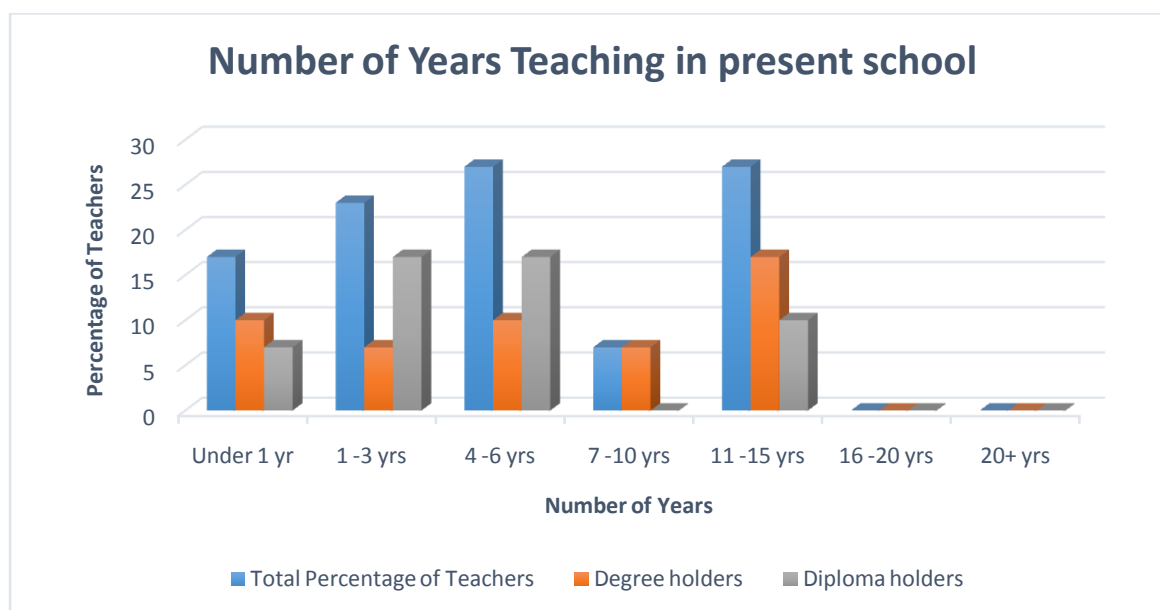


Figure 4.6 Period of Retention in present school

When participants were asked if they preferred to be in a different job to teaching, they responded with the following (Figure4.7).

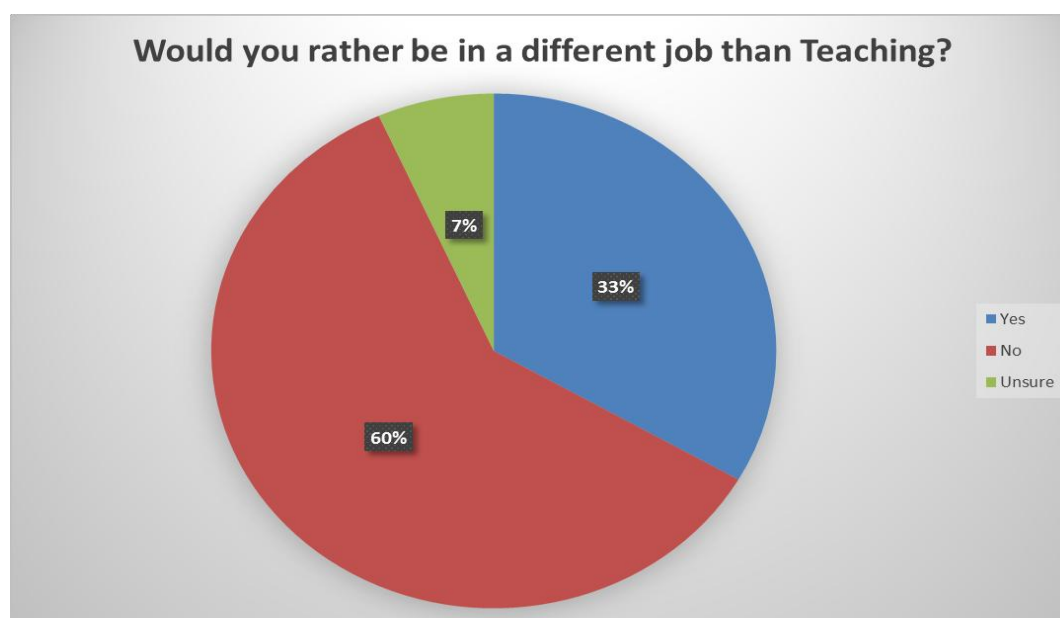


Figure 4.7 Percentage of teachers who preferred a different job.

Sixty percent answered 'No' and 33 percent answered 'Yes' while the remaining seven percent were unsure. Out of the 60 percent that answered 'No', 46.7 percent would stay for the love of their jobs while 13.3 percent recognised teaching as special vocation to benefit the whole community and fulfil a greater sense of purpose.

Out of the 33 percent that answered 'Yes', 20 percent expressed the desire to explore new opportunities in a science related field of employment while 13 percent expressed burn-out.

A cross analysis revealed that 83.3 percent of the teachers surveyed (25 out of 30) had been teaching for more than four years and out of the 11 teachers who expressed a desire to leave, 10 were experienced teachers who have taught for more than four years (Table 4.7).

Table 4.7 Cross Analysis of Teachers expressing desire to leave

| Teaching Experience | Number of Participants in Total | Number considering Leaving |
|---------------------|---------------------------------|----------------------------|
| Under 1 Year | 1 | 1 |
| 1 -3 years | 4 | 0 |
| 4 -6 years | 13 | 3 |
| 7 – 10 years | 1 | 0 |
| 11 – 15 years | 7 | 4 |
| 16 – 20 years | 1 | 1 |
| 20+ years | 3 | 2 |

Further cross analysis of the data presented in Table 4.7 shows seven out of 11 (63.6 percent) had been teaching for more than 11 years of teaching, all expressing a desire to leave. When probed further to consider some circumstances that might cause them to leave teaching, the 60 percent that answered "No" in the previous question was reduced to 24 percent who remained unperturbed, and 76 percent stated they would leave if one of the following presented itself (Figure 4.8).

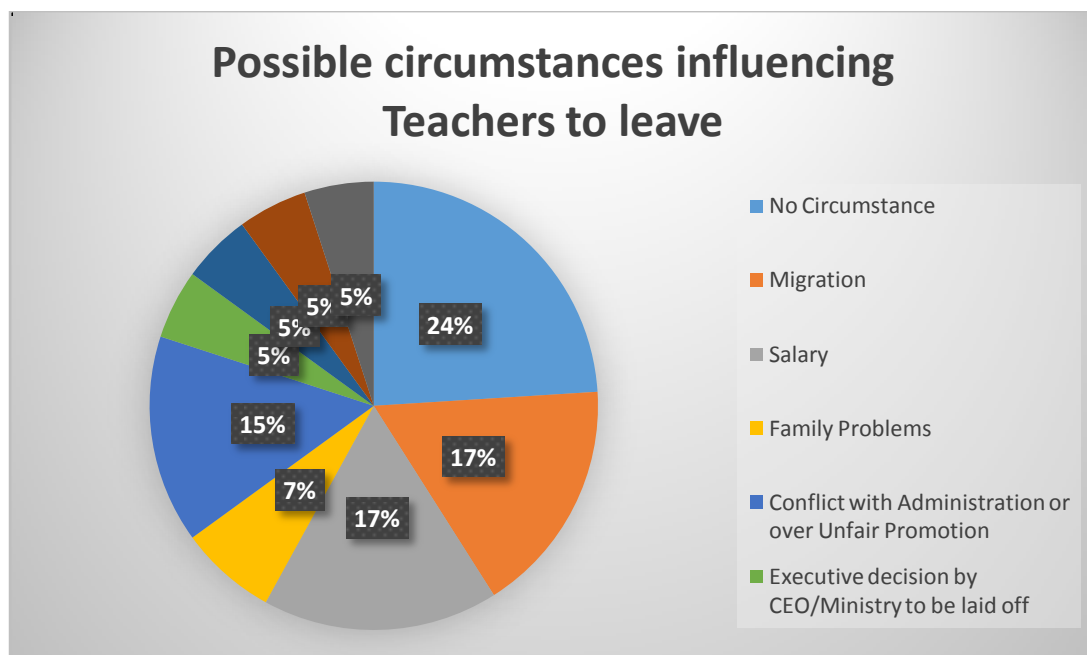


Figure 4.8 Circumstances that might cause teachers to leave

The three most outstanding factors that might cause teachers to leave are; bigger salary (17 percent), migration (17 percent) and if faced with conflicting relationships with senior management or administration (15 percent).

Their perceptions of rewarding aspects to teaching and challenges they faced were also considered and are presented in the next section.

4.5 Teacher Perceptions

Teacher perceptions were sought for rewards and challenges as teachers of science, and teachers were found to be either intrinsically or extrinsically motivated by these rewards and challenges.

Rewarding aspects of being a Science Teacher

The intrinsic factors listed by participants alluded to a sense of personal gratification and self-worth. One such aspect was to be a part of their students' achievements. Forty percent of the participants indicated satisfaction when students' achievements in class and examinations improved, enabling them to pursue further studies and build great careers. A quote from one participant reads; "Nurturing students to become scientists in future".

Another outstanding aspect was in establishing and forming new relationships with 26.7 percent of the participants recognising and stating the importance of “getting to know others”; not only the new students, but also forming new relationships and networks with colleagues and other professionals and members of the community. A comment from one participant reads; “Building relationships and getting to know a lot more people in society”.

The most rewarding aspect which 50 percent of participants indicated was that it provided them with an opportunity to learn new things alongside the student. One comment reads; “I learn more from science” and others read, “It is fun to learn”, “doing the practical” and “I always come across a new aspect”.

There were few extrinsic rewards listed with 10 percent indicating, receiving praise and recognition from parents and the community as a teacher an important rewarding factor. One participant wrote being motivated when awarded the in-school “teacher-of-the-month” prize. Another found it rewarding using the lessons used in the classroom to teach their own children science. The next section presents the challenges of being a science teacher in Tonga.

Challenges faced as a teacher of Science in Tonga

The biggest challenge the participants indicated was “lack of resources”; with 73.3 percent of the participants listing conditions from deficient, deteriorating or lack of; appropriate laboratory facilities including basic science equipment and chemicals, textbook and teaching aids as challenges. The second biggest challenge was student behaviour. Thirty percent of participants indicated that students are not disciplined enough in the classroom with their work habits and with low self-esteem. Likewise 6.7 percent of participants indicating parents not supportive enough for children’s learning.

Another challenging factor identified was the lack of communication and poor working relationships among colleagues. Thirty percent of the participants list from lack of departmental meetings and follow-ups, cooperation as a team, miscommunications between the team and head of department and senior management. Other challenges included; lengthy syllabus, time to fit all the required activities and class sizes being too large.

These intrinsic and extrinsic factors (rewards and challenges) form the core in building the self-efficacy of a teacher. Self-efficacy contributes in elevating the confidence of a teacher with their perceived school context and external control. The next section presents the findings of the teacher self-efficacy of the participants.

4.6 Teacher Self-Efficacy

The self-efficacy of Tongan science teachers was explored in two parts. The first was to explore their perceived collective teacher self-efficacy by enquiring about their confidence in teaching through six themes that included: instruction, ability to adapt teaching to individual needs of students, motivating students in science, managing student behaviour, cooperating with colleagues and parents and coping with changes and challenges. The second aspect of self-efficacy was the teachers' perceptions enquiring into parameters at the school context. The question about whether factors of external control might affect their self-efficacy was also incorporated into the same tool.

Collective Teacher self-efficacy

The closer the average Likert score was to 4 the greater the confidence of the teachers in dealing with the situations presented. The more confident they are, the greater the self-efficacy. The average collective self-efficacy of Tongan science teachers was high among all three of the experience groups in terms of their confidence in coping with the aspects presented (Fig 4.9). An average Likert value of between three and four means teachers are quite confident to very confident.

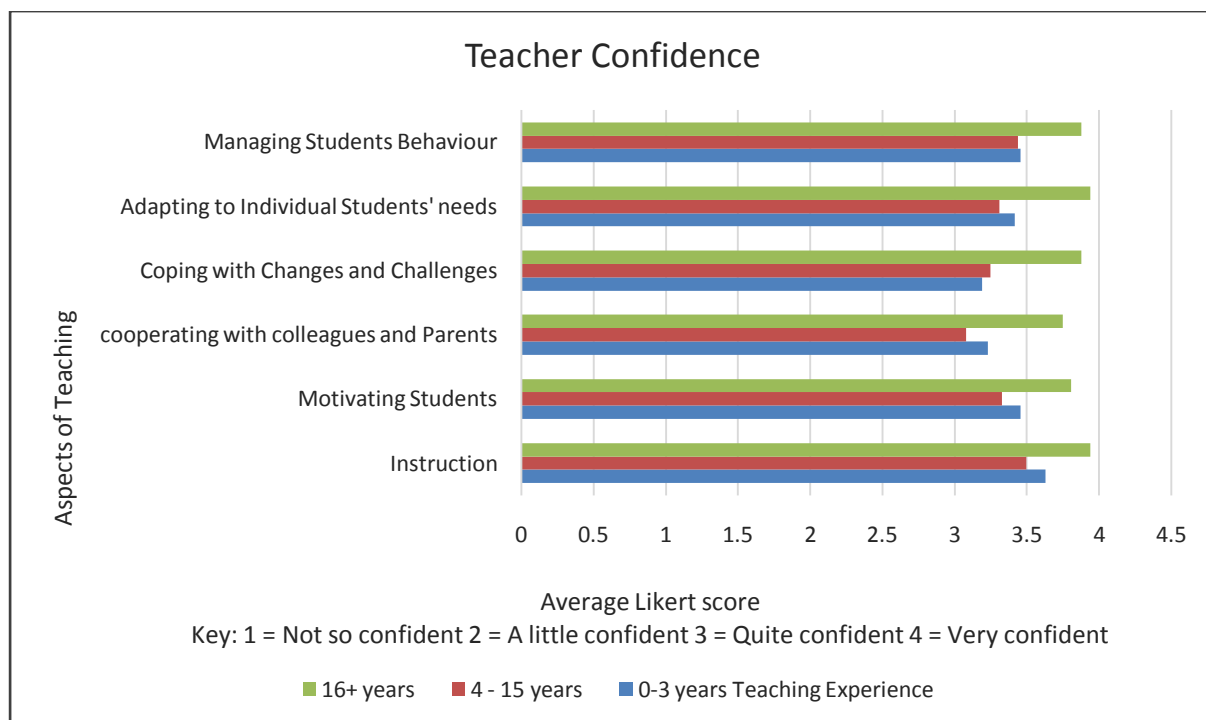


Figure 4.9 *Collective Self-Efficacy of Tongan Science teachers in relation to their teaching.*

The self-efficacy of the senior group (16+ years) was higher than the two younger groups (Figure 4.9). Confidence levels were much lower on cooperating with colleagues and parents for all three categories of teachers especially those who have been teaching for 4 - 15 years. The differences in responses between the three groups of participants were analysed for statistical validity using a T-Test and the mean differences and probability values (p value) are presented in Table 4.8.

