



Independent State of
Papua New Guinea

DEPARTMENT OF EDUCATION

**National Schools of Excellence
Policy : 2020**





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Department of Education

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Policy

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DEPARTMENT OF EDUCATION - NATIONAL SCHOOLS OF EXCELLENCE POLICY : 2020

Issued by the National Department of Education

Published in 2020 by the National Department of Education

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ISBN : 978 – 9980 – 909 – 49 - 7

National Library Service of Papua New Guinea

Acknowledgement :

The National Schools of Excellence Policy was compiled by the General Education Services Division of the Department of Education under the leadership of Mr. Walipe Wingi - Deputy Secretary, Schools and Education Standards Directorate, Mr. Andrew Angobe – Acting First Assistant Secretary, Provincial Services Wing, Mrs. Joyce Tepu – Assistant Secretary and Mr. Benny Rayappan – Director-Secondary Education & Management Coordination, General Education Services

The Department of Education Wishes to acknowledge the following people fo their support & contributions;

1. **Hon. James Marape**,MP – Prime Minister of Papua New Guinea, Member for Tari - Pori, who was instrumental in driving this policy since he was the Minister for Education (2009 -2011)
2. **Hon. Joseph Yopyyopy**, MP – Minister for Education & Member for Wosara - Gawi
3. **Dr. Uke Kombra** , Ph.D – Secretary for Education
4. **Dr. Clement Waine**, Ph.D – Technical Consultant on Policy Writing
5. **Committee Members** - National Schools of Excellence

Special word of thanks and appreciation to all who participated in the development of the Policy on National Schools of Excellence - 2020



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MINISTER'S STATEMENT

Papua New Guinea is facing three imperatives that require interventions

- (i) the advent of technology revolutions
- (ii) the need to develop a blended economy that is based on the extractive industries, knowledge, services and industrial productions
- (iii) the manpower with the relevant skills required to adopt these technologies to solve our existing problems and build a sustainable economy.

The government's intentions to reform the education system has been made abundantly clear through its policies encapsulated in the Development Strategic Plan 2030, Vision 2050, the Medium Term Development Plans 1/2/3 and standing National Executive Council decisions. These policies call for the Department of Education to introduce the School of Excellence Concept to the existing National High Schools and selected Secondary Schools and to reform their curriculum to achieve the policy objectives.

Science, Technology, Engineering and Mathematics (STEM) are at the heart of the technological innovations that are altering the global workplace and creating a huge gap between those countries that adopt them to improve their economies and those that fail to realize their impacts. STEM Education will allow PNG to bridge this technological and digital divide.

Through the introduction of the STEM Education the government intends to produce the next generation of man power that is agile at adopting the latest technological innovations and can interface with autonomous systems in order to drive the productivity and the efficiency of the economy. In an increasingly globalized world PNG has to operate in, it is also imperative that our Education System produces students that are globally competitive and employable anyway in the world.

This policy outlines the School of Excellence Concept and the STEM Education. It will define the contours of the reform intended to increase the production of highly skilled labor force entering the emerging labor market where the skills acquired through STEM Education is increasingly being sought after. Education must also aim to motivate and prepare students to pursue Humanities, Arts and Social Science courses in preparation for higher education and career in these fields.

The policy contains challenging proposals that require a multi-faceted stakeholder approach to achieve its intended objectives. Success of this policy will be a result of collaborative efforts between the Department of Education and relevant stakeholders.

The Secretary for the Department of Education and his team are highly commended for bringing this policy to the fore in preparation for its adoption and to kick start the needed reforms.

A handwritten signature in blue ink, appearing to read 'Joseph Yopyyopy'.

Hon. Joseph Yopyyopy, MP
Minister for Education

SECRETARY'S STATEMENT



The Department of Education has been tasked to introduce the School of Excellence Concept to the six National High Schools - Sogeri, Aiyura, Passam, Kerevat, Wawin and Port Moresby and selected Secondary Schools. The Concept will be implemented under the standing National Executive Council Decision and the other National Policies such as the Strategic Development Plan 2030 and Vision 2050.

The advent of technological innovations has altered the global work place in unimaginable ways. Papua New Guinea (PNG) is not spared from this onslaught. Countries that have adopted latest technologies and modernized their economies are now pulling ahead of the rest. The technological innovations are driven by the knowledge in Science, Technology, Engineering and Mathematics or in the abbreviated form as STEM.

In accordance with the government's numerous standing policy intentions, I will now be introducing the School of Excellence and STEM Education to the National High Schools. This is a strategic intervention which is intended to ensure that the middle tier of the education system starts to produce students that are highly educated, knowledgeable and agile in their abilities to comprehend scientific concepts and improvise to create innovative tools to solve everyday problems. This is a first step in an effort to convert the national manpower from end users of technology to innovators, inventors and creators of technology to solve domestic and global problems.

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inventors and creators of
technology..

The development of this Policy has been the result of intensive work by the National School of Excellence Committee. The efforts of the Committee and all our other stakeholders who have contributed in one way or another to finalize this Policy are highly commended.

This Policy entails the rationale for introducing the Schools of Excellence Concept and the STEM Education. Humanities, Arts & Social Science (HASS) Courses will also be intergrated in the School of Excellence Curriculum.

I am pleased that this Policy is now completed and will pave the way for the implementation of the concept to begin. I call on all our stakeholders to come forward and assist us to successfully implement the concept.

A handwritten signature in blue ink, appearing to read 'Uke Kombra'.

Dr. Uke Kombra, PhD
Secretary

EXECUTIVE SUMMARY

The advent of technological innovations has altered the way commerce and trade is being conducted and work environment functions. Countries that have the wherewithal to adopt these technologies and integrate them into their everyday lives are excelling in their economic growth and prosperity and those that fail to recognize them are lagging.

The National Executive Council in recognizing the challenges technological innovations present and the glaring shortage of manpower in the scientific, technical and technological fields has directed the Department of Education, through a NEC decision in 2009, to introduce the School of Excellence Concept to the National High Schools and a select Secondary Schools. The policy presented here emanates from this decision and describes the School of Excellence and the STEM Education.

The Department through this policy attempts to gain three key objectives

1. Convert the National High Schools and a few Secondary Schools to Schools of Excellence;
2. Enroll the top five percent (5%) of the grade 10 students to the Schools of Excellence; and
3. Introduce the STEM Education.

The policy objectives and the principles underpinning the School of Excellence Concept are discussed in Chapter 3.

STEM is an acronym that stands for Science, Technology, Engineering and Mathematics. The STEM Education is intended to ensure students are grounded in the concepts of science and mathematics and use them to design tools and processes to solve everyday problems. It is essentially an intervention program aimed at ensuring that over time PNG emerges from an end user of technology to creator of technologies (especially the intellectual property ownership over technologies or their utilities) .

The STEM curriculum and why it is important are discussed in Chapters 5 and 6, respectively. The principles of STEM Education are stated in Chapter 7. Chapters 8 and 9 discuss the pathways to success and the institutional arrangements necessary to achieve the objectives of STEM Education.

1. POLICY STATEMENT

a. Technological advancement

Papua New Guinea is witnessing the surge in adoption of technological innovations in delivering solutions to many of her problems, such as drones, smart phones, satellite technologies, cloud-based computing, surveillance, national identification system, software and apps, etc. Whilst these solve some problems there are still many areas that require technological solutions which can be adopted from existing ones and customized to country-specific requirements or developed from the ground-up.

