CHAPTER 3:
AFFECTING LEARNER STUDY AND CAREER CHOICES – LESSONS FROM THE YOUTH INTO SCIENCE STRATEGY

INTRODUCTION

This chapter forms part of the supply-side analysis to inform a strategy on human capital development in the biodiversity sector. Key to any human capital development strategy is the establishment of a pool of quality graduates from the school system. It is widely acknowledged that the South African schooling system has not produced the quality and quantity of graduates to meet the human capital needs of the country. Thus it is in the interest of any sector, including that of the biodiversity sector, to adopt a developmental approach that grows the pool of quality students from the school system needed and supports them to enter and complete science qualifications at tertiary institutions.

There have been many investments, interventions and programmes to meet the challenges of improving the quality and quantity of education in schools in the country. These responses have come from government, business, academic institutions and NGOs. The responses have included both in-school and out-of-school interventions. One out-of-school response has been the Youth into Science Strategy (YiSS) initiated by the Department of Science and Technology. This initiative is aimed at developing, among school-going students, an awareness and interest in mathematics and science and improved performance in mathematics and science, as well as to attract youth into science, engineering and technology-related careers. Sections of the YiSS have been evaluated by the Human Sciences Research Council (HSRC). In addition to the evaluation, the HSRC also tracked the participants of this intervention over a period of time to document their educational pathways and trajectories in higher education. These evaluations and tracking studies provide an analysis of a unique dataset regarding the impact of an intervention over time. The value of the study lies in the monitoring and tracking of these students, an element that is often absent in similar initiatives, sometimes due to resource constraints. These studies will form the basis for the recommendations of this chapter.

This chapter will briefly outline the state of education in South Africa as well as describe a few in-school and out-of-school interventions to improve education. We will review the literature regarding out-of-school interventions to improve education and comment on their successes. We will describe, in detail, the YiSS interventions and the methodology for tracking individuals post the interventions to determine their educational trajectories. The critical analysis of the YiSS interventions will provide the sector with the possible strategies it could adopt to attract school-going students to a career in the field of biodiversity. The tracking methodology used will provide the sector with information for future options to assess initiatives and determine the impact of the programme on career decisions.

THE SOUTH AFRICAN EDUCATIONAL LANDSCAPE

South Africa's unique history has left substantial legacies in its wake. One of the most critical of these is the educational outcomes where the vast majority of students are underperforming with low quality education. Analysis of the performance of the South African schooling population shows that

- the national mean mathematics scores are low
- the national average mathematics achievement scores for different grade levels are similar and stable
- there is a high differentiation in the performance of students in different socioeconomic contexts, that is, we have two systems of education
- the level of education in the population is low.

Low performance

Firstly, South Africa has participated in a number of international, regional and national large-scale systemic studies to assess the performance of the country in science and mathematics and these scores are low. The average numeracy score in the UNESCO coordinated Monitoring Student Achievement studies for Grade 4 students for South Africa was 30% (Chinapah V et al 2000). This is similar to the outcome of the Department of Education's systemic evaluation at the Grade 3 level which calculated that the national average score for numeracy was 30% (DoE 2002a). The subsequent Grade 3 systemic study in 2008 measured the average numeracy score as 35%, again showing similar low performance (DoE, 2008). The Department of Education's systemic evaluation at the Grade 6 level measured the national average score for numeracy as 27% (DoE 2004). In the TIMSS 2003, which tested mathematics and science proficiency at the Grade 8 level, South Africa came last of the 50 countries participating (Mullis et al 2004). The Grade 12 mathematics performance is unsatisfactory and, in particular, there is the concern about the small number of students passing higher grade mathematics.

Low national performance across grade levels

Secondly, the national average mathematics achievement score at different grade levels is similar and stable and performance ranges from 27% to 33%. The following graph is an analysis of Grade 12 results (exit-level examination) from 1991 to 2007 and illustrates the stability of low quality and quantity of higher grade mathematics graduates from Grade 12.