Statistical Validity:

Table 4.8 Mean Differences and p Values for Perceived Collective self-efficacy

| Teacher Groups (Experience) n=30 | Average I | Average A | Average M | Average D | Average P | Average C |
|---|-----------------|-----------------|-----------------|-----------------|-----------------|------------------|
| 0-3 YEARS 4-15 YEARS Mean difference | 0.13 | 0.10 | 0.13 | 0.02 | 0.09 | -0.06 |
| 0-3 YEARS 4-15 YEARS P Value | 0.301 p>0.05 | 0.315 p>0.05 | 0.291 p>0.05 | 0.458 p>0.05 | 0.342 p>0.05 | 0.409 p>0.05 |
| 0-3 YEARS 16+ YEARS Mean difference | -0.31 | -0.52 | -0.35 | -0.42 | -0.58 | -0.68 |
| 0-3 YEARS 16+ YEARS P Value | 0.063 p>0.05 | 0.026 P<0.05 | 0.109 p>0.05 | 0.070 p>0.05 | 0.038 P<0.05 | 0.023 P<0.05 |
| 4 -15 YEARS 16+ YEARS Mean Difference | -0.44 | -0.625 | -0.49 | -0.44 | -0.675 | -0.625 |
| 4 -15 YEARS 16+ YEARS P Value | 0.065 p>0.05 | 0.008 p<0.05 | 0.042 P<0.05 | 0.024 P<0.05 | 0.042 P<0.05 | 0.012 P <0.05 |

Key: I = Instruction, A = Adapting to individual students' needs, M = Motivating students,

D = Keeping Discipline (MSB - Managing students behaviour), P = Cooperating with colleagues and Parents, C = Coping with changes and challenges

Null Hypothesis: There is no difference in the responses of the three groups of teachers.

When $p < 0.05$ = Reject H_0 and when $p > 0.05$ accept H_0 .

The null hypothesis (H_0) is accepted for all three categories of teachers in relation to Instruction. It was also accepted for the groups 0-3 years and 4-15 years on all the aspects tested with p values greater than 0.05. There was no statistically significant difference in the responses between the three groups of teachers on these aspects.

However, there was a statistical difference between the 0-3 years and the 16+ groups on the aspects of adapting to students' needs, cooperating with colleagues and parents and coping with changes and challenges. The hypothesis is rejected for the two senior groups of teachers (4-15 years and 16+ years teaching experience) especially with all aspects except, Instruction.

Perceived School Context and External Control

The second part of the self-efficacy test explored their thought processes in a school context in terms of: time, autonomy, managing student behaviour (discipline), supervisory support and relations to parents. External control was also explored simultaneously. The closer the average Likert score was to 5 the greater the degree of agreement with the statements provided (Figure 4.10). Appendix 14 provides individual graphs for the summary provided in Figure 4.10. The responses from all three categories of teachers were between agree to strongly agree on supervisory support, autonomy and relation to parents. However, the teachers in the two senior categories (4 -15 years and 16+ years' experience) couldn't agree or disagree with the statements on managing students' behaviour, while the group 0 -3 years' response was much closer to agreeing with the statements presented.

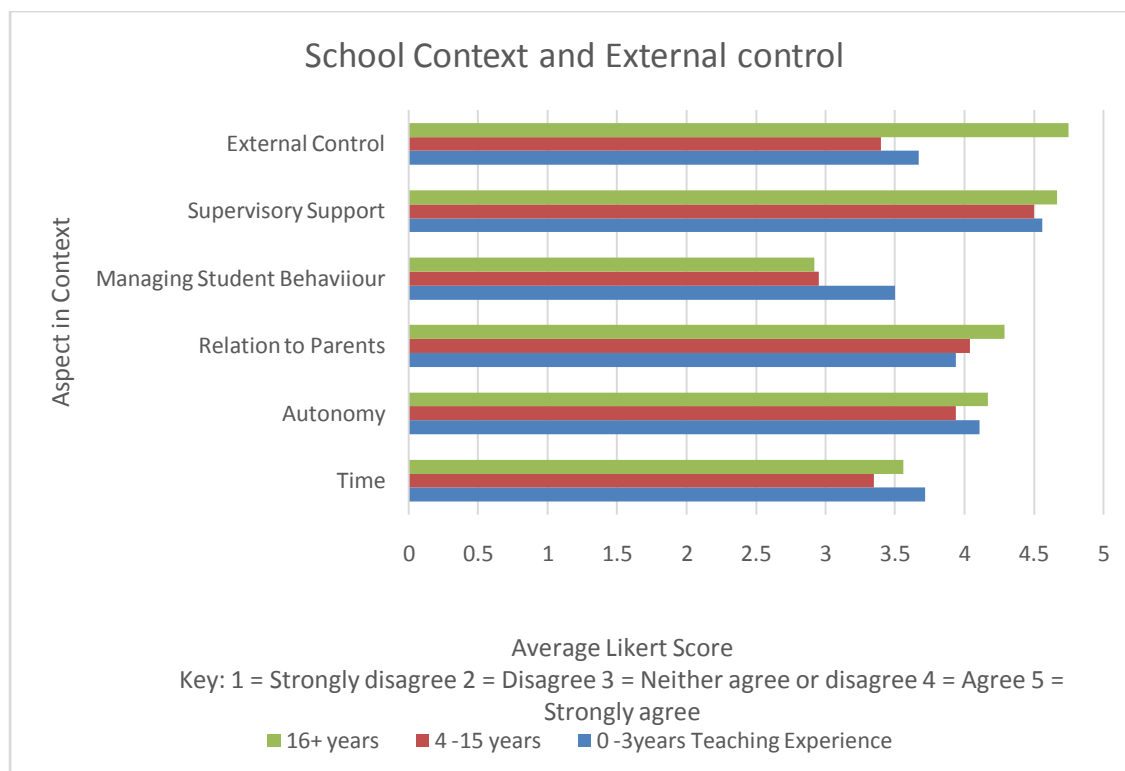


Figure 4.10 Average agreements on Aspects in a School context

The two senior groups (4-15 years and 16+ years) could, neither agree nor disagree with the statements on managing student behaviour, while the 0-3 years' group average was more towards agreeing (Appendix 14, Graph 4). The senior group (16+ years of experience) agreed more on the questions relating to external factors affecting self-efficacy than the other two groups. These differences were analysed for validity using a T Test and probability value (p value) calculated for the three groups of participants (Table 4.9).

Statistical Validity

Table 4.9 Mean Differences and p Values for perceived School Context

| Teacher Groups (Experience) n=30 | T | A | P | E | S | D (MSB) |
|--|---------------------------|------------------------------------|------------------------------------|------------------------------------|------------------------------------|-----------------------------------|
| 4-15 YEARS 0-3 YEARS Mean difference | 0.41 | 0.19 | 0.05 | 0.27 | 0.14 | 0.55 |
| 4-15 YEARS 0-3 YEARS P Value | 0.111 <i>p>0.05</i> | 0.220 <i>p>0.05</i> | 0.431 <i>p>0.05</i> | 0.296 <i>p>0.05</i> | 0.195 <i>p>0.05</i> | 0.007 <i>P<0.05</i> |
| 16+ YEARS 0-3 YEARS Mean difference | 0.39 | -0.06 -0.06 | -0.40 -0.40 | -1.08 -1.08 | -0.11 -0.11 | 0.55 0.55 |
| 16+ YEARS 0-3 YEARS P Value | 0.362 <i>p>0.05</i> | 0.387 -0.06 <i>p>0.05</i> | 0.107 -0.40 <i>p>0.05</i> | 0.049 -1.08 <i>P<0.05</i> | 0.204 -0.11 <i>p>0.05</i> | 0.055 0.55 <i>P>0.05</i> |
| 16+ YEARS 4-15 YEARS Mean Difference | -0.02 | -0.25 -0.06 | -0.45 -0.40 | -1.35 -1.08 | -0.25 -0.11 | 0.03 0.55 |
| 16+ YEARS 4-15 YEARS P Value | 0.484 <i>P>0.05</i> | 0.213 -0.06 <i>P>0.05</i> | 0.110 -0.40 <i>p>0.05</i> | 0.013 -1.08 <i>P<0.05</i> | 0.101 -0.11 <i>p>0.05</i> | 0.453 0.55 <i>p>0.05</i> |

Key: T = Time, A = Autonomy, P = Relation to Parents, E = External Control, S = Supervisory Support, D = Discipline (MSB - Managing Student Behaviour).

Null Hypothesis: There is no difference in the responses of the three groups of teachers.

When $p < 0.05$ = Reject H_0 and when $p > 0.05$ accept H_0 .

The null hypothesis (H_0) is accepted for all three categories of teachers for the factors of time, autonomy, supervisory support and relation to parents with p values greater than 0.05. There was no statistically significant difference in the responses between the three groups of teachers.

However, there was a statistical difference with managing student behaviour between the groups, junior (0-3 years) and senior (4 -15 years) with a p value less than 0.05 and external control between the 0-3 years group and the 16+years group plus the two senior groups (4 - 15 years and 16+ years) with p values groups 0-3 years and less than 0.05.

4.7 Summary of Findings

Recruitment to Training

The Tonga Institute of Education relies on secondary schools in Tonga to be able to produce students with passes in science at 6th or 7th Form to be eligible to make the entry criteria. CEO's of Education and Principals are indicating decline in students' interested in doing science at senior levels. That might also mean less number of students completing at 6th and 7th form, with science.

As we have seen from Table 2.0, there were more students who enrolled into USP for the Bachelor of Science program than the two teacher education programmes between 2006-2011, somewhat shifting the competition towards USP's favour. Tables 4.3 and 4.4 also indicate that, there were fewer graduates out of that programme between the years studied despite a high enrolment. With the decline in secondary students' interest in science at secondary school level, it might also reduce the demand for science teachers.

However, CEO's and Principals have already voiced the need to correct that situation. If the demand for science teachers is reduced, it would mean less students would be provided with an 'all-rounded' background preparation for life-long learning.

Tonga's current Science Teachers

Tonga's secondary science teachers have a range of qualifications and this study found a mixed group of untrained, diploma holders, degree holders with and without the education component, Master's degree holders and ones with incomplete qualifications. This study also found equal numbers of degree and diploma holders, 63 percent of all the participants had been teaching for less than 6 years. More teachers had studied Biology than Chemistry and Physics.

It was difficult to obtain the accurate number of science teachers in the Kingdom due to incomplete data at the EMIS division of the Ministry of Education however bio-data collected from the research sample revealed that 60 percent were female and 40 percent were male, mostly aged between 26 – 44 years. In 10 years' time, most of these teachers would probably not be classroom teachers but would have been shifted to other divisions within the Ministry such as Examination's unit or Curriculum division or migrated.

Retention of science teachers within schools in Tonga has been strong with 60 percent of the participants having taught at their current school for their entire teaching career and 60 percent of the participants indicated they wouldn't leave teaching. The reasons appear intrinsic such as: teaching science brings another opportunity to learn alongside the child as well as making a contribution to the child's future and forming new relationships. However, seven out of 11 most experienced teachers with more than 11 years of teaching, expressed a desire to leave for reasons associated with salary, migration and conflict with administration as possible causes.

The challenges facing science teachers include: 73 percent of the participants reported a lack of resources to effectively carry out their duties, 30 percent reported managing student behaviour a challenge as students were not disciplined enough in the classroom with their work habits and with low self-esteem. A further 30 percent indicated lack of cohesiveness and miscommunication between heads of departments, administrative staff and teaching staff as a challenge. 6.7 percent felt parents are not supportive enough of their children's learning.

The overall collective self-efficacy of Tongan science teachers is high, however finding adapting to individual students' needs challenging. When teachers are met with constant challenges and are not able to cope, they can be tempted to leave the teaching profession and find another career.

Finally, the CEO's recognise that they need to do more to equip their science teachers who are already in short supply, to carry out their duties effectively in the classrooms. The Tonga Institute of Education itself is short-staffed all the schools that participated are in need of qualified science teachers.

On the other hand the teachers are reporting that they are handicapped with very little resources to work with. Their overall self-efficacy is high, meaning they are confident to very confident with their teaching, however, would like more support from colleagues and parents. There are indications that, external control is having a greater effect on the senior teachers than the junior teachers. If these situations are not attended to, the country might end up losing some of its most experienced teachers.

I have attempted to weave the major findings of this research as the themes resulted in the data collection method. The next chapter presents a discussion on these themes.

CHAPTER 5.0 DISCUSSION– LUVA

Overview

This chapter presents a discussion of the key findings in this case study. The study asked the following research question;

To what extent has Tonga been able to attract to train and retain its science teachers?

In order to answer that question, the key findings were placed under four headings or sub-research questions to guide as themes of the discussion.

1. How has Tonga been able to attract and train its science teachers?
2. How has Tonga been able to recruit and retain its secondary science teachers?
3. How do Tonga's science teachers feel about their work?
4. What is the average perceived self-efficacy of Tongan science teachers?

As the data collection and analysis of findings were presented woven (Tui) in Chapter 4.0, likewise this discussion is also presented in the same manner as some sections overlap due to the nature of the views expressed in the interviews with the senior education officials (CEOs and Principals of schools and colleges) plus data collected from document analysis. This will be followed by the discussion of the findings of teacher perceptions and teacher self-efficacy. Finally the discussion concludes with the implications of not addressing some of the key concerns raised and how it might affect the quality of teaching and learning science in the Kingdom of Tonga.

5.1 Recruitment to Training

This section covers the ways in which student teachers enter into teacher education programmes. There are four ways in which interested students can enter a diploma programme in science teacher education at the Tonga Institute of Education (TIOE).

- (i) Senior secondary school leavers applying directly to TIOE
- (ii) Students who have completed all the Science Foundation courses at the University of the South Pacific

- (iii) Holders of other science qualifications for example: a Bachelor of Science degree in one or two of the main science disciplines; or a Diploma in Agriculture to upskill with teaching pedagogy
- (iv) Un-trained teachers from secondary schools who have been hired to cater for a shortage.

Teaching is an attractive career in Tonga which firstly, earns a lot of respect in the Tongan society and secondly, sits among the higher income brackets. Those two factors play a major part in attracting students into a teaching career (*P1*);(Tonga, 2004). Like other countries such as; Zimbabwe (Maphosa et al., 2014); Malawi (Mtika & Gates, 2011) and Singapore (Low, Lim, Alan, & Goh, 2011), candidates make their own choices based upon their own motivational inclinations when applying for teacher training as there are no reported specific teacher recruitment programmes in secondary schools to attract student (*P1*).

One of the biggest challenges for the college has been in recruiting students to study science especially with fewer students choosing to study chemistry than biology and physics (Interviewee *P1*). Senior education officials including five principals and 2 CEO's also indicated a perceived drop in the interest in science at senior secondary levels. This might have an impact on the number of students completing senior secondary level with science, leading to a question of quality of prospective student teachers at the source of recruitment in future.

Some students who pursue a degree qualification in education at tertiary level choose science while enrolled or choose teaching while completing a science degree. Others complete a science degree and choose to teach when they return to Tonga because there are limited career options in Tonga for holders of a science degree, and teaching becomes one of the main career destinations for this group (*Interviewee SEO2*). All these teachers make up part of a 'pool' of science teachers from which the country draws to cater for its staffing needs, which is discussed in the next section.