The advent of disruptive and sophisticated technologies that are deployed in the modern work environment is forcing countries world over to adjust their education system to meet this emerging challenges. Countries that adjust and adapt to this changing landscape thrive and dominate in global trade and those that are slow in changing their education curricula are lagging.

b. Economic imperatives

For economies that thrive on trading, building a blended economy is a matter of national security as it ensures stable growth and can withstand any external shocks. Economies such as South Korea, Singapore, Hong Kong, Taiwan, Malaysia and Thailand – the so-called Asian Tigers – have diversified from production/industrial based economic growth to knowledge and service-based economies. Taiwan is now focusing more on developing tools as a means for the next phase of economic growth. Although, Taiwan faced economic downturn in 2019 due to the tit-for-tat trade sanctions between China and USA, its exports of electronics and machine tools remain very competitive.

These Asian countries have emphasized science, technology, engineering and mathematics (STEM) as the core subjects in their schools and students coming through their education systems with these skills joined the labor force that drove their economies as they push relentlessly towards building a better society for themselves and in doing so altered the global economic and trading orders. The curriculums adopted by these countries have now become mainstream and popular and commonly referred to as the STEM curriculum.

Given that PNG is located within this dynamic Asian region where forty percent (40%) of the global trade is taking place and that the Asian region has set the pace in adoption of the STEM curriculum even before it became mainstream and popular globally, the government of PNG has recognized the need to reform its education system and to introduce STEM Education to its schools in order to meet the growing challenges the country is facing and to ensure PNG's economy is robust, competitive and remains in lockstep with the regional economies.

c. Blended Economy

It is the government's intention to build a blended economy based on production-based and knowledge-based economic growth. The knowledge-based economy is driven by the workforce with skills such as medical doctors, engineers, scientists, lawyers, economists, accountants, etc. acquired through university education and other tertiary institutions whilst the production-based or industrial economy is driven by the workforce with skill sets such as auto mechanics, plumbers, welders, boilermakers, electricians, carpenters, millwrights, machinists and machine operators acquired through the technical and vocational schools. Table 1 summarizes the economic components and their main drivers for economic growth.

Table 1: Economic Components and their main products

Economic component	Product	Education System*
Knowledge-based	Innovations, inventions and intellectual property rights	STEM
Production-based	Import replacement and exports	STEM and TVET
Service-oriented	Customer services (tourism/hospitality, medical services, etc.)	STEM, TVET and HASS
Tools-based	Precision machine tools for high value products; tools are also required for productivity and efficiency gains	STEM and TVET

* Education system:

STEM = Science, Technology, Engineering and Mathematics

TVET = Technical and Vocational Education and Training

HASS = Humanity, Arts and Social Sciences

The government has taken several steps through its policies to address the rapidly emerging gap between the need to build a blended/diversified economy that is resilient and remains in lockstep with the economies of the region as well as the shortage of labor force with the relevant skill sets to drive the economic engine for growth. It has directed for the STEM Education to be introduced in the education system.

The government also recognizes that the country has several comparative advantages that can be harnessed to build a robust and blended economy.

d. School of Excellence Concept and STEM Education

In accordance with the government's expressed desire to ensure a resilient economy that is driven by technological innovations and a skilled labor force, the National Department of Education is now planning to undertake two strategic interventions –

1. Upgrade the existing National High Schools and a select Secondary Schools under the School of Excellence Concept; and
2. Introduce the STEM Education and Curriculum under the School of Excellence Concept as an intervention strategy aligned with the government's intention to produce the next generation of labor force with the necessary skills in STEM to drive the next phase of economic growth.

e. PNG's comparative advantages and inherent constraints

Papua New Guinea has unique comparative advantages which if properly harnessed can make the country a great economic powerhouse within the region. Some of these comparative advantages are outlined below. Unlocking the potential of the land and to position it amongst the richest nations within the region requires a critical mass of labor force that can translate the vision into reality. Government understands this requirement and realizes that the existing education system is not robust enough to turn out the next generation of labor force with the pertinent skills set required to operate efficiently in an ever changing economic and technological landscape.

If PNG's comparative advantages (Table A1) are fully appreciated then the STEM curriculum can be properly designed to fully develop and harness these advantages to position the country to become an economic powerhouse in the region.


On the contrary, there exist the inherent constraints that inhibits the growth and prosperity of the country (some of which are listed in Table A2). To grow a sustainable economy that caters for all citizens it is critical that the comparative advantages are harnessed on a sustainable basis and the inherent constraints are mitigated through adoption of technological solutions whether sourced internally from indigenous innovations or imported and modified for local conditions.

f. Assessment of the domestic labor market

There is an inherent domestic market weakness in the supply of STEM skilled labor force to meet the demand. From the supply side, there is a lack of scientific and technically qualified workforce produced annually by the tertiary institutions in the fields of health sciences, information technology, engineering, maritime fields, etc. On the demand side there is a pressing need to diversify the economic base and attract foreign direct investments to create demands for STEM related jobs and increase global market demand for STEM qualified graduates. Few pointers are mentioned below.

1. Domestic STEM skilled workforce

Papua New Guinea has, and will continue to remain deficient in STEM skill sets. A recent study of PNG's labour market by ExxonMobil revealed that PNG does not have the scientific, technical and technological capacity and most of the workforce will be recruited from abroad. The study identified that 10,000 scientific, 10,000



technological, and 20,000 technical workforces were needed for ExxonMobil's two Liquefied Natural Gas (LNG) projects. One of the factors impeding the country's progress in developing highly skilled workforce is that successive governments over the decades lack investment in science, technology and technical manpower needed to develop our natural resources. Many new investments in the extractive industry and other sectors of the economy today and in the future would continue to be faced with similar problems of shortages of skilled and technical manpower.

2. *Overseas STEM jobs.*

Globally, the demand for STEM jobs is outstripping the supply. Advanced economies, such as USA, could not produce sufficient STEM workforce to keep pace with demand. On the other hand, China is increasing its quantity of STEM workforce from 200,000 to 1.6 million within a decade and is exporting them. This demonstrates the need for investment in STEM education to develop a labour force that is capable of being exported overseas.

3. *21st century workplace challenges*

PNG's development aspirations in this century also signal the need for a major shift in the education curriculum to meet the growing demands of the economy for STEM skills. The increase application of automation in workplaces, globalization resulting in reduced barriers of entry and exit for firms in many economies, and flexible labour mobility across national borders, advances in technology in workplaces, are some of the challenges that requires the need for critical thinkers, inventors, and creators of tools and knowledge to solve the emerging local problems and challenges presented daily.

Moreover, STEM skilled workforce would enable the country to position itself to create domestic jobs, increase employment and business, retain income that would otherwise be spent on foreign labor, and export labor to the global market as a commodity.

4. *Higher returns in STEM jobs*

There is a growing body of evidence that STEM jobs pay higher returns than jobs in other fields. The higher returns can be very beneficial both to the individual concerned and the economy. In a country like PNG, one working class person supports numerous others, in towns and villages. Remittances to families at home to meet customary obligations and other personal wealth creations can be undertaken where one works in higher return jobs. The multiplier effect in the economy can be huge. STEM jobs generate such higher returns that could help produce high multiplier effects within the economy. Whether the individual works in PNG or is employed overseas, there are higher returns associated with jobs in STEM fields.

5. *Diversification of the economic base*

Papua New Guinea does not have a strong, dynamic, competitive, and a diversified economic base, particularly in manufacturing, science, technological, technical, extractive industries (minerals and hydrocarbons), marine products, and services. This can be attributed to a lack of or non-existence of highly skilled manpower needed to support the growth of such industries where they exist, and or generate new industries, where the opportunities exist. An educated labour-force and plentiful supply of STEM labour force in particular could be a driver for the diversification of the economic base. The PNG economy therefore could not be competitive in the region and at the international level.