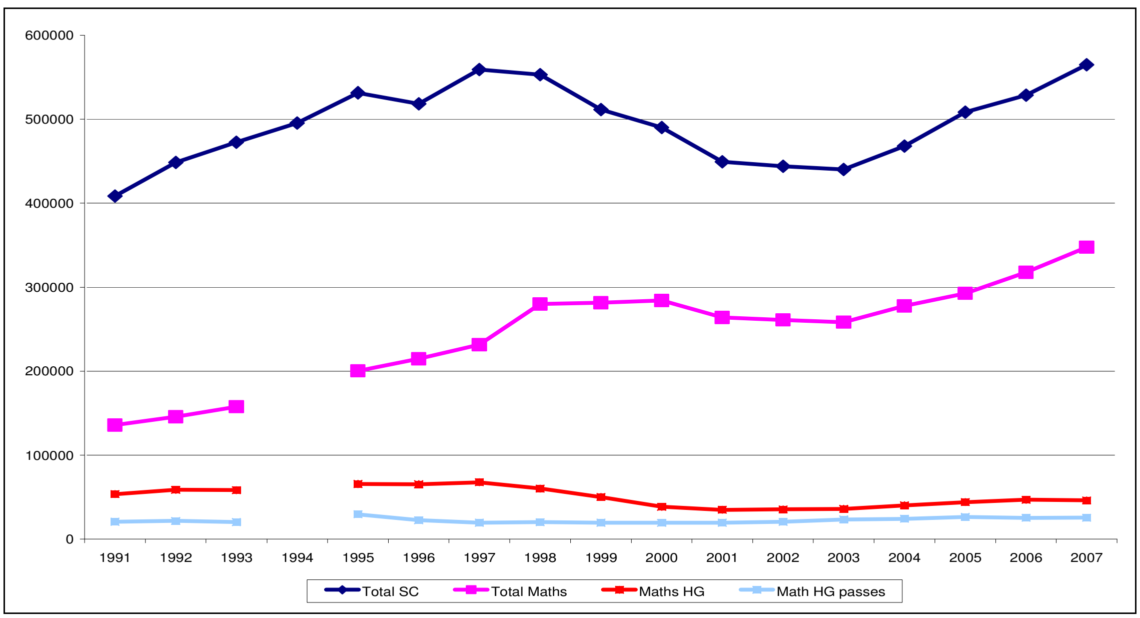

Figure 3.1: Number of Grade 12 and maths enrolments and maths passes at HG and SG level (1991–2007)

This graph shows that access of students to Grade 12 and participation in mathematics subjects has increased. However, quality of schooling, evidenced by the number of students graduating from school with a pass in higher grade mathematics, remains the same (and flat) since 1991. Furthermore, while mathematics and science school performance in general is poor, it is worse for African students. Each year around 25 000 students pass with mathematics higher grade passes and, of these, only around 5 000 African students pass higher-grade mathematics – further demonstrating the role of legacy inequities in mathematics performance.

Inequity in performance as evident by the range of achievement

Thirdly, when we examine South African achievement scores, in addition to being a low score, the range of scores is very wide, and the achievement scores are differentiated and aggregate analysis shows that we have two systems of education. The South African TIMSS mathematics mean score of 264 is well below the international mathematics mean of 467 (Reddy, 2006). South Africa is not a homogenous society and the single aggregated score is misleading for understanding mathematics and science performance in the country. Disaggregation of the TIMSS mathematics mean scores of students by schools categorised by the previous racial departments is essential to understand performance in schools now. The graph below illustrates the differences in performance of students attending the different types of school (we have classified these into African schools and the others as privileged).

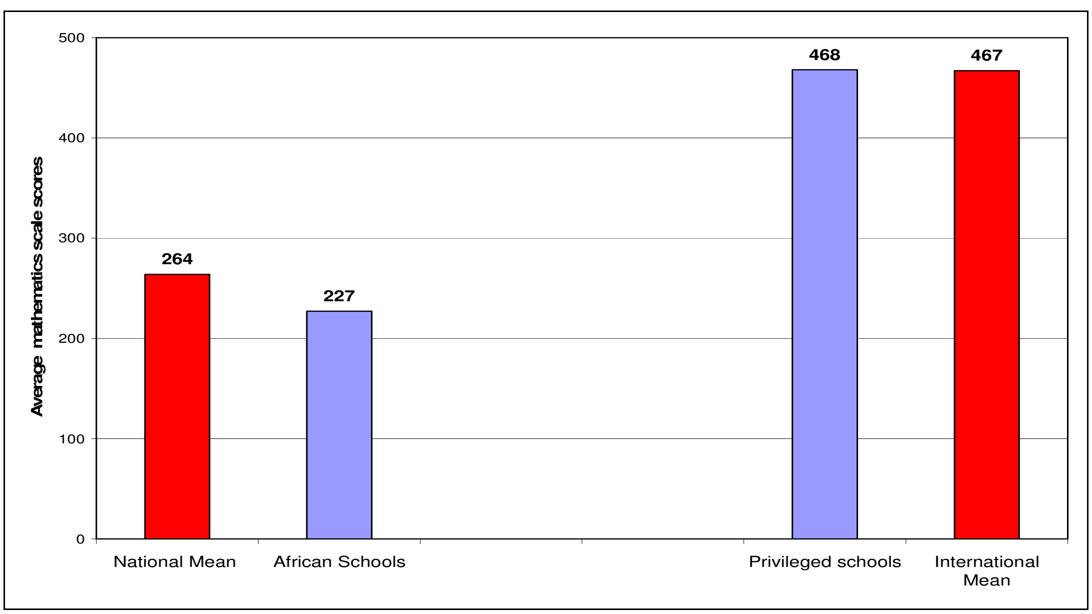

Figure 3.2: TIMSS 2003 mean mathematics scores for schools by ex-racial departments