5.2 Current pool of science teachers

One of the aims of this study was to investigate and report the total number of science teachers in the teaching pool but was unable to do so as seen in Table 5.0, due to available data being incomplete. Although it was difficult to ascertain the exact number of science teachers in the country, this study found that all three categories of qualifications are present in the workforce; diploma holders, degree holders and those with incomplete qualifications. With the initiative being taken by MOE's Educational Management of Information Services (EMIS) division, it appears that Tonga has begun taking a step in the direction outlined by Boe & Gilford (1992); Gilford & Tenenbaum (1990) and SACE, (2010), to collect national bio-data of teachers building a data bank. It is hopeful that the present data be updated and developed in future for a prediction model for a 'teacher pool' (SACE, 2010) and (Gilford & Tenenbaum, 1990) and be able to use it to balance out its supply and demand equation. The study also found that 63 percent of the science teachers surveyed had been teaching up to six years; 47 percent for four to six years and aged between 26 – 44 years of age. If a projection model like the one described by Boe & Gilford (1992) is to be prepared, it appears that since the majority of the current workforce surveyed is aged between 26 - 44 years, most of them will still be teaching in the next 10 years. Since 47 percent were degree holders, quite a number of them would have moved into more senior roles. The question becomes, who will replace them in the classroom when they do so? These considerations are already listed as policy outcomes on the Tongan Government's Education Policy Framework, aiming to provide well qualified teachers for its schools through advance planning and forward forecasting of teacher supply to avoid shortages by analysing emerging trends of teacher mobility under sections 8.114, 8.115, and 8.116 (Catherwood & Levine, 2004).

Although the number of new qualified science teachers graduating from the two degree programmes has increased, it is difficult to accurately determine from the current data the new science teacher graduates (USP, 2013), added to the 'pool' of teachers. It appears that, even though Tonga may have acquired new graduate teachers, some individuals might already have been part of the 'current science teachers pool', but pursuing further studies to upgrade, thus making it difficult to establish the exact numbers of new teachers. In the

process, the qualification standard of the 'science teachers pool' may have been raised without actually changing the numbers of the actual 'teachers pool'. For example, out of the number of teachers who graduated between the years 2006 to 2011, (61 diploma and 24 degree graduates respectively), it is still difficult to establish how many were new teachers added to Tonga's 'supply pool'. A more comprehensive study is needed to evaluate the supply and demand equation as outlined by (Boe & Gilford, 1992). During such a study, teachers from all categories can be adequately identified including those still in training (student teachers) as it adds to the supply factor from which proper forecasting of 'supply' can be made to cater for 'demand' for future staffing or professional development needs. This would coincide with the MOE's desired policy outcome 8.125, addressing policy issues relating to ways of raising the quality of teaching and improvements to the quality of pre-service and in-service teacher education (Tonga, 2004). The next section discusses the ways in which science teachers are recruited.

5.3 Recruitment of Teachers

According to (Boe & Gilford, 1992), the recruitment of teachers is often driven by 'demand'; defined as a position for which funding has been allocated or provisions made for remuneration towards the individual to be hired. The dynamics of teacher demand includes factors such as numbers of pupils enrolled that will need not only a teacher with the required specific skills. In other words, 'demand' most often tries to address a 'shortage'. Shortages are both manpower and specific skills (Ingersoll, 1991).

In countries like the United States (Blosser, 1983; Gilford & Tenenbaum, 1990b), Australia, (NEALS, 2012), Canada (Cassellius, 2013) and South Africa (SACE, 2010), where they could have non-practising teachers in 'teacher pools' and not actually in a 'teaching pool' are referred to as 'stock' by (SACE,2010). Usually for larger and more developed countries, the full process of recruitment begins from advertising through to short listing and interviews before a prospective teacher is informed if his or her application for the teaching position as successful (Gilford & Tenenbaum, 1990).

For a small country like Tonga with no formally listed 'science teacher pool', often 'compromise' cannot be avoided even though every effort can be made to recruit science

teachers of sufficient quality, with the desired qualifications and merit. Boe & Gilford, (1992) describe 'compromise' as having to lower recruitment standards in order to fill for shortages. One way 'compromise' is made is by employing untrained teachers and teachers with incomplete qualifications in an attempt to equilibrate supply and demand in schools (Interviewee P4, P6 & P7). The MOE advertises its vacancies and teachers are expected to apply in formal writing, while the church systems do not advertise, but vacancies are filled through word of mouth. Due to not having a reserve pool of qualified teacher as described by Boe & Gilford (1992), this results in the recruitment of unqualified teachers (students who have completed 6th or 7th Form with Science) to teach before the system assists through professional development to enable them to attain a formal qualification.

To some extent the observation made by (SACE, 2010) and (Gilford & Tenenbaum, 1990), regarding the return of local residents to a particular local area to staff local schools, may hold some truth for Tongans who return home to Tonga after attaining an overseas qualification, thus making a difference in the education system and to society in general. When there is a shortage in Tonga, the effect is felt immediately and systems try to find ways to help ease the shortage by other means such as; working through the school's ex-students association to look for volunteers among the Tongan community or church communities overseas. Usually the ones that volunteer are ones that understand the Tongan salary system and would not mind working under such conditions (Interviewee P4, P5, P6 & P7).

On the demand side, the perceived need for science teachers in schools is high, and employable science teachers have no difficulty finding work in any one of the country's 22 secondary schools. The only deterrent for most teachers applying to church-run schools would be lower salaries compared with the government-run state schools (Interviewee P3, P4, P5, P6 & P7).

The retention of teachers in particular schools depend on circumstances relating to that school's particular staffing needs plus the administrative procedures of the system; whether church-run or state schools. Although reshuffles are carried out annually by both systems to balance out the science skills 'pools', principals confirmed during interviews that they do

play an active role in ensuring good science teachers remain in their schools when staffing allocation is carried out with the senior management (Gilford & Tenenbaum, 1990), unless there is severe shortage elsewhere within the system or to fill a more senior role. During this time there can be some reshuffling to cater for a staff member away on further training.

One of the biggest challenges in attracting science teachers is their 'retention' because of their high skills demand from a small pool of teachers. When they find an opportunity elsewhere and wish to leave, there is no choice but to let them go (Interviewee P4, P7 & CR2). Their retention in Tongan schools is quite good because of limited employment opportunities in the sciences outside of teaching; however, those who are employed in state schools tend to be retained longer because of their satisfaction of a higher salary compared with the church systems. Although most will leave if they were successful in securing a science related job outside of teaching, there are some dedicated ones who will remain with the church system (Interviewee P4, P5, P6, & P7). Teachers in the church systems are equally looking for better opportunities (salary wise) with the government system or overseas, and if they wish to leave, not much can be done to retain them. So there is a 'twin' challenge, firstly to attract them to the school to teach science and secondly, looking for ways to keep them from leaving (Interviewee P4, P7).

Experiences from Tanzania (Mabula, 2012) and Solomon Islands (Daudau, 2010), show that science teachers in developing countries are often faced with the challenge of having to work under situations of little to no equipment and this study has shown that Tonga is no different. The lack of resources in science classrooms can be a barrier to recruitment and retention of teachers. This seems to be a genuine call with interviewees P2, P4 and P7 voicing that, science teachers find it extremely difficult to perform to their maximum capacity if not equipped adequately.

Tongan schools cannot afford to provide monetary incentives to teachers to retain them (Interviewee P4), but they can do their best to constantly look for ways to provide the necessary equipment to assist their science teachers. P5, P7 and CR2 provide incentives for their teachers through professional development such as scholarships or time from classes to enable them to do part-time studies to improve their individual capacities to fully utilize their potential so that we can have their full commitment when they return. All the

Principals and CEOs confirmed that science teachers are treated in the same way as all other teachers and most are kept for as long as possible in one school and incentives provided to retain them.

The two common incentives mission schools provide are; improved teaching facilities (acquisition of science equipment and teaching resources) and promise of further study if they stayed on. *Interviewees P4, P5 and P7* all revealed that incentives for further studies are provided in some schools on a rotation basis per subject for teachers with diplomas to upgrade to a degree. However, administrators are aware of the fact that if they (science teachers) want to leave, they have to sadly let them go.

Therefore, to answer the sub-research question; two aspects were considered; professional support and retention. As far as professional support is concerned, systems are aware of their responsibilities to provide quality education to children, and strive to do their best to encourage and support their staff to upgrade their qualifications when the need arises. However, more needs to be done in terms of improving the quality of science in finding ways to improve classroom practices among science teachers within their systems or as a country.

I have discussed some of the challenges faced by schools on recruiting and keeping science teachers in their respective schools. The next section will discuss how Tongan teachers feel about their work and what keeps them doing the work they do.

5.4 How does Tonga sustain its Teachers? Teacher Perceptions

How do Tongan science teachers feel about their work?

This section presents a discussion on the overall findings of the teacher perceptions from the Teacher Questionnaire (*Appendix 6*). I will begin with the rewarding aspects, followed by the challenges they face in their roles as science teachers and circumstances that might cause them to leave teaching. I will conclude this section with the discussion on their self-efficacy and what influences their self confidence in their work.

Rewarding Aspects

The findings of this study are consistent with Gibbs (2014) in which 40 percent of Tongan science teachers surveyed believe that they can effectively make a difference in a child's life. Teacher beliefs are usually deep especially about the nature of the subject matter that they teach and why it is worth learning, leading to a greater self-confidence and capability in what they do (Holtz, 2009).

In agreement with both Gibbs (2002) and Holtz (2009), teachers expressed it as rewarding when children perform and achieve passing grades in science. When their students pursue further studies in science and eventually become professionals with successful carriers, they feel rewarded for their commitment in the classroom and that they have influenced the student in some way. Another rewarding aspect is the ability to create new friendships and build relationships apart from gaining respect in the community as Tongan is a close-knit society. Tongans value education very highly and Tonga prides itself with its 99 percent literacy (Mundi-Index, 2014), the highest in the Pacific region and was evident in teachers valuing and being rewarded in the opportunity of learning alongside the child in the classroom. Some teachers indicated that they learn something new in every lesson taking the whole experience of the teaching and learning process for both the learner and the teacher to a new level. A significant number also found extrinsic factors such as, receiving praise from parents and superiors as rewarding.

The next section presents some of the challenges expressed that teachers face in Tonga.

Challenges faced

Many of the challenges listed by Tongan science teachers are consistent with those reported in Tanzania by Mabula (2012), and the Solomon Islands by Daudau (2010) in the Solomon with 73.3 percent of the participants identifying 'lack of teaching resources' as their biggest challenge. Second to lack of resources was the challenge of student behaviour. Thirty percent of participants indicated that students are not disciplined enough in the classroom with their work habits and with low self-esteem with 6.7 percent suggesting that parents were not supportive enough of their children's learning.

Consistent with the Tanzanian studies by Mabula (2009) Tongan participants listed another big challenge as lack of communication and poor working relationships among colleagues. Thirty percent of the participants indicated lack of departmental meetings and follow-ups, cooperation as a team, miscommunications between the team and head of department and senior management. Other challenges included; a lengthy syllabus, time to fit all the required activities and class size as challenges faced. If there was more communication between the heads of departments and junior staff, could there be more sharing of ideas and ways to motivate the students to raise their habits? Another question to ask is; are the parents rightfully blamed for not being supportive of their children's work? Have all avenues of dialogue being depleted? This study did not ask these questions, but they have emerged from the case study itself. These intrinsic and extrinsic factors influencing rewards and challenges form the core in building the self-efficacy of a teacher presented in the next section.

5.5 Teacher Self-Efficacy

What is the self-efficacy of Tongan Science Teachers?

Self-efficacy is described as a powerful predictor of how and whether a teacher will act under the given circumstances (Gibbs, 2002). It is the control factor that enables teachers to exercise personal control over their behaviour, thinking and emotions. When a teacher's role deals with instilling ideas and facilitating, building on from prior knowledge in young people, self-efficacy is crucial as it provides a strong sense of competence and facilitates cognitive processes and managing classroom situations. When children witness this competence and confidence being modelled, it raises their motivation and self-esteem as well (Gibbs, 2002).

The objective of this segment of the study was to measure the collective self-efficacy of participating science teachers and report it relating to their over-all self-confidence in teaching. It was found that the average group self-efficacy of the participants was high and self-confidence with an average Likert score of between 3.5 to 4 (*Appendix 9*) for the collective self-efficacy test.

Literature states that, what teachers believe about their own confidence and capability is a strong predictor of how effective they can be (Holtz, 2009). Therefore if teacher effectiveness results from teacher capability and teacher confidence, self-efficacy influences all three in the same way. The study found Tongans teachers with high teacher confidence, with their teaching theoretical capability which they had gained through professional teacher training. The question lies with logistical capability in terms of science materials and professional development to bring forth effectiveness. If the teacher does not have the correct tools, it may affect his or her self-efficacy, which affects teacher confidence, teacher capability and overall teacher effectiveness (Figure 5.1).

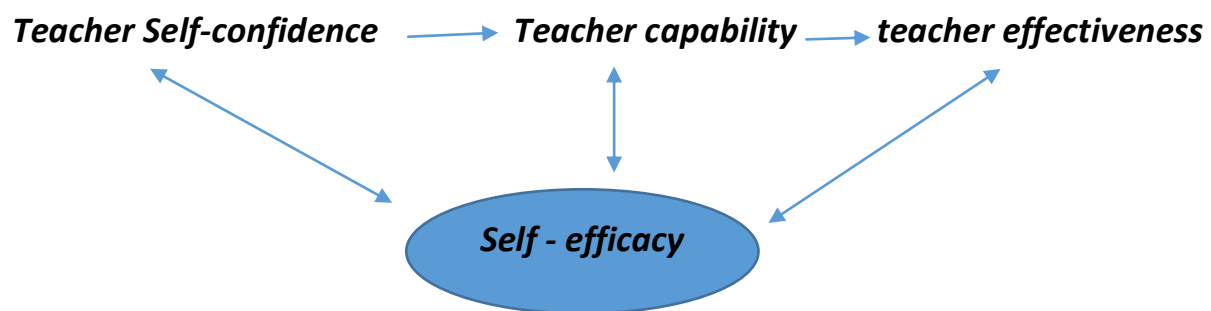


Figure 5.1 Schematic diagram of the effect of Self-efficacy (This study - Vaka-Vivili, 2014)

According to Gibbs (2002), four kinds of self-efficacy act as important indicators of teacher effectiveness; behavioural, cognitive, emotional and cultural that can interact and influence control of emotions, behaviour, thinking propelling confidence and capability of someone to teach effectively in the most appropriate manner. It was not an objective of this study to investigate each kind separately, but as a collective self-efficacy of their overall self-confidence.

In doing so, it was found that understandably the self-efficacy of the senior group (those teaching 16+ years) was much higher than the other two junior groups. They would most likely be the group that tend to persist in 'failure situations' of tough challenges far more than the other two groups. They would persist and persevere in taking risks with the curriculum trying new teaching approaches. For many Pacific countries, there are numerous

challenges in the practicalities of curriculum implementation and having highly motivated teachers with a high self-efficacy can be considered a bonus (Daudau, 2010; Jokhan, 2007; Massey, 2013). With 60 percent of the teachers surveyed indicating to leave, if an opportunity came up, it can be assumed that, that number will remain because of job satisfaction; however, at this stage there is a great need for qualified science teachers (and indicated by the all the SEO's and principals that, they do not have a science teachers pool, but are managing. Another concern for Tonga is that 7 out of 12 most experienced science teachers surveyed indicated they would leave if an opportunity arose. If that were to occur, it would leave a very young (less teaching experience) teaching work force.