6. *Education curriculum restructuring*

It is recognized that the current education system is not producing the required skills that meets the demands of the domestic labour market. There are myriad of reasons associated with this, one of which is largely the past and current education systems at post primary levels failing to equip the students with the requisite knowledge for entry into university and postgraduate studies. This is because the role of post primary institutions is preparing young people to supply higher education institutions with first-rate scholars crucial to supply the skilled workforce required for the country's development. However, this is not the case and it is evident in the large number of foreigners holding scholarly jobs, including highly technical and scientific jobs at managerial levels. The government has an important role to ensure that a sufficient number of people are graduating from within PNG, as well as overseas, to fill such gaps. The current annual enrolment and graduate output in the fields of sciences, technology and humanities are inadequate to match the current demand created by new investments and an ageing workforce.

Introduction of STEM curriculum is a deliberate attempt to address the supply side of the labour market, by producing quality and competent graduates that meets domestic needs as well as generate a pool of competitive and highly qualified and marketable graduates for the overseas labour market.

2. POLICY DOCUMENT AUTHORITY

The government's intention to undertake the required reform to make PNG's economy highly competitive within the region has been made abundantly clear through its various policy initiatives. These policy statements are summarized below.

a. Standing NEC Decisions

In 2009, the National Executive Council (NEC) in its meeting in Wabag, Enga Province, approved the School of Excellence concept. The NEC endorsed Sogeri, Passam, Kerevat, Aiyura, Port Moresby and Wawin National High Schools and Kabiufa Secondary School to begin the School of Excellence concept. The Department of Education was tasked to immediately start work on the concept.

The government, at the time, was concerned that despite huge investment in education over the last decades the country lags behind on improving high level of excellence in sciences (chemistry, physics, and biology), mathematics, and information and communication technologies. It realized that there was not much investment in developing the highly skilled and technical workforce needed to develop the country's natural resources as well as the skill sets needed for agriculture, fisheries, arts, crafts, dancing and music. The introduction of School of Excellence has the potential to produce and transform the country into one of the highly scientific and technological countries in the world. School of Excellence is therefore the school of the future.

b. Constitutional and Enabling Legislative Authority

This Policy initiative is developed consistent with the National Goals and Directive Principles, especially the Directive Principle 1 which espouses Integral Human Development, and the enabling powers of the Secretary for Education under the Education Act 1983, taking into account the NEC Directive of 2009.

In particular, Section 4(1)(a)-(d) of the Education Act 1983 provides for the Objects of the National Education System as stated hereunder:

"

(a) for the integral human development of the person;

(b) to develop and encourage the development of a system of education fitted to the requirements of the country and its people; and

(c) to establish, preserve and improve standards of education throughout the country; and

(d) to make the benefits of such education available as widely as possible; and

(e) to make education accessible to the poor and physically, mentally and socially handicapped as well as those who are educationally disadvantaged,

As far as this can be done by legislative and administrative measures, and in such a way as to foster among other things, a sense of common purpose and nationhood and the importance and value of education at all its levels.

.....”

Moreover, the *Education Act* 1983 provides for the Secretary’s roles and functions relating to the education sector. Amongst other powers, *Section (28)(j)* provides that the Secretary has power to perform any other functions which are necessary or convenient for carrying out, or which are ancillary to, the functions set out in *Section 4*.

c. Development Strategic Plan 2030

The Development Strategic Plan 2030 (DSP 2030) recognizes the need to overhaul the education system in order to provide quality education that will produce manpower to contribute to a “high and sustained growth and development”

The Plan advocates for curriculum reforms to be instituted at all levels of schools to ensure that students are conversant with the core subjects including mathematics, information and communications technology and sciences.

d. Vision 2050

This Plan outlines major initiatives expected to be undertaken in the education sector to achieve universal and quality education in the longer term. This canvasses expanded educational infrastructure and institutions, public-private partnership arrangements for delivery of education, revised curriculum to include other subjects of significance to learners, as well as improvement of teachers and academics employment conditions and Teacher to Student ratio to be reduced to 1:30.

e. National Education Plan (2015-2019)

The NEP 2015–19 is designed to give everyone in Papua New Guinea, regardless of their ability, gender or socio-economic background, an opportunity to be educated and to transform their lives, using a holistic, inclusive and integrated approach.

f. Medium-Term Development Plans II & III (2018-2022) MTDP III Vol. 2 pg 41 - 43

The MTDP II and III places priority on quality education with certain targets being outlined for achievement. Whilst MTDP II has lapsed, it shows the government was keen to establish Schools of Excellence in every province, an increase from six that NEC approved earlier in 2009.

g. Education Sector Strategic Plan 2010-2030

This Plan talks about ‘access, teachers and teacher education, curriculum, system management and planning, technical and vocational education and training.

3. NATIONAL SCHOOLS OF EXCELLENCE

a. The Concept

The National Schools of Excellence is a strategic intervention to develop the manpower requirement to meet the developmental challenges of the new century and to position the country to advance well into the next. It is being developed in accordance with standing government decisions and policies as advocated for in the nation’s development strategic plans. It is the intention of the government to create the next generation of highly skilled workforce that will participate not only as end-users but innovators and creators of scientific and technological inventions and innovations that solve the country-specific problems as well as those of the global economy.


The School of Excellence is... to develop...the next generation of highly skilled workforce that will participate not only as end-users but innovators and creators of scientific and technological inventions and innovations...

The National Schools of Excellence Concept is being developed and implemented under the standing NEC Decision and in accordance with the *Education Act* (1983), especially Sections 4 and 28, which empowers the Secretary to develop policies and plans for the growth and expansion of schools in the country. It is anticipated that the implementation of this Concept will increase the throughput of highly qualified students and subsequently labor force in the fields of Science, Technology, Engineering and Mathematics (STEM). The emerging labor force will drive the goals of making PNG one of the highly scientific and technologically advanced economies in the world.

b. Policy Implementation

The Government’s vision envisages a vibrant, healthy, wealthy and a smart society by 2050 (Vision 2050). This is a desired state of the future, a dream which cascades into the DSP 2030 and the MTDP 2011-2015. This calls for PNG to build its capacity in research, science and technology. There are fundamental principles or ideologies that inform and support the practices of the School of Excellence concept that will be true today and for many years.

In accordance with the standing NEC Decision, the National Department of Education is tasked to implement the following resolutions:

- 
- i. Convert the existing National High Schools and a select Secondary Schools to Schools of Excellence;
 - ii. Select the top five percent (5%) of the students coming out of high schools to enter the Schools of Excellence; and
 - iii. Introduce curriculum that are compatible with the international best practices, infrastructure standard, staff qualifications, teachers' pay structure, and student behavior and quality.

The STEM Curriculum will be adopted for the Schools of Excellence but tailored to meet the development objectives of PNG and to fully harness the comparative advantages of the country.

c. Policy Intent

The implementation of the policy will ensure the achievement of the following specific objectives:

1. Produce highly intelligent students capable of entering tertiary institutions and seek employment both in country and abroad to pursue further studies in their respective fields.
2. Create highly competitive schools with coherent emphasis on ethical and Christian values for quality character building.
3. Promote national unity, nationalism and patriotism.
4. Foster schools with research focus on innovation and invention.
5. Focus on establishing and maintaining high standard of professionalism outlook.
6. Establish higher standard and benchmark for fair and just competition.
7. Promote self-actualization and realization of talents, skills and abilities.
8. Prepare and link students to highly specialized job markets.
9. Provide model, advanced and internationally competitive learning environment.
10. Promote highly motivated staff and students to excel.

d. Principles/ Policy Rules

The National Schools of Excellence Policy is informed and guided by the following principles:

i. Excellence

Provide excellent and conducive learning environment to enhance the ability of students to be intellectually competent nationally, regionally and internationally.

ii. Ethics and values

Instill and uphold strong discipline in students and staff to maintain good behavior and enhance peaceful and harmonious relationship amongst the school and community. Strong ethics and values should be maintained at all times for it is an integral part of a person's life and this is to mould and shape people to have concern and respect others.

iii. Standard

Create an enabling environment of high standard in all aspects of instructional programs, academic performance, leadership and management that will entail high level of achievement.

iv. Equity

Provide equal opportunity to students who meet the requirements regardless of gender, disability, geographical isolation, ethnicity, religion, and culture.

v. Leadership

Demonstrate dynamic and lively leadership, management and administration qualities to influence aspiring young leaders who are able to contribute meaningfully to the growth of the nation. The teaching and working staff should demonstrate quality and effective leadership and illustrate excellent role models to aspiring vibrant young leaders who will emulate these qualities.

Prepare and develop highly motivated and innovative students who will become vibrant and transformational leaders who will then inspire and influence followers to rise above their self-centered needs and goals.

vi. Cultural identity

Promote and uphold cultural values and norms in the schools to preserve our heritage. Students have pride in themselves, know their origin, respect and appreciate diverse cultures.

vii. National identity and unity

Promote and advocate for national identity and unity through various activities in collaboration and partnership with community and other stakeholders in order that there is peace and harmony.

viii. Research oriented

Encourage and promote strong research-based activities and outcomes to stimulate innovative and strategic thinking to contribute to inventions, innovations and imitations.

ix. Specialization

Offer specialized programs to promote and enhance scientific, technological, and technical fields of study.

e. What about the next categories of students?

The next category of students that do not qualify to enter the School of Excellence will follow a separate path that leads them to Provincial and District Schools of Excellence, other secondary schools or technical and vocational trainings. These students are still expected to reach tertiary colleges and universities. The diagram below (Figure 1) explains the path students could take to reach tertiary level education.

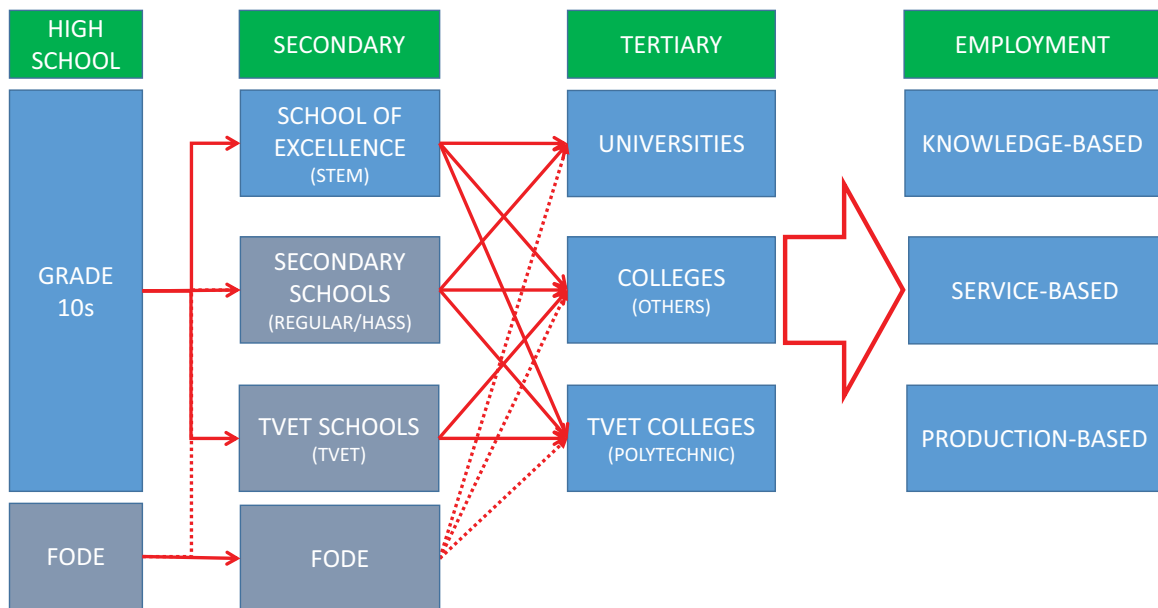


Figure 1: Schematic diagram showing the possible paths students could take as they progress through their education. The School of Excellence will be teaching the STEM curriculum while the other Secondary Schools teach regular and HASS courses and TVET Schools teach TVET courses. After TVET Colleges students can choose to enroll at Universities. The FODE program is added in this diagram but is not discussed in this policy. Overseas enrolments are not considered at this stage.

f. Provincial and District Schools of Excellence

There will be dedicated Provincial and District Schools of Excellence. The next tier of graduating grade ten (10) students that do not qualify to enter the National Schools of Excellence program can be selected to these schools by the Provinces and/or the Districts. These schools will teach the current secondary schools curriculum.

g. TVET and HASS

The other Secondary Schools that are not part of the National Schools of Excellence program will continue to teach the standard science courses and Humanities, Arts and Social Sciences (HASS) courses whilst TVET Schools will continue to teach the TVET programs.

Further reforms in future will include dedicated National Schools of Excellence to teach Humanities, Arts and Social Sciences (HASS) as well as those that will teach TVET courses.

4. RESPONSIBILITY FOR IMPLEMENTATION

To qualify for the prestigious National Schools of Excellence Program, the following minimum standards must be in place and adhered to at all times.

a. Minimum operating standards

The following standards to be applied to National Schools of Excellence (NSoE) Program are consistent with the National Qualification Standards Framework developed for the Department. These are **School Leadership**, **School Environment**, **School Management** and **Learning Outcomes**.

i. School Leadership


- a. Teachers teaching in the NSOE must be qualified to teach proficiently, to ensure a high degree of performance standard is achievement and maintained.
- b. The requirement is a master's degree in a specific discipline with pedagogic qualification and experience.
- c. ICT/computer knowledge, understanding and use will also be an essential requirement for teachers in the NSOE. Teachers must possess a certificate in computing or will undergo an advanced computer test to determine their skills in computing.
- d. Highly motivated staff and students to excel and prepare and link students to highly specialized job markets.

ii. School Environment

- a. The school environment must be highly competitive with coherent emphasis on ethical and Christian values for quality character building.
- b. Schools will provide equal opportunity to students who meet the requirements regardless of gender, disability, geographical isolation, ethnicity, religion, and culture.
- c. Promote and uphold cultural values and norms in the schools to preserve our heritage. Students have pride in themselves, know their origin, respect and appreciate others
- d. Provide excellent and conducive learning environment to enhance the ability of students to be intellectually competent nationally, regionally and internationally.
- e. Promote and advocate national identity and unity through various activities in collaboration and partnership with community and other stakeholders in order that there is peace and harmony.
- f. Promote national unity, nationalism and patriotism.
- g. Provide model, advanced and internationally competitive learning environment.
- h. The International English Language Testing System (IELTS) is designed to assess the language ability of candidates who need to study or work where English is used as the language of communication. IELTS is recognized by and required for entry to university in the UK and many other countries.

iii. School Management

- a. Demonstrate dynamic and lively leadership, management and administration qualities to influence aspiring young leaders who are able to contribute meaningfully to the growth of the nation. The teaching and working staff should demonstrate quality and effective leadership and illustrate excellent role models to aspiring vibrant young leaders who will emulate these qualities.
- b. Prepare and develop highly motivated and innovative students who will become vibrant and transformational leaders who will then inspire and influence followers to rise above their self-centered needs and goals.
- c. Instill and uphold strong discipline in students and staff to maintain good behavior and enhance peaceful and harmonious relationship amongst the school and



community. Strong ethics and values should be maintained at all times for it is an integral part of a person's life and this supposed to mold and shape people to have concern and respect others.