Some indicators of strong self-efficacy are; a greater job satisfaction, more committed to their work and a low absenteeism from work. In doing so are able to motivate their student's learning and get better gains on their students' achievements (Gibbs, 2014).

The second aspect of self-efficacy was to test teachers' perceptions of specific situations pertaining to school context and external control; where they were asked to indicate the degree to which they agreed or disagreed with the statements presented (Appendix 9). This would provide an understanding on whether or not these situations played a role in their self-efficacy. The same tool as the first part was used except that the scores were different, because the questions were asked quite differently (*Appendix 13*) producing high average scores of 3.5 - 5 for aspects affecting their teaching in a school context (*Appendix 13*).

Closer examination of the average agreement chart revealed that the younger two groups of teachers were neither agreeing nor disagreeing with the statements presented for 'managing student behaviour in the classroom'. Could this pattern be attributed to the perception reported earlier that teachers felt the parents are not helping their children enough at home? Or is it a case of the teacher's inability to effectively present his or her lesson due to lack of equipment in the school and expecting the children to learn science at home with the parents? Some students could actually be confused if this is the case and therefore losing interest in science and appear as not taking ownership of their own learning, causing the teachers to be frustrated with their attitude. Although the overall average self-efficacy of the teachers seemed to be in agreement, future quantitative studies are needed to evaluate the details of the individual aspects tested.

This study tested two factors; collective teacher self-efficacy and their perceptions of school context and external factors using some of their questions. As this was a new area of study in the Pacific, and even though only two factors were tested, there was evidence of teacher burn-out detected which could affect job satisfaction. As mentioned, although the overall self-efficacy was high, indicating a greater sense of confidence in their teaching (Gibbs, 2004), this study now propels the need for future studies on self-efficacy to be carried out testing all the factors and drawing links to teacher burn-out and overall job satisfaction. As the flowers in a *kahoa kakala* or lei are held together by the *fau* for embodiment or structure, teacher self-confidence, teacher capability and teacher effectiveness become the flowers of fragrance held together by the fibre of self-efficacy into the *kahoa kakala* or lei of quality teaching and learning.

I have discussed the second sub-research question; to what extent has Tonga been able to attract and retain its science teachers?

5.6 Summary

The aim of the study was to explore and document current practices in attracting science teachers for training and find out how they are recruited, and retained in their respective schools.

In answer to the first sub-research question, Tonga has been relying on student interests especially with attraction factors propelled by a desire for societal recognition and higher remuneration benefits in teaching as propellants into a teaching career. According to the principal of TIOE, the numbers entering into science education has been low, and this study found that the numbers remained below 15 between the years 2006 -2011. As a result of those low numbers, science skills have been on high demand in schools. Equally there have been efforts made by the Ministry and church systems to recruit graduate teachers. At times science degree holders who did not study teaching pedagogy have been employed, and are required to upskill through professional development. Although there may be other factors involved to produce a result such as this, studies need to be carried out to explore the quality of secondary school graduates in science and the numbers passing out from secondary school with science.

With recruitment only carried out in Tonga and positions not advertised overseas, other attempts are made especially in the church schools to keep their schools staffed adequately. There was no denial by senior education officials of the fact that there is 'shortage' in the sciences both skills wise and man-power. However, there was also a perceived drop in interest in science by senior secondary schools shifting their interest to more Information Technology (IT) related and practical oriented subjects. The dilemma here is, students firstly need the science knowledge to be able to study Information Technology (IT) or a practical oriented science subjects such as plumbing or electricity. Although the study was not directly seeking to establish the quality of science secondary school students leave school with, questions can be raised as to how much science and what science would be ideal for Tongan children to be taught compatible with national needs.

The third and fourth sub-research questions were on teacher perceptions and how teachers felt about their work of which part was measured through a self-efficacy test. A large proportion (73.3 percent) of the science teachers surveyed in both state and church-run schools voiced that they are not being resourced adequately. They indicated that lack of proper scientific equipment in their schools has become a very big challenge to their teaching even though their teaching confidence and overall self-efficacy was high. The self-efficacy test showed issues dealing with managing student behaviour as one factor affecting self-efficacy. Since self-efficacy connects and compliments teacher confidence to teacher capability and overall teacher effectiveness; could it be possible that teachers are not capable to adequately perform due to some missing element? Even though 60 percent of the teachers surveyed indicated they would rather teach than to be in a different job, seven out of 12 most experienced science teachers (all graduates) indicated they would leave teaching if an opportunity arose. I hope that this research has presented some warning sign for authorities to start acting to address the appropriate needs. The current policy outcomes specific to this research question seems to be in place already, however; how there seems to be disconnect between policy and practice in terms of resource provision to science teachers to better able to utilise their expert knowledge in its fullest capacity.

5.7 Implications

This section attempts to link the findings of this study to some future implications by pondering on the presented findings in relation to the sub-research questions.

The overall outlook is that, Tonga needs to consider conducting thorough and comprehensive studies to gauge further insight into some of the following situations.

Attraction to teacher training

The implication of the current system of attraction to teacher training may seem adequate for a small nation like Tonga but is unsustainable as seen in 2006 – 2007 when the number of student intakes for science dropped to six. With the commencement of the new revised TIOE due to begin in 2015, this might be a good time to carry out research into student interests in science at secondary levels and find out approximate percentages of students who might be interested in becoming teachers in future.

Quality and Professional Development

With both skills and manpower shortages in science throughout the Kingdom, Tonga still cannot avoid 'compromise' and rely on untrained teachers especially in the church-run schools. It is of particular concern for this group of schools because the bulk of Tonga's population of secondary school children attend these schools. If these schools lowered the quality of science taught due to staff and skill shortage, the bulk of Tongan children coming out of these secondary schools will have limited science. Some students transfer from school to school during their secondary schooling years, if the schools they move to are not delivering the prescribed science curriculum, these students may not get the quality of science they need to leave secondary school with. Tonga must realise that the nation's future doctors, agriculture experts and engineers are not only enrolled in state schools but could be in the church-run schools right now. If this is not addressed, a generation of professionals could be affected of their future careers.

It is understandable that in many developing countries, schools need to improvise where there is lack of science equipment (Daudau, 2010), but it has to be decided how improvisation may compromise the quality of science learning. The technological world is advancing and science teachers need to be kept abreast with some of these innovations as

well as find ways to teach their science. If resources are not made available to them, quality cannot be improved from improvised materials. Science is about discovery and innovation and improvement; quality science cannot be taught from improvised materials from year to year; at some point, there has to be improvement.

The teacher being inadequately resourced, hasn't fully provided the student the entire learning opportunity, but now, expects the child to take responsibility of his or her learning also expecting the parents to assist from home, forgetting that the school is the best place for a child to learn science. The school science laboratory provides the best environment for the child with his or her peers. When the subject is not taught properly and students do not enjoy it, they may develop a negative attitude towards it, which may remain with them for a lifetime. Although not all will choose a science career in their senior years of study, at least in the junior years, they have been taught how to raise questions (enquire), investigate, test, analyse and prove something. They have "learnt how to learn", *Interviewee SEO2*.

Retention of teachers

This study found over 60 percent of the science teachers surveyed indicating that if an opportunity arose somewhere else, they would leave. In order to prevent attrition of this nature and scale, all needs to be done to ensure their self-efficacies are not lowered making them frustrated and allowing them reason to leave. The self-efficacy of the science teachers need to be strengthened to convert that teacher confidence into teacher effectiveness. Already the most experienced and most qualified teachers are saying they would leave if an opportunity presented itself. They might have a high self-confidence in themselves – a high collective self-efficacy, but when individual aspects are considered it reveals the true nature of the *fau* being porous.

I have presented the implications the findings of this study has for Tonga in relation to student teacher attraction for training, the quality and professional development of teachers after being recruited and their retention in schools. The following section brings the recommendations to consider.

5.8 Recommendations – *Malie mo Mafana*

This section intends to highlight some considerations that arose as a result of this study.

This study recommends further research into the following.

1. The need for a comprehensive study to be conducted and a 'Projection Model' as the one described by Boe & Gilford (1992). This study will help the MOE in a number of areas;
 - (i) Forecast how many students are studying science at senior secondary levels,
 - (ii) how many students could be expected to apply for teacher training,
 - (iii) how many are currently in training
 - (iv) how many are expected to complete each year from TIOE
 - (v) An improved National Bio-data bank containing information of current teachers' information currently held with EMIS creating an up-to-date 'National science teachers pool'.

This study will also help to gauge the interest of the students annually and help calculate teacher-pupil ratios for staffing purposes and forward planning. Part of this recommendation already exists as a desired educational policy outcome that needs implementing.

2. In order to overcome shortage of equipment dilemma faced by Mabula (2012), in Tanzania, and many developing countries, Tonga may need to consider long term policy planning at inter-governmental level. Many of the science teachers surveyed have high intrinsic motivations scoring very highly in their self-efficacy test. If it is possible to get a few highly qualified teachers possibly from overseas or within the region to work alongside Tongan teachers to practice some good teaching techniques with the use of minimal laboratory equipment.
3. Nurture the fibre that weaves the lei (*kahoa kakala*). Although 73 percent of science teachers surveyed have indicated lack of laboratory facilities as their biggest challenge, an effective teacher can still teach science concepts without the use of laboratory equipment. Otherwise, quality classroom enjoyment of science between

the teacher and students might soon disappear with teachers pointing fingers back at admin for not being given the correct tools to work with (laboratory equipment). This may also cause frustrations to set in, lowering their self-efficacy. They may do their best by providing the best diagrams on the board but the students might not have a visual clue as to what the teacher is talking about. School administrations need to find ways to assist the teacher to give some practical observations and experience to the students.

Therefore, I would like to suggest the use of the self-efficacy test to be carried out if possible from time to time as a professional development or teacher appraisal tool to gauge student teacher progress or teacher self-confidence for established teachers.

I have presented some recommendations that emerged as a result of this study. The next section informs of the *fau* concept (an important element in *kakala* weaving) as a conceptual framework within the Kakala Research Framework.

5.9 My contribution and final thoughts

Koe fau, koe no'o anga ia o e kakala– The fau is the fibre that holds or fastens the flowers of a lei (kakala)

The *fau*: a conceptual framework for Teacher Self-Efficacy

The fau (fibre) is the hidden part of the lei that actually holds the flowers together and secures it into place while providing the support and structure for the lei.

The methodological framework for this study was a combination of the Kakala/Kakala Research Frameworks. It seemed appropriate to examine the research question through this lens as it aligned with the context of the study being a Pacific Research Framework with a Tongan context. As described in Chapter 3.0, in selecting the above research framework, it was important to examine its metaphorical components in order to align the data collection and analysis techniques while at the same time, answer the research question. Hence, it can also be generally asked, what keeps the science teachers teaching in Tonga?

The following section provides a discussion on how this study expanded and included a major component of the kakala (lei) which is significant in the whole lei making process – the fibre (*fau*).

Upon careful analysis of the Kakala Research Framework, the study rested upon an important element that is needed for the Kakala weaving process to set the theme of data collection and analysis, the fibre known as the *fau* in the local vernacular. By placing the *fau* into context enabled the study to understand how the Tongan systems operated. The *fau* is a light porous bark used for weaving helps the flowers to be held in the correct place on the lei and provides structure. Typically three strands of *fau* are adequate to weave a basic *kahoa kakala*. In an educational context, a strand of *fau* metaphorically represents the following three areas:

- the culture (present)
- The education policy (present but needs full implementation)
- Building the self-efficacies of the science teachers by providing the assistance they need to ensure effective curriculum delivery (need work on).

(i) the Tongan culture – the first strand of *fau*

The flowers (*pua*) can be the teachers of the system or the students of the Kingdom. The cultural aspects of *ofa fonua* and *mateaki li'oa* translates across to 'love of the job' for the teachers out in the schools. The spiritual aspect of '*lotu*' binds that love and commitment on their part which propels them to give their best to their community and their country. Evidence of this was noted in this study; it was voiced quite frequently by most SEO's the words, 'for the good of Tonga'. The strong culture and spiritual aspects will propel this type of altruism to a state where teachers will still teach, no matter how dire the conditions may be. This fortitude and spirit was also vocalised by two SEO's and three principals as; "we make do with what we have". This is one strand.

(ii) the education policy framework- the second strand of fau

Sections 1.5.2 and 1.5.3 have discussed the educational policy framework (Catherwood & Levine, 2004) and the cultural mapping policy frameworks (Fua, S. u. J. et.al, 2011) that guide the Ministry's educational goals and objectives for the country. Tonga prides itself with its educational achievements especially with 99 percent literacy (Mundi Index, 2014) and has set policy guidelines and educational frameworks (TESP, 2014) even at the Tonga Institute of Education with its vision statements as *Faiako ma'a Tonga ki he Tonga* (TIOE, 2013), to provide the structure for operations. This study has found that in some areas policy aspects are existent at present but needs to be fully implemented.

(iii) the self-efficacy of the teachers– the third strand of fau

The third strand of fau is the self-efficacy of the teachers as science teachers. It has been mentioned that their cultural and spiritual strengths will keep them teaching, but this strand if made more porous than it is might not be able to keep the lei as structurally sound as desired. Science teachers often require specialised equipment to work with as specialist subject teachers or special training and assistance given. To keep science teachers motivated and retained for long may be a challenge as working conditions become incongruent to exercise and transfer their specialist knowledge. This is when problems of attrition may arise leading to inadequate teacher retention and teacher shortages. However, in Tonga, the cultural, spiritual and policy aspects alone may be just enough to keep them dedicated and committed to doing the best job they can amid all other challenges they face, but this study has found that the situation is volatile. If an opportunity arose, a majority of experience science teachers would not hesitate to leave.

My Final Thoughts

In order for a beautiful *kahoa kakala* to be woven and presented to be appreciated, all the strands that are used must be adequately strong, if one strand is weak, it will weaken the sturdiness of the *kahoa kakala*. When all three strands are overlapped to weave the *pua* in place, an admirable piece of handiwork or product is produced. The collective overall self-efficacy of the Tongan science teachers surveyed was high. They are very confident with their work as teachers. However, there were differences when individual aspects were analysed. As the *fau* is porous in nature, so is human nature; the teachers remain confident in their work mostly out of love of the job and willingness to make a contribution to society, *ofa fonua*, and *mateaki li'oa* (the culture and spiritual aspects). They remain confident by teaching within the statutes and guidelines of the education policy however, their self-efficacies need to be strengthened with the provision of the correct laboratory equipment and resources needed for them in order to make their job more effective.

If the MOE or the church education systems are to construct a beautiful *kakala*, not only is the *pua* important but the *fau* that holds the *pua* in place to provide structure.

Malo aupito.