- d. Create an enabling environment of high standard in all aspects of instructional programs, academic performance, leadership and management that will entail high level of achievement.

iv. Learning Outcomes

- a. Produce highly intelligent students capable of entering tertiary institutions both in country and abroad to pursue further studies in their respective fields. Only the top 5% of the country's best performing students in the Secondary Schools will be selected for the National School of Excellence. This will be determined by the Grade 10 National Examinations results, students will be ranked and the top 5% will qualify for NSOE.
- b. High achievements for students selected from two sets of entry tests administered to determine if the students can perform exceptionally well in the National School of Excellence, students attempting the entry tests must pass all to qualify for the NSOE
- c. Best performing students in Mathematics, Science and Social Science Entry Exams set by the Measurement Service Division will be taken by those students selected for the National School of Excellence.
- d. Strong research-based activities and outcomes to stimulate innovative and strategic thinking to contribute to inventions, innovations and imitations.
- e. High standard of professionalism outlook.
- f. Establish higher standard and benchmark for fair and just competition.
- g. Promote self-actualization and realization of talents, skills and abilities.

5. STEM EDUCATION

a. What is STEM?

STEM is an acronym that stands for Science, Technology, Engineering and Mathematics. These will constitute the curriculum to be taught at the Schools of Excellence around the country. The courses will be designed to produce the labor force that will participate in fully harnessing the comparative advantages of the country and to participate in the new emerging job markets.

STEM education will use a blended learning model that combines traditional classroom teaching with online learning and hands-on practical activities. It will aim to give students the opportunity to experience different ways of learning through problem-solving.

b. STEM Curriculum

The STEM Curriculum obviously will encompass Science, Technology, Engineering and Mathematics. These core subjects are defined below.

Science

Science pertains to the systematic study of the structure and behavior of the physical and natural world through controlled experiment and observation. In the Schools of Excellence, students will be required to take focused classes in chemistry, biology and physics to a greater depth, with electives available in other subjects such as geology, meteorology, ecology and astronomy.

- **Chemistry**

Chemistry is the study of the composition, structure and properties of matter. It concerns itself with the elements of the periodic table and their subatomic compositions and how these elements fuse together to create new compounds through chemical reactions.

Students are expected to learn about chemical reactions, their stoichiometry and applications in everyday life.

- **Biology**

Biology is the study of living systems and how they organize themselves at molecular and cellular levels to function efficiently within a living organism and within an ecosystem. It encompasses studies on how genetic materials interact to decode genetic information and translate this to complex life forms, whether single celled organisms (e.g. amoeba) or complex forms like fish, birds or mammals (e.g. human

beings) and how these organisms interact within their ecosystems to create an environment to exist.

- **Physics**

Physics encompasses the science of matter, motion and energy. It concerns itself with trying to understand the interactions of sub-atomic particles that constitute matter as well as the expanding universe. Physics also attempts to explain how and why matters transition from one state of existence to another form.

Technology

Technology is the application of scientific knowledge and engineering concepts to create tools to solve everyday problems. These tools can be machines or simple processes adopted to improve daily lives. The basic goal of deploying technology is to achieve two fundamental goals – improve productivity and efficiency of any organization whether it is in a production plant, running an organization or governing a nation. Deployment of advanced tools allows an organization and a nation to maintain its competitive advantage. USA, for instance, utilized technology-based planning to emerge as the superpower after World War 2 and not economic-based planning. Its government identified companies whose core business was science-based and preferentially supported them to focus on research and development to generate intellectual properties and commercialize them to dominate global markets and propel USA into a superpower.

Students will be expected to utilize information technology to (i) write computer programs in different codes to solve existing problems or (ii) utilize the internet to study and understand how different technologies work. Students will also be encouraged to identify real life problems and propose solutions that utilizes either existing technologies or improves existing processes.

Engineering

Engineering uses the principles of science to design and develop new technologies, build structures and alter the environment to improve the quality of life (e.g. a hydroelectric dam) or extract/harness natural resources (e.g. a mine pit). Engineering classes might include topics like civil engineering, electronics, electrical engineering, mechanical engineering, and robotics.

Mathematics

The study of mathematics includes topics like number theory (e.g. integers such as prime numbers), structure (algebra), space (geometry), and mathematical analysis (such as calculus, functional analysis, algorithms that use numerical approximations).

c. STEM Lessons

The following six characteristics of an effective STEM Lesson have been described in an article that appeared in the Education Week Teacher.¹ These are listed below:

1. focus on real-world issues and problems
2. guided by the engineering design process
3. immerse students in hands-on inquiry and open-ended exploration
4. involve students in productive teamwork
5. apply rigorous math and science content
6. allow for multiple right answers and reframe failure as a necessary part of learning

It is anticipated that the STEM Lessons, as much as possible, will be geared towards solving some of the local problems, including harnessing the comparative advantages and mitigating the inherent constraints of the country.

d. How does STEM differ from the traditional education approach?

With the advent of modern technologies (such as computers, tablets and smartphones) knowledge is easily accessible to the new breed of students. They have at their disposal a plethora of tools (devices) and opportunities to broaden their learning scope unlike the past generations. In the past teachers and books in the library were the main domain of information. Today online libraries and information make learning so much easier. Students just “google” the information they need or the questions they want answered!

Although, the same classroom teachings may still be adopted for STEM education, the emphasis is on experiences gained by the students through experiments, testing out ideas and improvising to create new tools and processes to solve problems and scenarios at hand.

A simple comparison between the traditional curricula and STEM curricula is presented below.

1. Lectures vs Interactions

Traditional education system involves teachers choosing and presenting lectures on a topic. Students are required to understand the concepts and pass the test administered at the end. In STEM, students acquire knowledge from different sources and learn through interactions.

¹ https://www.edweek.org/tm/articles/2014/06/17/ctq_jolly_stem.html (accessed August 22 2019)



2. Theory vs Understanding

In traditional education students learn of certain concepts. In STEM education students are expected not only to learn the concepts but to understand why such concepts are necessary and how they apply to daily lives.

3. Replication vs Innovation

In traditional education a concept is presented by the teacher and students are expected to learn and simulate experiments under control conditions to derive an expected outcome. These are true and tried methods and leaves no room for innovation. In STEM education, however, students are expected to think freely, improvise and create new products by applying the concepts and utilizing the available resources.

4. Knowledge vs Applications

In traditional education knowledge is instilled in the students by the teachers. In STEM education students are expected to apply the concepts and knowledge to solve everyday problems.

5. Test vs Experiments

In traditional education the knowledge instilled in the students are tested at the end to assess them. In STEM education students are required to understand the concepts presented and apply them to real-life experiments and applications.

6. WHY STEM EDUCATION IS NEEDED

The common questions asked during consultation for this policy are “why School of Excellence and STEM education?” Chapter 3 deals with the question concerning the School of Excellence. As stated earlier the global economy is changing rapidly due to automation and advances in technology as well as globalization. These new realities mean that students will require STEM skills to compete for jobs, both here and abroad.

a. Emerging Job Markets

The emerging job markets globally require employees with higher level of complex skills and knowledge. Papua New Guinea is adopting STEM Education in order to train the next generation of labor force with the elevated levels of complex skills and knowledge required to compete at a global level as the country continues to push to build a very competitive economy.

b. Advances in Technology

Technologies are emerging much faster these days. Countries, companies or individuals that are unable to cope with them are lagging behind. There are eight technologies that have the potential to alter the global economy in ways we have not yet anticipated based on available research data and trends. These are:

- ❖ big data;
- ❖ satellites;
- ❖ robotics and autonomous systems;
- ❖ life sciences, genomics and synthetic biology;
- ❖ regenerative medicine;
- ❖ agri-science;
- ❖ advanced materials and nanotechnology; and
- ❖ energy and its storage.

c. Automation

The jobs that used to be performed by humans are now being increasingly replaced by robots and automated systems. The technology change we are about to witness are trending towards a more highly automated and computerized form, through the deployment of cyber-physical systems, big data and cloud computing. These systems are characterized by high levels of inter-operability between machines and people, large-scale aggregation of data and decentralized decision-making – greater automation and decision-making by cyber-physical systems. This has been described as the Fourth Industrial Revolution.

For employees the fast pace at which technology is evolving requires them to constantly upskill themselves to remain current and viable.

d. Globalization

Competition for jobs is now extended beyond national boundaries. Labor mobility is becoming a global phenomenon now. The PNG LNG Project has highlighted the need for highly skilled labor force that was not present in the country so these were brought in from outside. As other economies become cost competitive they are able to attract new investments that deploy advanced technologies for production. This brings with it the need for local talents and if these are not available they will be brought in from outside.

e. Culture of Innovation and Entrepreneurship

Countries that invest early in the research and development of these growth trends identified above are able to stake out their claims on the intellectual property landscape and commercialize their inventions and technologies to enhance the resilience of their economies. They will be dominating the global economic spheres during the life of their patents which is almost two decades.

For Papua New Guinea, STEM Education must result in creating a culture of innovations and inventions. An increased number of students must enter their respective fields of studies at the university level to undertake research with the view to innovate and secure their intellectual property rights to their inventions. These intellectual property rights can then be sold to market leaders and royalties can be derived as sources of income. Alternatively, the local researchers must be supported through incentives to commercial their inventions.

f. STEM as an Enabler of Growth

For knowledge-based sector of the economy to flourish in an increasingly competitive global market STEM-based skills and expertise are highly important and desirable. Technologies can be developed and deployed to increase output and productivity across a broad range of industries and the whole economy. The emerging job markets are increasingly tailored towards STEM qualifications and the average salaries for STEM skills are comparatively higher.

g. Workforce Demographics

The present workforce has passed the requirement for STEM qualifications but it has a duty to ensure it promotes the importance of STEM education to the next generation of work force entering the market or still in school.

Gender: Although the demographic composition of Papua New Guinea's population between male and female is on parity, women are historically always under-presented at all tiers of the education system as well as within the workforce. This disparity has always been present for various cultural and socio-economic reasons.

The traditional stereotypical gender biases and assumptions for type of work or roles that women and men perform is being slowly broken down but not at a pace that is required and expected. It is expected that through STEM education this stereotypical biases, perceptions and assumptions will be eliminated and that more women will enter the STEM-related fields.

Age: As stated above, STEM Education must be introduced to upstream school sooner in order to identify and nurture latent talents. Younger generations are more adept at adopting the latest technology faster than their parents.

Ethnicity: Papua New Guinea is facing a concentration risk from ethnic groups dominating a certain field of study. For instance, a certain province tend to dominate the fields of science and another province has an over-supply of labor force in law and business related fields. It appears that present efforts to diffuse this risk by forcing students to take up mismatched combination of courses (such as two courses of science and minor mathematics) at grade 12 and then forcing them out of science, as they do not qualify to enter science streams at universities, and into other fields should be discouraged. The School of Excellence, whilst aiming to recruit the top five percent (5%) of the grade 10s into the STEM Education must at all times be cognizant of this existing disparity and adopt strategies to mitigate without penalizing natural talents. This requires STEM Education to be introduced to the upstream high schools and primary schools much sooner to capture and nurture latent talent at an early age.

Geographic Disparity: Students from urban, semi-urban and rural areas face very different challenges and opportunities available to them and hence their choices will be impacted by these. Selections of students for entry into STEM education must take this into consideration and ensure discrimination due to geographical barriers are minimized. This is poignant because students from rural areas come from poor families.

h. Perceptions

There may be some misperceptions with the current arrangement within the existing National High Schools that will be converted to the Schools of Excellence to teach STEM Curriculum. The public must be made aware of the conversion of the schools and the curriculum they will be teaching. In addition to the traditional sciences (chemistry, biology and physics) and mathematics courses, new subjects in engineering and technology will be introduced. The contents of the traditional courses will also change.

i. Policy Drivers

There will be debates for and against regarding the introduction of this policy on School of Excellence and STEM education. It should be noted that the Department of Education has already delivered on several policy matters and these have already catered for some

of the major concerns. This policy is an intervention strategy to address the impending gap in the supply of labor market and consistent with the global trends and world’s best practices.

7. PRINCIPLES UNDERPINNING THIS STEM EDUCATION

STEM Principles

There are five main ideas that underpin the STEM Principles which are expected to help guide the Department, schools, leaders, teachers and key stakeholders to play a proactive role in providing a high-quality STEM experience for the future generations. These are enumerated below and described further in Table 2:

- a. ***Aligns with National Development ambitions*** - Supporting national development agenda to train and produce quality graduates in STEM fields.
- b. ***Inspiring a new generation of learners*** - Enriching and inspiring learners to be curious, inquisitive, critical thinkers and problem solvers to become inventors, innovators and imitators.
- c. ***Continuous pedagogy improvement*** - Support teachers in their profession through pre-service and in-service, up-skilling and re-skilling; and encouraging a culture of research and continuous improvement to pedagogy.
- d. ***Harnessing our comparative advantages*** - Improve the STEM learning environment and devise STEM teaching and learning approaches in Schools of Excellence to harness the comparative advantages of the country.
- e. ***Institutional arrangements*** – the success of STEM Education will be due to institutional and stakeholder support

Table 2: Principles of STEM Education

Principle	Description	Descriptor
Principle No.1 <i>Alignment with National Development ambitions</i>	STEM Education is founded on the long standing government’s strategic policies and legislations.	Standing NEC Decision for the establishment of the School of Excellence gives impetus for STEM to be given prominence and taught to the next generation of learners. Reference is also drawn from the DSP2030, Vision 2050, various National Education Plans and Policies, and the <i>Education Act</i> 1989.

<p>Principle No.2</p> <p><i>Inspiring a new generation of learners</i></p>	<p>STEM should inspire students to be inquisitive and curious, and adopt technologies to solve existing problems.</p>	<p>STEM education should encourage and enrich students to develop curiosity about classroom based learning and real world, and inquiry based activities. It should;</p> <ul style="list-style-type: none"> • encourage learners to be curious about the world they live in • be relevant to nation’s needs and aspirations • enable learners to develop skills to be active citizens, to be entrepreneurial, and be able to use modern communications to enhance wellbeing and make informed and ethical choices • be inclusive for all learners irrespective of their ethnicity, gender, abilities or socio-economic backgrounds • enable learners to make informed choices in their career paths.
<p>Principle No.3</p> <p><i>Continuous pedagogy improvement</i></p>	<p>STEM is geared to empower teachers improve pedagogy and using available teaching resources to impart knowledge to students.</p>	<p>STEM education supports teachers and students to improve high quality learning outcomes. It should;</p> <ul style="list-style-type: none"> • encourage a research atmosphere for teachers • use evidence based on practice in classroom to inform student learning, teacher pedagogy, and school management and leadership practices • motivate teachers to govern, and showing leadership and management examples to students within and outside classroom and school environments, to produce maximum learning outcome and experience for students • enhance teaching and classroom learning experiences for students and teachers through practical tasks and activities.