Bibliography:

- Bandura, A. (1989). Regulation of cognitive processes through perceived self-efficacy. *Developmental Psychology*, 25(5), 729-735.
<http://dx.doi.org/10.1037/0012-1649.25.5.729>
- Blosser, P. E. (1983). Science Teacher Supply and Demand. *Science Fact Sheet*. Retrieved from <http://eric.ed.gov/?id=ED232842>
- Boe, E. E. & Gilford, D. M. (1992). *Teacher Supply, Demand and Quality: Policy Issues, Models, and Data Bases*, Washington D.C. National academic Press. Retrieved from <http://www.nap.edu/catalog/2040.html>
- Brown, M. (1953). On a Definition of Culture (Vol. 60, pp. 1): University of North Carolina.
- Cassellius, B. (2013). *Teacher Supply and Demand Fiscal Year 2013 Report to the Legislature*. Minnesota.
- Catherwood, V. & Levine, V. (2004). *Tonga_Final-draft_policy_framework_2004-2019*. Tonga Ministry of Education
- Cherry, K. (2013). What is self-efficacy? Retrieved from http://psychology.about.com/od/theoriesofpersonality/a/self_efficacy.htm
- Chiu, C. (2011). The Kakala framework - Prof Konai Thaman. Retrieved from <https://akoaootearoa.ac.nz/project/pasifika-learners-and-success-tertiary-education/blogs/kakala-framework-prof-konai-thaman>
- Cook, J. (2013). The importance of learning science. Retrieved from http://www.ehow.com/about_6169591_importance-learning-science.html
- Cooper, J. M. & Alvarado, A. (2006). *Preparation, recruitment and retention of teachers*. International Institute of Educational Planning. Paris. UNESCO.
- Cuadra, E., Moreno, J. M., Crouch, L., Nagashima, Y., Koda, Y., Bundy, D. & Abu-Ghaida, D. (2005). Expanding opportunities and building competencies for young people: A new agenda for secondary education. World Bank. Retrieved from <http://go.worldbank.org/TU36ANZYW0>
- Daudau, P. (2010). *Teachers' perceptions of outcomes - based science curriculum: A case study from Solomon Islands*. (Master of Education thesis, Victoria University of Wellington. New Zealand).
- Feilzer, M. Y. (2010). Doing mixed methods research pragmatically: Implications for the rediscovery of pragmatism as a research paradigm. *Journal of Mixed Methods Research*, 4(1), 6-16. doi: 10.1177/1558689809349691

- Fensham, P. J. (2008). Science education policy-making: Eleven emerging titles. *United Nations Scientific and Cultural Organizations*. Paris. UNESCO.
- Fua, S. J., Tuita, T., Kanongata'a, S. L. & Fuko, K. (2011). *Cultural Mapping Planning and Policy: Tonga*. Secretariat of the Pacific Community cataloguing in publication data. Retrieved from http://www.spc.int/hdp/index2.php?option=com_docman&task=doc_view&gid=297&Itemid=44.
- Geyer, P. D. (2014). Political skill and self-efficacy among college students. *Researcher's World - Journal of Arts, Science & Commerce*, V(3), 5.
- Gibbs, C. (2002). *Effective Teaching: Exercising self-efficacy and thought control of action*. Paper presented at the Annual Conference of the British Educational Research Association, England. University of Exeter. Retrieved from <http://www.leeds.ac.uk/educol/documents/00002390.htm>
- Gilford, D. M. & Tenenbaum, E. (1990). *Precollege Science and Mathematics Teachers: Monitoring Supply, Demand, and Quality*. Washington DC: National Academy of Sciences.
- Harlen, W. (1992). *The teaching of science*. London: David Fulton Publishers.
- Hassan, G. (2011). Students' Views of Science: A comparison between tertiary and secondary school students. *Science Educator*, 20(2), 54-61.
- Holtz, B. W. (2009). Making choices: Teachers' beliefs and teachers' reasons. *Journal of Jewish Education*, 5.
- Ingersoll, R. (2001). Teacher turnover and teacher shortages: An organizational analysis. *American Educational Research Journal*, 38(3), 35.
- Ingersoll, R., Merrill, L. & May, H. (2011). *What are the effects of teacher education and preparation on beginning math and science teacher attrition?* Paper presented at the annual meeting of the American Educational Research Association. New Orleans.
- Ingersoll, R. & Perda, D. (2010). Is the supply of mathematics and science teachers sufficient? *American Educational Research Journal*, 47(3), 563-594. doi: <http://dx.doi.org/10.3102/0002831210370711>
- Investopedia. (2014). T-Test. Retrieved from (<http://www.investopedia.com/terms/t/t-test.asp>).
- Johnson, B. & Christensen, L. (2008). *Educational Research Quantitative, Qualitative, and Mixed Approaches* (Third Edition ed.). United States of America: Sage Publication.
- Jokhan, A. (2007). USP holds workshop to address neglect of science education. Retrieved from <http://www.usp.ac.fj/news/story.php?id>
- Jones, T. & SpringerLink. (2013). *Understanding Education Policy: The 'Four Education Orientations' Framework*. Dordrecht, Netherlands: Springer.

- Low, E. L., Lim, S. K., Alan, C. n.& Goh, K. C. (2011). Pre-service teachers' reasons for choosing teaching as a career in Singapore. *Asia-Pacific Journal of Education*, 31(2), 15.
- Luft, J. A., Wong, S. S.& Semken, S. (2011). Rethinking recruitment: The Comprehensive and strategic recruitment of secondary science teachers. *Journal of Science Teacher Education*, 22(5), 459-474. doi: 10.1007/s10972-011-9243-2
- Lysgard, H. K. (2013). The definition of culture in culture-based urban development strategies: antagonisms in the construction of a culture-based development discourse. *International Journal of Cultural Policy*. 19(2), 182-200. doi: <http://dx.doi.org/10.1080/10286632.2011.647005>
- Mabula, N. (2012). Promoting science subject choices for secondary school students in Tanzania: Challenges and opportunities. Retrieved from www.savap.org.pk
- Maka, L. (2005). International Aid to Tonga: For better or for worse? In Sanga, K. & Taufe'ulungaki, A. (Eds.), *International Aid Impacts on Pacific Education*. Victoria University Wellington, New Zealand.
- Mangrubang, F. R. (2005). Issues and trends in science education: The shortage of qualified science teachers. *American Annals of the Deaf*, 150(1), 42-46.
- Maphosa, C., Bhebhe, S., & Shumba, J. (2014). What motivated them to become teachers? An Examination of Trainee Teachers' motives of training as teachers. *Meditarranean Journal of Social Sciences*, 5(7), 9.
- Massey. (2013). Tokelau: Scholarships address teacher shortage [Press release]. Retrieved from <http://www.massey.ac.nz/massey/about-massey/news/article.cfm?mnarticle=scholarships-address-teacher-shortage-11-03-2013>
- Mayor, F. (1997, Nov 1997). Science education and sustainable development. *The Unesco Courier*, 50, 38-39.
- McElroy, M. (2009). Science teacher retention: It takes more than money. Retrieved from <http://www.aas.org/news/science-teacher-retention-it-takes-more-tanh-money>
- Moala, E. H. (1995). Review of Tonga Teachers' College - 1995/96. *Directions*. Retrieved from <http://www.directions.usp.ac.fj/collect/direct/index/assoc/D1175728.dir/doc.pdf>
- Morgan, R. D. (1994). Factors affecting the retention of K-12 Pacific Union teachers. *CIRCLE*. Retrieved from <http://circle.adventist.org/browse/resource.phtml?leaf=2187>
- Mtika, P., & Gates, P. (2011). What do secondary trainee teachers say about teaching as a profession of their "choice" in Malawi? *Teaching and Teacher Education*, 27(2), 424-433. doi: 10.1016/j.tate.2010.09.012
- Mundi-Index. (2014). Tonga literacy. Retrieved from <http://www.indexmundi.com/tonga/literacy.html>

- Mundia, L. (2012). Policy changes in Brunei teacher education: Implications for the selection of trainee teachers. *The Educational forum*, 76(3), 326-342.
- Muralidhar, S. (2004). Human resource development and science education in the Pacific: Where are we heading?45-59. Retrieved from <http://www.directions.usp.ac.fj/collect/direct/index/assoc/D770139.dir/doc.pdf>
- Nature. (1963). Science and adult education. *Nature*, 200, 1. Retrieved from <http://www.nature.com/nature/journal/v200/n4909/pdf/200834e0.pdf>
- Nature. (1980). Shortage of science teachers. *Nature*, 283(21), 1. Retrieved from (<http://www.nature.com/nature/journal/v200/n4909/pdf/200834e0.pdf>)
- NEALS. (2012). *2010 - 2011 Teacher supply and demand report for the Victorian teacher supply and demand reference group*. Victoria, Australia. Retrieved from <http://www.education.vic.gov.au/hrweb/careers/teach/tchdemand.htm>.
- Oxford online dictionaries(2014).
http://www.oxforddictionaries.com/definition/american_english/culture
- Padaguri, V. G. (2011). Case study: Job selection and career planning: Unwidning the dilemma. *Journal of Contemporary Research in management*, 6(3).
- Perry-Castañeda. (2013). Library map collection. Retrieved from http://www.lib.utexas.edu/maps/islands_oceans_poles/tonga.jpg
- Poisson, M. (2000). Science education for contemporary societies: Problems, issues and dilemmas. In M. Poisson (Ed.)International Bureau of Education the Chinese National Commission for UNESCO. Geneva, Switzerland. UNESCO.
- Prakash, J. (2014). What is the importance of science education as a school subject? Retrieved from <http://www.preservearticles.com/201105216961/importance-of-science-as-a-school-subject.html>
- PRIF, (2013). Pacific Islands Infrastructure Facility:Map of the South Pacific region. Retrieved from <http://www.theprif.org/>
- Rosenberg, M. S., Westing, D.L.J. & McLeskey, D.L . (2010). The impact of culture on education. Retrieved from <http://www.education.com/reference/article/impact-culture-education/>
- Rots, I., Aelterman, A., Devos, G.& Vlerick, P. (2010). Teacher education and the choice to enter the teaching profession: A prospective study. *Teaching and Teacher Education*, 26(8), 1619-1629. doi: 10.1016/j.tate.2010.06.013
- SACE. (2010). A review of teacher demand and supply. South African council for educators, research report. Retrieved from <http://www.sace.org.za/files/>
- Satbir. (2012). Four pillars of education as recommended by UNESCO. *Education and Development*. Retrieved from <http://bednotes.blogspot.in/2012/10/four-pillars-of-education-as.html>

- Skaalvik, E. M. & Skaalvik, S. (2009). Teacher self-efficacy and teacher burnout: A study of relations. *Teaching and Teacher Education*, Norwegian University of Science and Technology, Trondheim, Norway. Retrieved from www.elsevier.com/locate/tate
- SPC (2014). Secretariat of the Pacific Board for Educational Assessment. Retrieved from <http://www.spbea.org.fj/Home/About-SPBEA.aspx>
- Syed Zin, S. M. b. (1999). Science education in secondary schools in Brunei Darussalam. *The development of human resources: The provision of science education in secondary schools*. Paris, France. UNESCO. International Institute for Educational Planning.
- Tang, Q. (2010). Current challenges in basic science education: Education sector. Paris, France. UNESCO. Retrieved from http://unesdoc.unesco.org/images/0019/001914_191425e.pdf
- TESP. (2014). *Monitoring and Evaluation Framework (Inclusive of Tonga Education Support Project)*. Retrieved from [http://spbea.org.fj/Workshops/MnE/Country Presentations and Resources/Tonga](http://spbea.org.fj/Workshops/MnE/Country%20Presentations%20and%20Resources/Tonga)
- Thaman, K. H. (2010). Teacher capacities for working towards peace and sustainable development: *International Journal of Educational Development*, 11(4), 11. Retrieved from www.emeraldinsight.com/1467-6370.htm
- Thaman, K. H. (2014). Community expectations of secondary education in Tonga. School of Education: University of the South Pacific, Suva Fiji. Retrieved from <http://directions.usp.ac.fj/collect/direct/index/assoc/D769835.dir/doc.pdf>
- TIOE. (2004) Diploma of Education (Secondary) Curriculum document. *Tonga Institute of Education*. Nukualofa, Tonga.
- TIOE. (2013). *Tonga Institute of Education Enrolment Data*. Unpublished raw data.
- Tonga, MOE. (2004). *Tonga Education Policy Framework Final-draft_policy_framework_2004-2019*. Ministry of Education. Nuku'alofa, Tonga.
- Tonga, MOE. (2014). Educational Management Information Systems Data. *Ministry of Education*, Unpublished raw data.
- Tschannen-Moran, M. & Hoy, A. W. (2001). Teacher efficacy: capturing an elusive construct. *Teaching and Teacher Education*, 17, 22. Retrieved from www.elsevier.com/locate/tate
- UNESCO. (2002). Meeting international commitments, the response to Dakar: Funding EFAGMR15. Chapter 5: EFA Global 2002 monitoring report, UNESCO Paris, France.
- UNESCO (2006). *Pacific Education for Sustainable Development*. Nadi Fiji. Retrieved from <http://unesdoc.unesco.org/images/0014/001476/147621e.pdf>
- USP (2013). The University of the South Pacific: List of Enrolments & Awards records. Unpublished raw data.
- Whistler, W. A. (1992). *Tongan herbal medicine*. Honolulu Hawaii, USA. Isle Botanica.

Wikipedia (2013). 5 Point Likert scale. Retrieved from http://en.wikipedia.org/wiki/Likert_scale.

WorldBank (2013). Pacific Islands Overview. Retrieved from <http://www.worldbank.org/en/country/pacificislands/overview>

WorldBank (2014). Pacific Islands Overview. Retrieved from <http://www.worldbank.org/en/country/pacificislands/overview>

APPENDICES

APPENDIX 1. Letter to the Minister for Education Women and Culture – Tonga.



Minister for Education

Ministry of Education, Women & Culture

Nuku'alofa,

Kingdom of Tonga

Kingdom of To

02/10/2013

SUBJECT: REQUESTING PERMISSION TO CONDUCT EDUCATIONAL RESEARCH IN THE TONGA

Research Title: The Future of Science Teacher Education in Tonga

Dear Madam,

Greetings! In the Name of our Lord and Saviour, Jesus Christ.

My name is Margaret Vaka-Vivili and I am from Victoria University of Wellington. I write to seek your kind permission to conduct educational research in your beautiful country towards my Master's thesis in Education.

My research title is stated above, and my Research Question is;

Research Question: To what extent has Tonga been able to attract, train and retain science teachers?

At your permission, I would like to write and seek the interest of the principals and secondary science teachers to participate in this case study. Science is one of the compulsory subjects in many high school curricula worldwide, including Tonga, which is very important to a child's cognitive development and assists them in lifelong learning no matter what career path they take after leaving secondary school. It is also equally important that the 'teacher of science' is adequately trained and facilitated to carry out his or her duties effectively. I am hoping that my research will discover and document as a case study valuable information & insight into the science teacher education and facilitation processes in Tonga. In doing so, I also hope that the information will contribute and assist towards long term development, improvement & facilitating educational planning the development of human resources overall.

Your kind assistance is needed to carry out the research field work using the following modes of data collection.

Research Method: A mixed method is proposed to involve 3 tools; document analysis, Questionnaire and semi-structured interviews.

1. Document Analysis:

I wish to request permission to view documents and make enquiries in relation to the following;

- (i) Tonga's secondary school Science curriculum policy document or vision statement.
- (ii) Tonga's performance data in Science at School Certificate Level, and the Pacific Senior Secondary and or equivalent examinations for your Forms 6's & 7's over the past 10 years.
- (iii) Record of student enrolments & numbers of science teacher graduates in comparison to other teacher graduates at Tonga Institute of Education (TIOE) for the past 10 years.

The second tool I intend to use is the Questionnaire.

2.