<p>Principle No.4</p> <p><i>Harnessing our comparative advantages</i></p>	<p>STEM is all about establishing a pathway for students to harness the nation’s comparative advantages and contribute to nation-building.</p>	<p>STEM education should enable;</p> <ul style="list-style-type: none"> • schools to prepare students to select career paths that harness our comparative advantages. • students to develop conceptual understanding of and interest across multi-disciplinary fields, allowing them to address both domestic and global societal issues. • students to have the opportunity to explore concepts and engage in problem-solving, while developing their knowledge and skills.
<p>Principle No.5</p> <p><i>Institutional arrangements</i></p>	<p>STEM is about ensuring the institutions and institutional practices and arrangements are current, and stakeholders are involved, in improving and advancing STEM education for nation building.</p>	<p>Successful STEM education depends on participation by stakeholders at all levels of the education system. STEM education should;</p> <ul style="list-style-type: none"> • motivate school and local communities to support learning environments of students to excel • inspire a collaborative approach by stakeholders towards improved learning outcomes • enable change in upstream and downstream curriculum development and pedagogy • generate a sense of nationalism and unity for students.

8. PATHWAYS TO SUCCESS IN STEM EDUCATION

The following challenges are identified as crucial to the successful STEM Education within the national education system.

Challenge 1: Ring Barking Strategy

The present intervention to introduce STEM curriculum to the National Schools of Excellence is a “ring barking” strategy. The success of this intervention will be dependent on the change to the curriculum of the elementary and high schools as well as the corresponding changes to the tertiary learning institutions (universities and colleges).

Challenge 2: STEM curriculum

The curriculum developed for the STEM Education and the teaching aids deployed for these courses will determine the success of the program and the quality of students graduating from the program.

Challenge 3: STEM Teacher workforce

Besides the requisite Master’s degree in a STEM-related discipline with pedagogic qualification and experience, STEM teachers must be adequately resourced to deliver course contents. Both pre-service and in-service programs must be introduced to ensure teachers have a firm grasp and command of the subject matter as well as to ensure teacher knowledge of the subject matter is harmonized through the various STEM schools. Some teacher’s aids can be provided through various available online resources.

Challenge 4: Introduction of STEM Education to high schools and universities

Given that the introduction of the National School of Excellence and STEM Education is a strategic intervention, any changes to the curricula of the high schools and universities/colleges will have to follow suit to ensure students come through a seamless curriculum of STEM Education.

High School Curriculum

Change to the high school curriculum could be gradual given the existing constraints in terms of both the geographical challenge impeding penetration and resources available. Provincial Education Boards must ensure students have early exposure and equitable access to the STEM Education.



University Curriculum

Blended courses

Universities will have to be prepared to receive the new generation of students coming from STEM background. In order to ensure a seamless flow of learning experiences for the students it is recommended for universities to offer new hybrid courses that blend different core subjects such as biochemistry or molecular biology instead of biology and chemistry separately.

Double majors

Students could also be allowed to undertake double courses majoring in a STEM-related disciplines and a minor in humanities or business.

Research degrees

One very practical suggestion is to introduce Bachelor of Philosophy (BPhil) programs where students can enter straight into tailored research degree programs which will take three years to complete and then spend an extra year to convert to Master of Philosophy (MPhil). Furthermore, students can continue to Doctor of Philosophy (PhD) for another three years to qualify. In this way there will be a high out put of students contributing to the national intellectual capital.

Entrepreneurship

Students entering research programs must be exposed to opportunities in entrepreneurship where intellectual properties can be created through their research and commercialized.

One measure of success for STEM Education is the number of intellectual property ownerships through patents, copyrights, trademarks or trade secrets.

9. ROLES AND RESPONSIBILITIES

All National School of Excellence plans and programs are guided by this Policy. To achieve the ultimate goal of this policy, the national goal and directive principles stipulated in the constitution, the Scientific, technological, technical workforce production, adoptability and adaptability initiated by the National Executive Council in 2009 in reference to Vision 2050, a clear understanding of respective individuals and organizational roles and responsibilities is required.

The following are Divisions of the Department of Education and other Government Departments who have part to play in the National School of Excellence:

a. The National Government of Papua New Guinea

The National School of Excellence concept was given birth to by the Government of Papua New Guinea through the National Executive Council. The Government will be committed to supporting and funding the implementation of the NSOE from its inception until maturity. Funding will be the main driving force for the growth and sustainability of the NSOE.

b. Department of Education (DOE)

The Department of Education is responsible for overseeing the overall management and implementation of the National School of Excellence Programs, and report to National Executive Council (NEC) on National School of Excellence through coordinating, monitoring and evaluating its activities. Its main responsibilities are to:

- * Ensure that the established standards for National School of Excellence are adhered to and maintained at all times
- * Approve and endorse National School of Excellence activities
- * Provide directions, guidance to all National School of Excellence implementing agencies
- * Provide adequate funding for National School of Excellence Programs
- * Develop efficient and effective strategies and control mechanism to support the management of National School of Excellence programs
- * Establish a National School of Excellence Management Committee and establish sub-committees to manage the National School of Excellence activities.


- * Develop and review the National School of Excellence Program/activity plans, guidelines, strategies and procedures periodically for improvement.
- * Develop an appropriate system for finance and budget.
- * Review Department structure to accommodate and enable the effective implementation of this policy.
- * Strengthen and/or establish an efficient and effective networking and communication system through all forms of ICT for all National School of Excellence Institutions.
- * Develop a code of ethics and apply ethical practices consistent with existing national and global practices.
- * Determine and ensure minimum basic supplies of equipment and resource materials for school needs.
- * Assess and determine the annual cost of delivering educational ICT programs.
- * Develop an appropriate centralized data storage system for inventory and archiving for all NSOE Activities.
- * Liaise with appropriate authorities for the future development of ICT to strengthen links between national, provincial and institutional levels.
- * Establish and manage an efficient and effective implementation strategic plan for NSOE Programs.
- * Create better employment conditions and an enjoyable working environment to maintain the deployment of competent personnel.
- * Liaise with appropriate authorities for the future development of ICT to strengthen links between national, provincial and institutional levels.
- * Establish and manage an efficient and effective broadcasting/transmitting system for Educational ICT Programs.
- * Create better employment conditions and an enjoyable working environment to maintain the deployment of qualified personnel.
- * Develop competent and effective strategies and control mechanism to support the management of National School of Excellence.

- * Establish a NSOE management branch within the GES division to oversee its functions.
- * Put in place proper recruitment and coordination mechanism for recruiting of teachers in all institutions.
- * Develop appropriate strategies for selection, coordinate it and liaise and negotiate with institutions abroad for placement
- * Establish effective system for budgeting and financing for National School of Excellence institutions.
- * Provide effective quality assurance and monitoring mechanism to maintain the standards in all curriculum, teaching & learning, study facilities & management and other activities).
- * Create better employment conditions and an enjoyable working environment to maintain and attract qualified personnel
- * Encourage and strengthen networking in all institutions through research and information sharing in conferences and seminars.
- * Liaise with relevant authorities and stake holders for future development and expansion of NSOE to cater for the growing population.

c. General Education Services (GES)

The General Education Services Division is responsible for administering the overall operations of the National School of Excellence. This includes the following:

- * Provide advice and guidance to the National School of Excellence Management and its Operational Matters;
- * Recruit teachers for National School of Excellence institutions;
- * Facilitate the selection of students to National School of Excellence institutions;
- * Provide information for budgeting and Financing the National School of Excellence institutions;
- * Coordinate and develop National School of Excellence plans;

- 
- * Coordinate and develop procedures and guidelines in the implementation of National School of Excellence activities;
 - * Coordinate and implement National School of Excellence activities with other stakeholders and partners;
 - * Provide technical and professional assistance through ICT;
 - * Coordinate, develop and implement National School of Excellence training programs in consultation with appropriate divisions and organizations;
 - * Develop and review National School of Excellence ICT ethical guidelines periodically;
 - * Procure and upgrade the National School of Excellence equipment and facilities;
 - * Conduct, research, monitor and evaluate National School of Excellence programs in liaison with other key divisions;
 - * Provide reports on National School of Excellence to the appropriate authorities; and
 - * Provide relevant course information and identifying tertiary institutions

Appendix

Table A1: Papua New Guinea’s comparative advantages

Comparative Advantages	Description
Geography	PNG is located proximal to Asia and provides the land bridge between Asia and the Pacific and close to the equator.
Geopolitics	PNG is the biggest nation when compared to the small Pacific nations, besides Australia and New Zealand, and the smallest nation when compared to the big Asian nations. It shares borders with two G20 nations – Australia and Indonesia. It is the leader of the Pacific. It is a member of the APEC and observer on ASEAN.
Political Stability	In the last 20 years PNG had only 3 PMs
Mineral and Hydrocarbon Resources	PNG is endowed with abundant precious and industrial minerals, rare earths and platinum group elements as well as oil and gas deposits.
Energy Resources	PNG has an abundance of energy sources ranging from hydrocarbons, hydropower potentials, geothermal sites, solar, wind, biomass and coal that can be harnessed to make the country the hub of energy in the Asia-Pacific region
Forestry and Fisheries Resources	PNG has the 3 rd largest forest footprint in the world and the largest tuna stock in the Pacific due to its large EEZ.
Agriculture	PNG has big land mass for agriculture and has one of the world’s largest agricultural diversity (e.g. banana, yam, taro, sugar cane, etc.)
Biodiversity	PNG has one of the world’s largest diversity of flora and fauna
Ethnic and Cultural Diversity	PNG is a mini-United Nation with the largest ethnic diversity and boasting 850 different languages.
Fiber Optics	By the end of 2020 PNG will have one of the largest penetration of fiber optics in the world provided by the Coral Sea Cable and National Broadband Network with the last mile to be reached by cell towers.

Table A2: A select list of PNG’s inherent constraints

Inherent Constraints	Description
Geography	Very hostile and isolated – mountainous, swampy, forested, big rivers, high rainfall, unstable soil surface
Geology	Located on the Pacific rim of fire – subjected to earthquake and volcanoes, and tsunamis induced by earthquakes
Law and order	Perception and reality – both reinforcing each other
Corruption	Real and perception reinforcing each other
Demography	Unplanned population growth presents an imbalance with a broader base constituting youth and narrow stem; this presents a population time-bomb.
Gender inequality	Demographic split is on parity but female population is under-represented in all careers and opportunities
Environment	Deforestation and mining discharge
Education	Quality compromised for quantity through tuition-fee free education
Health services	Shortages of medicines and ratio of doctor to population is one of the lowest in the world
Lifestyle diseases	On the rise amongst the productive population
Betel nut	Uncontrolled spittle in public presents risks to public health and safety, dental hygiene of the chewer and aesthetics
Agriculture	Introduction of plant diseases and pests pose risks to the economy; declining yields of major tree crops due to stresses and senility; uniform pricing for agriculture produce
Economy	Government's revenue base is contracting; inflation is eroding personal savings and dwindling the middle income earners; both fiscal and monetary policies do not cater for the bulk of the population
Infrastructure	High costs and poor quality constructions; maintenance is non-existent

Selected Bibliography

1. <https://www.aip.org/fyi/2018/rapid-rise-china%E2%80%99s-stem-workforce-charted-national-science-board-report> (accessed on September 4, 2019)
2. PNG Development Strategic Plan 2010-2030, pp. 54-59
3. Grapragasem, S., Krishnan, A. and Mansor, A.N. (2014), Current Trends in Malaysian Higher Education and the Effect on Education Policy and Practice: An Overview, *Intl. J. Higher Ed.* 3(1), 85-93.
4. Anne Jolly, Six Characteristics of a Great STEM Lesson, *Education Week*, June 17, 2014 (https://www.edweek.org/tm/articles/2014/06/17/ctq_jolly_stem.html) (accessed August 22 2019)
5. Gonzalez, H. B. and Kuenzi, J. J. (2012), Science, Technology, Engineering, and Mathematics (STEM) Education: A Primer, *Congressional Research Service* 7-5700 (www.crs.gov) R42642
6. Yamada, A. (2017), Japanese Higher Education Reform Trends in Response to Globalization and STEM Demand, *J. Comparative & International Higher Edu.* 9 (2017). pp.14-22.
7. Ireland STEM Education Policy Statement 2017-2026 (<https://www.education.ie/en/The-Education-System/STEM-Education-Policy/stem-education-policy-statement-2017-2026-.pdf>)
8. UK STEM Education (<https://www.stem.org.uk/>)
9. Engineering for kids (<https://www.engineeringforkids.com/about/news/2016/february/why-is-stem-education-so-important-/>)
10. Lifewire (<https://www.lifewire.com/what-is-stem-4150175>)
11. STEM Education Works (<https://stemeducationworks.com/>)
12. STEM Jobs (<https://edu.stemjobs.com/about/>)
13. STEAM: Experts Make Case for Adding Arts to STEM, *Education Week* (published online December 1, 2011)
14. A comprehensive plan for Science, Technology, Engineering and Mathematics Education in Australia, National STEM School Education Strategy, 2016–2026 (www.educationcouncil.edu.au)
15. National Education Plan 2015-2019: Quality learning for all, PNG Department of Education.
16. Education Policies in Europe, *Scientix Observatory Report* - October 2018 (<http://www.scientix.eu/observatory/stem-education-practices-europe>)
17. STEM Education in Victoria: Supporting Science, Technology, Engineering and Mathematics Teaching and Learning (http://stem.global2.vic.edu.au/2016/01/23/six_principles_of_great_stem_lessons/)
18. STEM education is the learning of science, technology, engineering and mathematics in an interdisciplinary or integrated approach, NSW Department of Education (<https://education.nsw.gov.au/teaching-and-learning/curriculum/key-learning-areas/stem>)
19. Juliet Kimotho, Bridging the gender equality gap in STEM to fully transform Africa, Global Partnership for Education, March 08, 2019 (<https://www.globalpartnership.org/blog/bridging-gender-equality-gap-stem-fully-transform-africa>)
20. STEM Framework and Principles, Tasmania Department of Education (<https://stem.education.tas.gov.au/framework/>)
21. STEM Education and Workforce Development, U.S. Advanced Manufacturing Plan (http://storage.dow.com.edgesuite.net/dow.com/AdvancedManufacturing/US_AMP_STEM_1216_15.pdf)
22. Promotion of STEM Education: Unleashing Potential in Innovation, Hong Kong Curriculum Development Council, November 2015

10. POLICY DOCUMENT HISTORY

Effective Date	Authorised by	Version #	Comments
26 th March 2020	Dr. Uke Kombra Ph.D	Version 01	
	Secretary for Education		

Approved by:



Signature