The questionnaire is aimed at all science teachers in all the secondary schools in Tonga. The questionnaire is **totally anonymous** and consists of **3 parts: basic information, a self-efficacy test and four (4) open-ended questions of a qualitative nature**. I intend to post them to the respective schools once I have obtained permission firstly from your office, and secondly from the respective principals. It will contain stamped self-addressed envelopes to return via air mail postage back to me at Victoria University of Wellington – Karori campus. A copy of the Questionnaire is attached for your information.

3. The third tool is a series of semi-structured interviews with the following senior personnel responsible or linked to the delivery of secondary education in the Tonga.

- (i). Principal of Tonga Institute of Education (TIOE)
- (ii). Principals of all secondary schools
- (iii) The Director of Education/CEO, Ministry of Education, Women and Culture
- (iv) The Directors of Education for the four Church School systems in Tonga.

The following are the sub-research questions I intend to find answers to during the course of the study.

- 1. The current number of science teachers in the country (both trained and untrained).
- 2. The total number of enrolments/graduates of TIOE in the past 10 years.
- 4. How do Tongan science teachers feel about their work? What is their self-efficacy?
- 5. Is there a relationship in the number & quality of passes in science at secondary school and the number of intakes for teacher training at TIOE?

6. How does Tonga attract and train its science teachers?
7. How does Tonga recruit, support and retain its science teachers?
8. How does Tonga value science education and what is its perspective of an efficient science teacher of “adequate quality?”

All information collected will be used primarily for the purpose described above. However, it may also be used for the purpose of other educational publications by the researcher otherwise as cited. An overview of the findings will be made available upon request from participating schools. All data collected will be stored in password protected offices at Victoria University and will be destroyed 3 years after the completion of the research.

The following documents are attached to this letter; Letter to the Principal, Principal Consent Form, and Participant Information sheet (Questionnaire) and Participant Consent Form together with the Questionnaire.

This research has been approved by the Faculty of Education Human Ethics Sub-committee under delegated authority from the Victoria University Human Ethics Committee. If you have any concerns about the way the research is conducted, please contact Dr Allison Kirkman (Allison.Kirkman@vuw.ac.nz), Ph: 04 463 5676, Chair of the Human Ethics Committee, Victoria University of Wellington.

Please feel free also to contact me at (margaret.vaka-vivili@vuw.ac.nz) or my Supervisor Dr. Louise Starkey (Louise.Starkey@vuw.ac.nz) to discuss the research and ask any questions.

I solemnly intend to abide by all Ministry of Education and Tongan Government requirements during this research. My current anticipated date of my arrival in Nuku'alofa will be on the 12th of October with data collection anticipated to begin immediately from the 14th of October, through to the 22nd of November, 2013. During my stay in Tonga, I intend to fully fund myself and stay in my family home at Halaleva, Tongatapu

I am hoping for a favourable outcome to this request and look forward to meeting with your officers in the not too distant future.

Thank you sincerely for your kind assistance and May God continue to Richly Bless you.

Yours Truly,



Margaret Vaka Vivili (Researcher)

(Masters Student - Victoria University of Wellington)

Copied: CEO/Director for Education.

Attachments:

1. Letter to the Principal
2. Participant Information sheet (Questionnaire)
3. Teacher Questionnaire
4. Participant Consent form
5. Principal's consent form
6. Participant's Consent - Principal of TIOE
7. CEO's Consent form
8. Information about the Researcher.

APPENDIX 2 : Letter to the Director of Education

(Generic for all Directors)



Director of Education

Ministry of Education, Women & Culture

Nuku'alofa,

Kingdom of Tonga

Kingdom of

18/11/2013

SUBJECT: INVITING YOUR PARTICIPATION IN EDUCATIONAL RESEARCH AS AN INTERVIEWEE

RE: The Future of Science Teacher Education in Tonga

Malo e lelei!

My name is Margaret Vaka-Vivili and I am a student from Victoria University of Wellington, currently studying for a Master's in Education. I am writing to invite your participation, as an **interviewee** in the above case study. I would like to request 30 minutes of your time for a short interview at convenient time for which we can arrange in the next few days.

I am particularly interested to find out about your policy regarding science in secondary schools and how you recruit & retain your science teachers. I am hoping that your contribution will assist my research to document valuable information & insight into the science teacher education and facilitation practices in these two countries. It may also assist both countries to better plan & facilitate educational developments and their overall human resource development.

I will be phoning you in the next few days as a follow-up to this letter to arrange an appropriate time and mode (either face to face or by telephone) for this interview.

All information collected will be used primarily for the purpose described above. However, it may also be used for the purpose of other educational publications by the researcher otherwise as cited. An overview of the findings will be made available upon request from participating schools and agencies. All data collected will be stored in password protected offices at Victoria University and will be destroyed 3 years after the completion of the research.

The research has been approved by the Faculty of Education Human Ethics Sub-committee under delegated authority from the Victoria University Human Ethics Committee.

If you have any concerns about the way the research is conducted, please contact Dr Allison Kirkman (Allison.Kirkman@vuw.ac.nz), ph: 04 463 5676, Chair of the Human Ethics Committee, Victoria University of Wellington. Please feel free also to contact me at (margaret.vaka-vivili@vuw.ac.nz) or

my Supervisor Dr. Louise Starkey (Louise.Starkey@vuw.ac.nz) to discuss the research and ask any questions. Otherwise, I will be in contact with you by telephone to confirm the time and date for the interview.

I thank you sincerely for accepting my invitation and hope to hear from you soon.

Yours faithfully,

A handwritten signature in purple ink, appearing to read 'M Vaka-Vivili'.

Margaret Vaka-Vivili (Researcher)

(Masters Student - Victoria University of Wellington)

Attachment: Information about the researcher.

Appendix 3: Letter to the Principal of Tonga Institute of Education



FACULTY OFFICE

FACULTY OF EDUCATION, TE WHĀNAU O AKO PAI

VICTORIA UNIVERSITY OF WELLINGTON, PO Box 17-310, Donald St, Karori, Wellington 6147, New Zealand

Phone + 64-4-463 9500 Fax +64-4-463 9649 Email
education@vuw.ac.nz Web www.victoria.ac.nz/education

The Principal,
Tonga Institute of Education
Ministry of Education, Women and Culture
Nuku'alofa,
Kingdom of Tonga

18/11/2013

SUBJECT: INVITING YOUR PARTICIPATION IN EDUCATIONAL RESEARCH

RE: The Future of Science Education in the Pacific: A Tongan Case Study

Dear Sir/Madam,

My name is Margaret Vaka-Vivili and I am a student from Victoria University of Wellington, currently studying for a Master's in Education. I am writing to invite your participation, as an **interviewee** in the above case study. I would like to request 30 minutes of your time for a short interview at convenient time for which we can arrange in the next few days.

I am particularly interested to find out about your policy regarding science in secondary schools and how you attract, train and provide on-going support for your secondary science teachers. I am hoping that your contribution will assist my research to document valuable information & insight into the science teacher education and facilitation practices in these two countries. I am particularly interested in your participation for the following data:

- (1) TIOE's enrolment & graduate's list for the past 10 years. It may also assist both countries to better plan & facilitate educational developments and their overall human resource development.
- (2) Any policy statements or guidelines by which the college strives towards meeting.
- (3) 30 minutes of your time for a short interview to discuss ways in which you attract, train and provide professional assistance for your science teachers.

I will be phoning you in the next few days as a follow-up to this letter to arrange an appropriate time for this interview.

All information collected will be used primarily for the purpose described above. However, it may also be used for the purpose of other educational publications by the researcher otherwise as cited. An overview of the findings will be made available upon request from participating schools and agencies. All data collected will be stored in password protected offices at Victoria University and will be destroyed 3 years after the completion of the research.

The research has been approved by the Faculty of Education Human Ethics Sub-committee under delegated authority from the Victoria University Human Ethics Committee.

If you have any concerns about the way the research is conducted, please contact Dr Allison Kirkman (Allison.Kirkman@vuw.ac.nz), ph: 04 463 5676, Chair of the Human Ethics Committee, Victoria University of Wellington. Please feel free also to contact me at (margaret.vaka-vivili@vuw.ac.nz) or my Supervisor Dr. Louise Starkey (Louise.Starkey@vuw.ac.nz) to discuss the research and ask any questions. Otherwise, I will be in contact with you by telephone to confirm the time and date for the interview.

I thank you sincerely for accepting my invitation and hope to hear from you soon.

Yours faithfully,



Margaret Vaka-Vivili (Researcher)

(Masters Student - Victoria University of Wellington)

Attachment: Information about the researcher.

Appendix 4: Letter to Principals of Secondary schools (Generic)



FACULTY OFFICE

FACULTY OF EDUCATION, TE WHĀNAU O AKO PAI

VICTORIA UNIVERSITY OF WELLINGTON, PO Box 17-310, Donald St, Karori, Wellington 6147, New Zealand

Phone + 64-4-463 9500 Fax +64-4-463 9649 Email education@vuw.ac.nz Web www.victoria.ac.nz/education

Dear Principal,

RE: The Future of Science Teacher Education in Tonga

My name is Margaret Vaka-Vivili and I am a student from Victoria University of Wellington, currently studying for a Master's in Education. I am writing to seek your interest to participate in the above study with me. It has been very well documented that science education is very important to a child's cognitive development and assist them in lifelong learning no matter what career path they take after leaving secondary school. It is also equally important that the 'teacher of science' is adequately trained and facilitated to carry out his or her duties effectively. I am hoping that your valued contribution will assist my research to find out and document valuable information & insight into the science teacher education and facilitation practices in Tonga. It may also assist in better planning & facilitating educational developments and human resource development overall.

First of all, I would like to request your permission to invite **all** the members of your science teaching staff to participate in a written **Questionnaire or Survey**. A copy of the Questionnaire is attached for your information. Each participant will receive a **Participant Information Sheet** accompanied by a **Participant Consent Form**. The nature of the survey is '**totally anonymous**', therefore may I ask that, they **confirm their consent by placing a tick (✓)** in the appropriate boxes. **No names or signatures are required** and participant are allowed to opt out of the research during data collection should they wish. All Questionnaires are accompanied with a self-addressed envelope for its safe return to myself at the address which I have provided.

The Questionnaire consists of **three parts**.

Part 1: Questions 1 & 2 make up Part 1, where I am interested in some basic information about the participant.

Part 2: Questions 3 & 4 make up Part 2, which is a **self-efficacy test**. In this test, I am interested about the way the participant feels about his/her teaching and/or may include other factors that might affect his/her teaching.

Part 3: Questions 5, 6 and 7 make up Part 3, where the questions are more specific. Here, I am interest to find out a little bit more about the participant's journey as a science teacher – the challenges and the rewards and what the future holds for him or her. I have also provided an additional space in Question 8, in-case he/she might have something else that they might like to add.

Secondly, I would like to request **30 minutes of your time** for an interview at a time that is convenient with you. I will be phoning you in the next few days as a follow-up to this letter to arrange an appropriate time and mode (either face to face or by telephone) for this interview.

All information collected will be used with confidentiality for the primary purpose described above. However, it may also be used for the purpose of other educational publications by the researcher otherwise as cited. An overview of the findings will be made available upon request from participating schools. The full thesis will also be made available online. All data collected will be stored in password protected offices at Victoria University and will be destroyed 3 years after the completion of the research.

The research has been approved by the Faculty of Education Human Ethics Sub-committee under delegated authority from the Victoria University Human Ethics Committee.

If you have any concerns about the way the research is conducted, please contact Dr Allison Kirkman (Allison.Kirkman@vuw.ac.nz), ph: 04 463 5676, Chair of the Human Ethics Committee, Victoria University of Wellington. Please feel free also to contact me at (margaret.vaka-vivili@vuw.ac.nz) or my Supervisor Dr. Louise Starkey (Louise.Starkey@vuw.ac.nz) to discuss the research and ask any questions. Otherwise, I will be in contact with you by telephone to confirm your participation before I send out the questionnaires.

I thank you sincerely anticipate for a favourable answer to my invitation.

Yours faithfully,

Signed:



Margaret Vaka-Vivili (Researcher)

Attachments:

1. Information sheet for participants
2. Teacher Questionnaire (Principal's copy)
3. Participant Consent form (Principal's copy)
4. Principal's consent form
5. Information about the Researcher
6. Participant Consent form
7. Information about the Researcher.

Appendix 5:

Participant Information Sheet



FACULTY OFFICE

FACULTY OF EDUCATION, TE WHĀNAU O AKO PAI

VICTORIA UNIVERSITY OF WELLINGTON, PO Box 17-310, Donald St, Karori, Wellington 6147, New Zealand

Phone + 64-4-463 9500 Fax +64-4-463 9649 Email education@vuw.ac.nz Web www.victoria.ac.nz/education

Participant Information Sheet (Questionnaire)

Dear Participant,

RE: The Future of Science Teacher Education in Tonga

My name is Margaret Vaka-Vivili from Victoria University of Wellington. I am currently researching the above topic for a Master's in Education and hereby like to invite your participation in this research by the above title. I am hoping that my research will provide valuable information and insight about the Science teacher education programmes, recruitment and retention practices and assist in better planning & facilitating science teacher education and the development of human resources overall.

I would like to invite your participation by completing the following written **Questionnaire or Survey**. The nature of the survey is '**totally anonymous**', therefore please **do not write your name or signature on any part of the questionnaire booklet**. You can **confirm your consent by placing a tick (✓) in the box on the consent form which is attached**. All Questionnaires are accompanied with a self-addressed envelope for its safe return to me at the address provided.

The **Questionnaire** consists of **three 3 parts**.

Part 1: Questions 1 & 2 make up Part 1, where I am interested in some basic information about you.

Part 2: Questions 3 & 4 make up Part 2, which is a **self-efficacy test**. In this test, I am interested about the way you feel about your teaching and/or may include other factors that might affect your teaching.

Part 3: Questions 5, 6 and 7 make up Part 3, where the questions are more specific. Here, I am interest to find out a little bit more about your journey as a science teacher – your challenges and rewards and maybe what the future holds for you. I have also provided an additional space in Question 8, in-case you might have something else that you would like to add.

All information collected will be treated with strict confidentiality, and primarily towards my thesis; however it may also be used for the purpose of other educational publications by the

researcher otherwise as cited. All information will be stored in password protected offices at Victoria University and will be destroyed 3 years after the completion of the research. An overview of the findings will be made available upon request from participating schools.

The research has been approved by the Faculty of Education Human Ethics Sub-committee under delegated authority from the Victoria University Human Ethics Committee.

If you have any concerns about the way the research is conducted, please contact Dr Allison Kirkman (Allison.Kirkman@vuw.ac.nz), ph: 04 463 5676, Chair of the Human Ethics Committee, Victoria University of Wellington. Please feel free also to contact me at (margaret.vaka-vivili@vuw.ac.nz) or my Supervisor Dr. Louise Starkey (Louise.Starkey@vuw.ac.nz) to discuss the research and ask any questions.

You are allowed to withdraw your participation at any time during the collection of these data. If you change your mind and do not wish to participate, please write **“Do not wish to Participate”**, and return the form to the Researcher at the above address.

I thank you sincerely for accepting my invitation to participate in the study and look forward to receiving your completed Questionnaire.

Yours faithfully,

Signed:



Margaret Vaka-Vivili (Researcher)

Attachments:

1. Information sheet for participants
2. Teacher Questionnaire (Principal's copy)
3. Participant Consent form (Principal's copy)
4. Principal's consent form
5. Information about the Researcher
6. Participant Consent form
7. Information about the Researcher.

Appendix 6: Teacher Questionnaire



FACULTY OFFICE

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VICTORIA UNIVERSITY OF WELLINGTON, PO Box 17-310, Donald St, Karori, Wellington 6147, New Zealand

Phone + 64-4-463 9500 Fax +64-4-463 9649 Email education@vuw.ac.nz Web www.victoria.ac.nz/education

TEACHER QUESTIONNAIRE

The Future of Science Teacher Education in Tonga

Instructions:

1. Please place a tick in the Participant consent form before you begin writing.
2. This Questionnaire is totally anonymous targeting ALL Science teachers. Participants **PLEASE NOT TO WRITE YOUR NAME** on any part of this booklet due to its anonymous nature.
3. Please indicate your answers by placing a “tick the appropriate box” and write in the space provided.
4. Please place your completed questionnaire booklet in the return of the self-addressed and stamped envelope and return via air mail post to the Researcher.

Assurance:

1. All information collected will be used for the purpose described above, and may also be used for the purpose of other educational publications by the researcher otherwise, as cited.
2. An overview of the findings will be made available to participating schools upon request.

I thank you sincerely for your kind assistance in completing this survey.

1. (i) **ABOUT YOURSELF**

| | |
|----------------------------|-----------------------|
| Gender: (Please circle) | Age: Please tick (v) |
| Male | Between 18 – 25 years |
| Female | Between 26 – 44 years |
| Nationality _____ | Between 45 – 65 years |

(ii) Why did you choose to become a teacher?

(iii) How many years have you been teaching Science? (Please circle)

Under 1 year 1-3 years 4-6 years 11 -15 years 16 -20 years 20+ years

(iv) How many years have you been teaching at this present school? (Please circle)

Under 1 year 1-3 years 4-6 years 11 -15 years 16 -20 years 20+ years

2. EDUCATION

Complete this table to indicate your academic qualifications gained since leaving school.

| Qualification obtained | Institution | Year | Number of Years of study | Science content studied |
|------------------------|-------------|------|--------------------------|-------------------------|
| | | | | |
| | | | | |
| | | | | |

3. YOUR TEACHING

(Please indicate with a tick (✓))

| How confidently can you do the following: | | Very confidently | Quite confidently | A little Confidently | Not so Confidently |
|---|---|------------------|-------------------|----------------------|--------------------|
| 1 | Explain science themes in a way that all students can understand. | I | | | |
| 2 | Get all students interested and wanting to learn about science | M | | | |
| 3 | Involve the parents and cooperate with them in their child's learning. | P | | | |
| 4 | Successfully use several teaching techniques to meet school /departmental requirements. | C | | | |
| 5 | Adapt planning and teaching to meet individual needs. | A | | | |
| 6 | Maintain discipline in any school class or group of students. | D | | | |
| 7 | Find adequate solutions to conflicts of interest with other teachers. | C | | | |
| 8 | Provide good instruction and explanation of theory to all students, regardless of their level of ability. | I | | | |
| 9 | Teach students with challenging behaviours and keep them participating in the lesson. | D | | | |
| 10 | Stir up a desire to learn science in all students. | M | | | |
| 11 | Provide realistic challenges for all students in mixed ability classes. | A | | | |
| 12 | Provide a simple answer to a science problem which students might be finding difficult. | I | | | |
| 13 | Collaborate constructively with parents of students with challenging behaviours. | C | | | |
| 14 | Get all students to follow classroom rules and procedures. | D | | | |
| 15 | Get students to do their best even when some science problems appear too hard. | M | | | |
| 16 | Explain subject matter so that most students can understand the basic science principles. | I | | | |
| 17 | Manage the lesson regardless of how the students are grouped in the class. | C | | | |
| 18 | Adapt teaching techniques and practical experiences suitable for all students of including both gender. | A | | | |

| | | | | | |
|----|---|---|--|--|--|
| 19 | Get all students to behave politely and respect the teachers, members of clergy and other members of the public. | D | | | |
| 20 | Manage teaching even if there is a change in the curriculum is or lack of resources. | C | | | |
| 21 | Motivate students who show low interest in learning science. | M | | | |
| 22 | Co-operate effectively and constructively with other teachers, for example, in teaching teams or professional teacher associations. | P | | | |
| 23 | Organise classroom work so that both low- and high- ability students learn through tasks that are adapted to their abilities. | A | | | |
| 24 | Teach well even if you are instructed to use methods that would not be your choice. | C | | | |

4. YOUR THOUGHTS (Please indicate with a tick (v))

| Do you agree or disagree with the following statements? | | Strongly Agree | Agree | Neither | Disagree | Strongly Disagree |
|--|--|-----------------------|--------------|----------------|-----------------|--------------------------|
| 1 | Preparations for teaching should be done after working hours | T | | | | |
| 2 | I am free to choose the teaching methods and strategies I use daily | A | | | | |
| 3 | I feel that the parents of my students trust my teaching | P | | | | |
| 4 | My teaching is often disrupted by students who lack discipline | D | | | | |
| 5 | I can always seek help and advice from the school leadership, in educational matters | S | | | | |
| 6 | Life at school is so hectic and that there is no time for rest and recovery | T | | | | |
| 7 | I feel free to decide what content to focus on in science. | A | | | | |
| 8 | If the pupils have not learned discipline at home, there is not much the school can do | E | | | | |

| | | | | | | |
|----|---|---|--|--|--|--|
| 9 | Meetings, administrative work and documentation take up much of the time that I need for preparing lessons. | T | | | | |
| 10 | A teacher cannot do much to improve students' achievements | E | | | | |
| 11 | My students' parents are easy to work with. | P | | | | |
| 12 | Some students with challenging behaviour problems make it difficult to carry out lessons as planned. | D | | | | |
| 13 | My relation with the principal is one of mutual trust and respect. | S | | | | |
| 14 | I feel I can influence my working condition. | A | | | | |
| 15 | Parents trust and accept my decisions regarding their child's learning. | P | | | | |
| 16 | Controlling students' behaviour takes a lot of time and effort. | D | | | | |
| 17 | A teacher cannot do much to improve the achievements of students who have low ability in science. | E | | | | |
| 18 | My school leadership is supportive and my praise good work. | S | | | | |

5. Name three challenges in your science teaching that lowers your job satisfaction?

- (a) _____
- (b) _____
- (c) _____

6. Name three most rewarding aspects of being a science teacher.

- (a) _____
- (b) _____
- (c) _____

7. Would you rather be in a different job than teaching? Why?

8. Name some circumstances that might prompt you to leave teaching;

9. **Any other Comments.**

(Please feel free to make any further comments)

Thank you very much for your participation

Explanatory Notes:

1. Table 3: **Your Teaching** is to test **self-efficacy** in relation to **their teaching** (adapted from; Skaalvik & Skaalvik, 2010).

The questions have been divided into 6 themes;

I = Instruction

A = Adapting to individual needs

M = Motivating students

D = Keeping Discipline

P = Cooperating with colleagues and parents

C = Coping with changes and challenges

I have inserted beside each question its coding letter. That will be removed before the final question is printed for the actual survey.

2. Table 5: **Your thoughts**; is also testing their **self-efficacy** in relation to their **perceived school context and external control**(Skaalvik, 2010; Betram, 2013; Brouwers & Tomic, 1999).

Those have been coded as;

T – Time, A- Autonomy, D – Discipline, S- Supervisory support, P – relation to parents and E- External control.

The letters will be removed before printing of the final questionnaire.

APPENDIX 7: Ethics Approval letter from Victoria University of Wellington



FACULTY OF EDUCATION
PO Box 17-310 Wellington 6012, New Zealand
Website www.victoria.ac.nz

24 October 2013

Margaret Vaka-Vivili
MEd student
Victoria University of Wellington Faculty of Education
C/- School of Educational Policy and Implementation
Donald Street
Wellington

Dear Margaret

RE: Ethics application SEPI/2013/67 RM 20310

I am pleased to advise you that your ethics application '**The Future of Science Education in Tonga**', with the required changes, has been approved by the Victoria University of Wellington Faculty of Education Ethics Committee. Please note that the approval for your research to commence is from the date of this letter.

Best wishes for your research.

Yours Sincerely

A handwritten signature in blue ink that reads 'J. A. Loveridge'.

Dr Judith Loveridge

Co-Convener
Victoria University of Wellington Faculty of Education Ethics Committee

APPENDIX 8: Ethics approval letter from the Office of the Prime Minister - Tonga.



PRIME MINISTER'S OFFICE
NUKU'ALOFA, TONGA

21st of January, 2014

Directors of Education
Church Schools
Tonga

To whom it may concern,

Re: Mrs. Margaret Vivili's Request to Allow Research in Science Education in Tongan
Church Schools

The Tongan Prime Minister's Office would like to endorse Mrs. Margaret Vivili from Victoria University in Wellingtons' initiative to conduct research with the Science Education in Tongan Church Schools. The Prime Minister's Office has supported Mrs. Vivili's research in 2013 where she carried out her research in Tongan Government Schools.

We would also like to take this opportunity to assure you that Mrs. Vivili has fulfilled all requirements stipulated in Cabinet Decision No. 410 from the 12th of May, 2011 needed to obtain a research permit from the Government of Tonga. We once again wish Mrs. Vivili the very best with her studies and hope for your cooperation during her time in the Kingdom of Tonga.

Sincerely,

A handwritten signature in blue ink, appearing to be 'F. Tuita'.

Hon. Fatafehi Tuita

For Acting Chief Secretary & Secretary to Cabinet



Appendix 9: Participant Consent Form (Research)



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The Future of Science Teacher Education in Tonga

Participant Consent Form (Research)

- I have had the above research topic explained to me
- I understand what would be required and agree to participate in the survey.
- I understand that my participation in the research is voluntary and I was given an opportunity to withdraw.
- I understand that my identity and the school's identity would be protected.
- I understand that I may withdraw my participation at any time during the data collection.
- I understand that all data would be stored in password protected computers at Victoria University and will be destroyed 3 years after the completion of the research.
- I understand that my responses will be used in strict confidentiality and may also be used in papers or presentations that are concerned with science teacher education.
- I consent to this invitation to be part of the research.
- I consent that I was invited and voluntarily chose on my own to be part of this research.

(Please tick (✓) the box if you agree).

Date: _____

Appendix 10. Principal's Consent Form for school to participate



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The Future of Science Teacher Education in Tonga

Principal Consent Form (Research)

- I have had the above research topic explained to me
- I understand what would be required of science teachers from this school who participate in the research.
- I understand that the science teachers' participation in the research is voluntary and that they may withdraw from it during the data gathering.
- I understand that the teachers' and school's identity would be protected.
- I understand that all data would be stored in password protected computers at Victoria University and will be destroyed 3 years after the completion of the research.
- I understand that participation is totally voluntary on the teachers' part and that they may withdraw their participation at any time during which the data is collected.
- I understand that teachers' responses may be used in papers or presentations that are concerned with learning and self-assessment and researching with children.
- I consent to science teachers being invited to be part of the research.
- I consent to my science teachers being invited to be part of this research.
- I consent to provide the researcher with any relevant information and school documents about the recruitment and on-going Professional Development of science teachers in my school.
- I consent that any information I provide as Principal will only be used in that regard and quoted accordingly.

Signed: _____ (Principal)

Date: _____

Appendix 11: Participant consent Form(Interview-Principals& CEO's)



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The Future of Science Teacher Education in Tonga

Participant Consent Form

Consent to participate in an Interview – Principals

- I have had the above research topic explained to me.
- I consent to provide the researcher with any relevant information about the training, recruitment, retention and on-going Professional Development of science teachers in my country.
- I understand that my participation in this interview is voluntary and that I was given an opportunity to decline.
- I understand that my responses will be used for the primary purpose of assisting the researcher towards her thesis and may be used in papers or presentations that are concerned with learning in science and science teacher education.
- I understand that all data would be stored in password protected computers at Victoria University and will be destroyed 3 years after the completion of the research.
- I consent to being invited to be part of the research.

Signed: _____ (Principal)

Date: _____

Appendix 12: Interview Schedule for Principals of Secondary Schools



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VICTORIA UNIVERSITY OF WELLINGTON, PO Box 17-310, Donald St, Karori, Wellington 6147, New Zealand

Phone + 64-4-463 9500 Fax +64-4-463 9649 Email education@vuw.ac.nz Web www.victoria.ac.nz/education

RE: The Future of Science Education in Tonga

Interview Questions for Principals of Secondary schools.

Recruitment of Teachers

1. How do you attract and retain science teachers to your school?
Prompts:
2. Have you ever had a shortage of science teachers? If so, how did you cater for that shortage?
3. Do you provide incentives to enable a science teacher to stay longer in your school?
4. Apart from Teacher's college and experienced teachers from the field, where else do you currently recruit teachers from?
5. Have you ever had to recruit science teachers from overseas to fill vacancies?
6. What are some challenges you experienced in attracting science teachers?
7. What are some challenges in retaining a science teacher at your school?

Quality of Science Teachers

1. How would you describe an "effective science teacher?"
Prompts: What qualifications do you think an effective teacher needs?
2. Are you satisfied with the overall performance of your students in science at F5, F6 and F7 so far?
3. How would you improve the overall quality of science teaching/learning in your schools?

Thank you very much for your time.

Appendix 13: Interview Schedule for CEO's of Education



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VICTORIA UNIVERSITY OF WELLINGTON, PO Box 17-310, Donald St, Karori, Wellington 6147, New Zealand

Phone + 64-4-463 9500 Fax +64-4-463 9649 Email education@vuw.ac.nz Web www.victoria.ac.nz/education

RE: The Future of Science Education in Tonga

Policy

1. What is your overarching policy on science education in Tonga?
Prompt: Explore for vision - aims & goals for science in secondary education system.
2. How do you recruit teachers to your schools?
Prompts: Where from, issues and challenges with supply of science teachers
3. Have you ever had a shortage of science teachers?
Prompt: How did you cater for that shortage?
4. Apart from Teacher's college and experienced teachers from the field, where else do you currently recruit teachers from?
5. Have you ever had to recruit science teachers from overseas to fill vacancies?
6. What are some challenges in attracting science teachers?
7. What are some challenges in retaining a science teacher in your school?

Quality of Science Teachers

1. How would you describe a "qualified and effective science teacher?"
2. What are your performance indicators of "adequate quality?"
3. Are you satisfied with the overall performance of your students in science at F5, F6 and F7 so far?
4. How would you improve the overall quality of science teaching/learning in your schools?

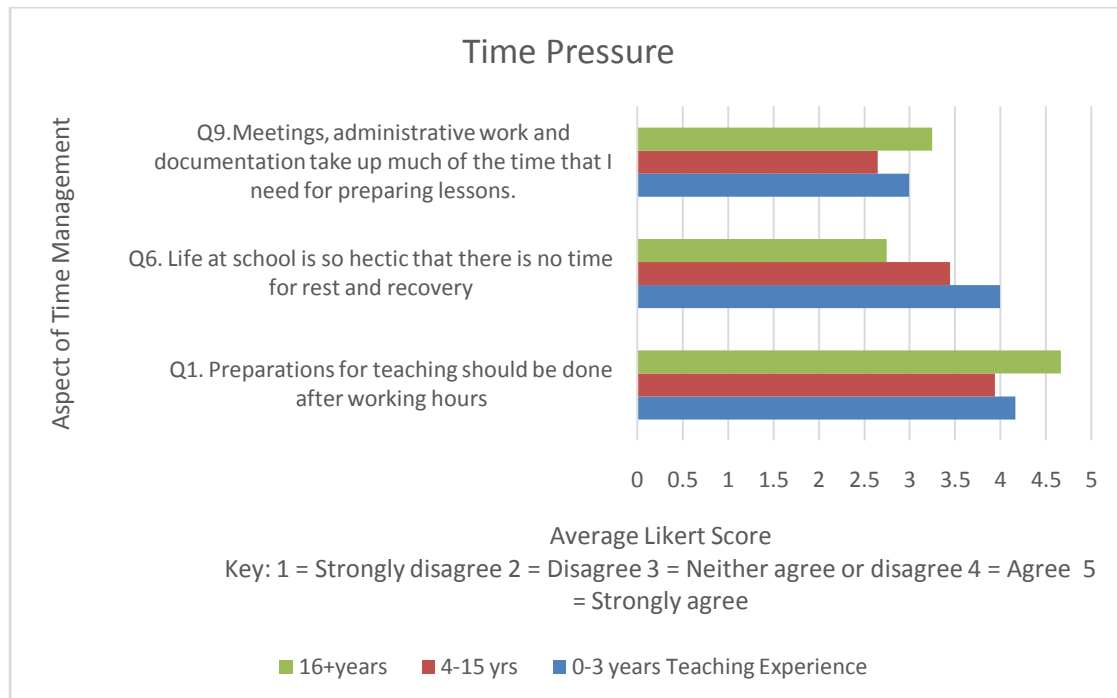
Professional Development/In-service Training

1. What is your current Professional Development programme for science teachers?
Prompt: How would science teachers qualify for professional Development or In-Service Training?
2. How effective do you believe the professional development of science teachers is?
Prompt: What outcomes would you expect and is this expectation realised?
3. On a scale of 1 -5, how important do you consider science in your school system? Why?
(1 being the least important and 5 being very important).
Prompt: Could you please name the five most important subjects in your schools? Why?

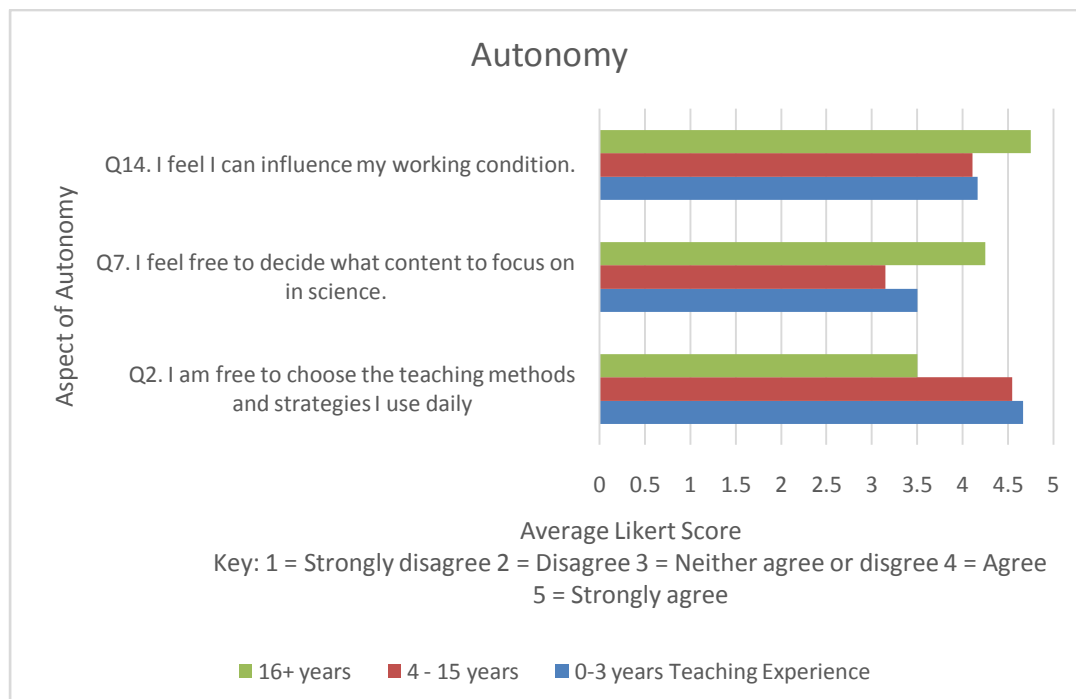
Thank you very much for your time.

Appendix 14. Individual Self-efficacy aspects tested

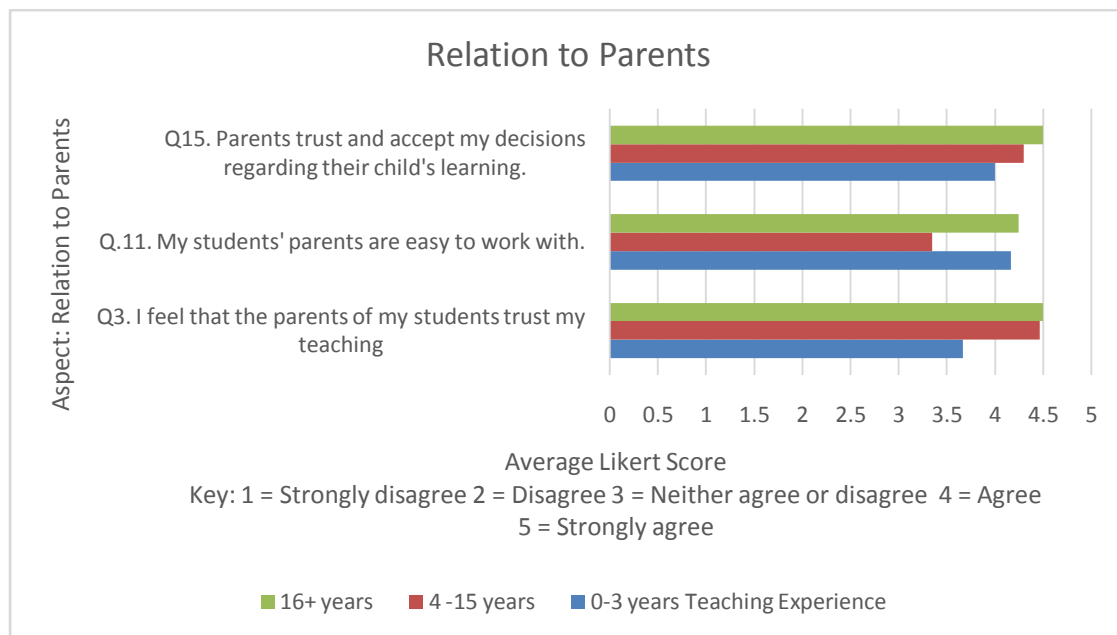
(i) Graph 1



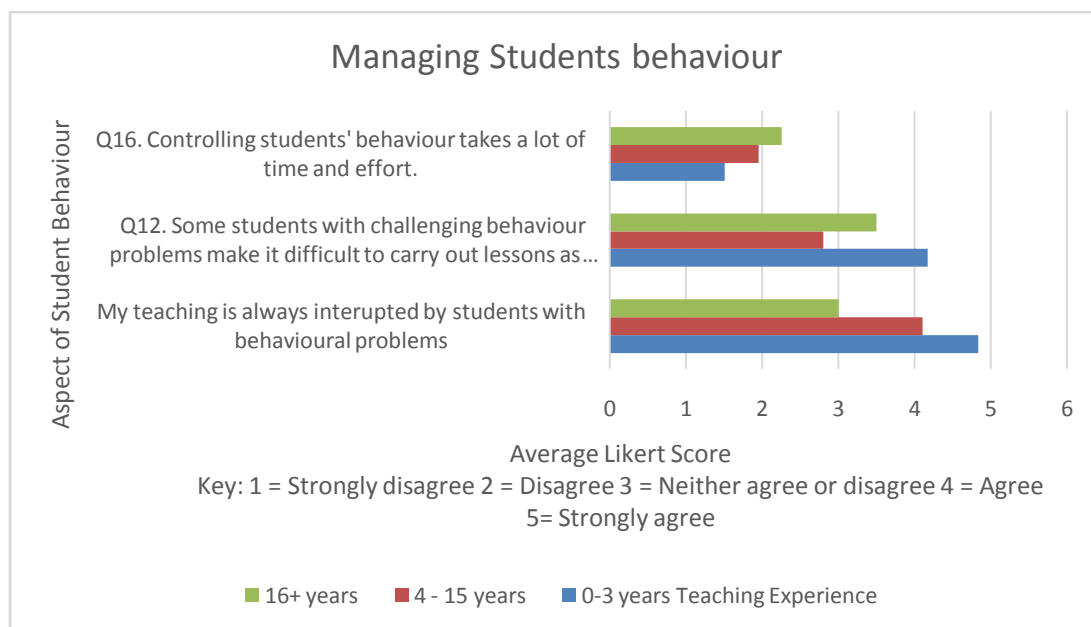
(ii) Graph 2



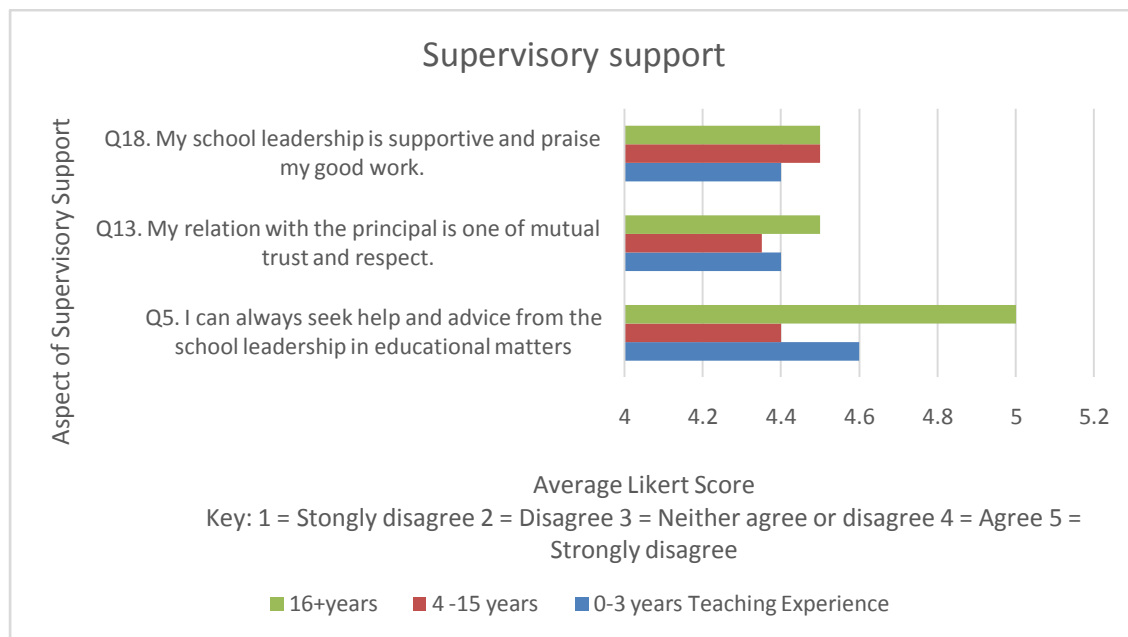
(iii) **Graph 3**



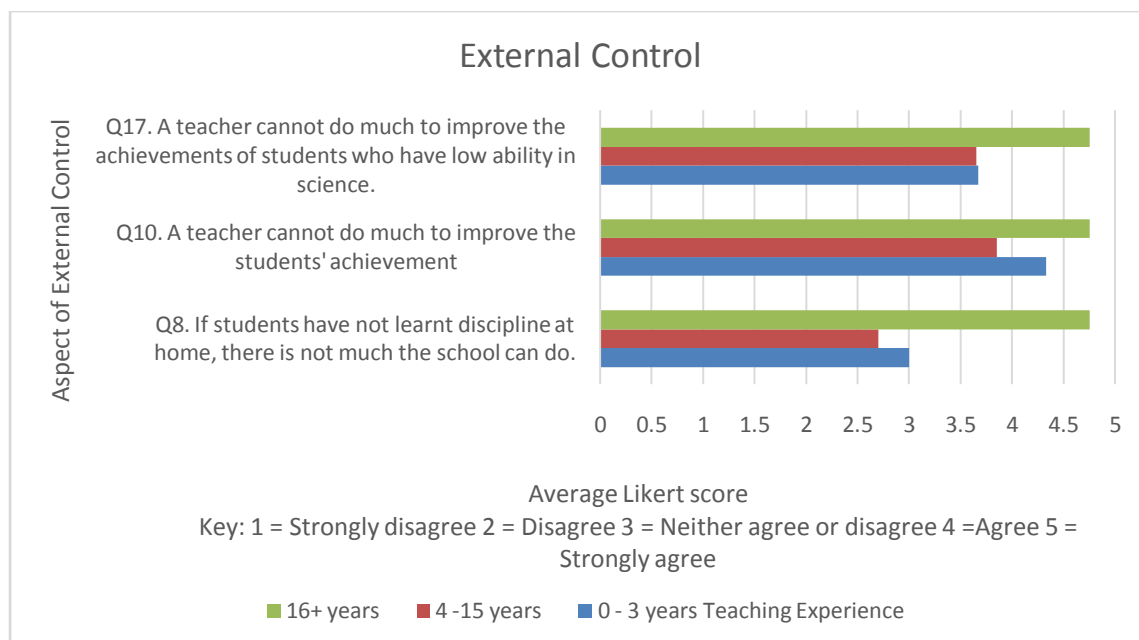
(iv) **Graph 4**



(v) Graph 5



(vi) Graph 6



APPENDIX 15: About the Researcher



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VICTORIA UNIVERSITY OF WELLINGTON, PO Box 17-310, Donald St, Karori, Wellington 6147, New Zealand

Phone + 64-4-463 9500 Fax +64-4-463 9649 Email education@vuw.ac.nz Web www.victoria.ac.nz/education

About the Researcher:



Kia Ora and Malo e lelei ,

Margaret Vivili is a science teacher/tutor/teacher educator who hails from Papua New Guinea, but now lives in New Zealand. She has served as a senior secondary science (Chemistry) teacher with the Api Fo'ou Catholic College & the Ministry of Education Women and Culture as a graduate science teacher, examiner/moderator of Science, for the Tonga school certificate and the Pacific Senior Form Seven Certificate (Chemistry). Her last role in Tonga was as senior Science lecturer – Physics & Science Education at the Tonga Institute of Education. Margaret has also been a Science (Chemistry) tutor with the University of the South Pacific-Tonga campus for 9 ½ years before moving to New Zealand.

In NZ, she has taught up to NCEA Level 3 Biology and is very familiar with both the NZ and Tongan/SPBEA science curriculums. Her on-going educational Research interests saw her serve the Ministry of Education (NZ) on their TIMMS (Trends in Mathematics and Science study) project in 2011 & the NMSSA project (National Monitoring Study of Student Achievement) with University of Otago in 2012.

Margaret is very passionate about teaching and learning in Science especially among Pacifica children and speakers of English as second Language; hence the importance of sound science teacher education and the purpose of pursuing this qualification. We very much appreciate your most valued assistance to her pursuits to document the data she is seeking for the enhancement of Science Teacher education in Tonga and the Pacific at the same time. We also hope that her findings will contribute to Pacifica education in the long term. Her physical address and contact details are provided below.

Malo aupito.