Education attainment

Fourthly, the general education level of the present-day South African population is low. Figure 3.3 illustrates the level of education for the general population for 1996, 2001 and 2007.

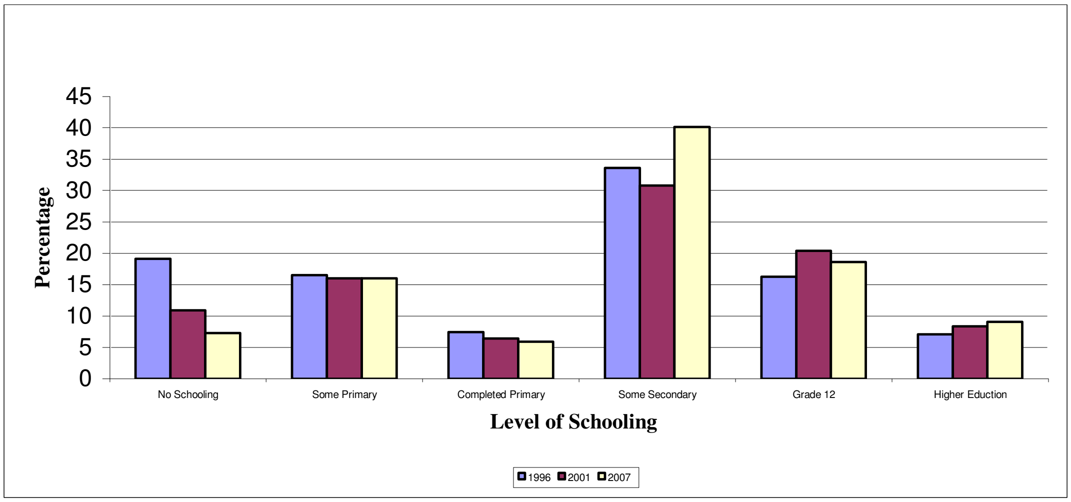

Figure 3.3: Level of schooling of the general population (1999, 2001 and 2007)
Sources: Census, 1996, Census, 2001, Community Survey 2007

Grade 12 student subject choices and performance

The profile of the school-going population that participated in and passed the Grade 12 subjects in the last five years is as follows; around 10% participated in Mathematics and Physical Science at higher grade level. Of the students who participated in these subjects half of them passed. Twenty percent of those who wrote Grade 12 enrolled for Biology at the higher grade level and 45% participated at the standard grade level. The pass rates in biology are better and approximately three quarters of those who wrote the examination passed.

In 2008, students in Grade 12 wrote the new National Senior Certificate examinations. The following table outlines the participation and performance patterns in a few subjects. While many students passed, it was a low quality pass (achieving 30%). Fewer students achieved quality passes which would ensure access to tertiary education.

Table 3.1: Participation and performance patterns in Grade 12 students (2008)

	Selected	Achieved at 30%	Achieved at 40%
Life Science	571 085	71%	40%
Mathematics	298 821	46%	30%
Math Literacy	263 464	79%	
Geography	213319	80%	41%
Physical Sciences	218 156	55%	27%

Attempts to improve education

Given the concerns about education, all sectors (government, business, academia, parents) have recognised the importance of a quality schooling system which would lead to high quality science and mathematics passes in order to support the development of the country. The commitment to mathematics and science and the redress agenda has been outlined in various government gazettes and policy documents (DoE 1995, DoE and DoL 2002, DST 2002). In addition, in the last few years government has embarked on the Foundations for Learning Campaign (DoE 2008), and the Quality Improvement, Development, Support and Upliftment Programme (QIDS-UP) launched in 2006 to provide the poorest primary schools with access to resources.

The Department of Education embarked on the National Strategy for Mathematics, Science and Technology education to improve participation and performance in mathematics and science education (DoE, 2004). The flagship programme in the strategy was the identification of 100 (extended to 102, and then to 500) schools in the Dinaledi project. This strategy targeted a few schools in each province that showed the potential to perform well and the schools received additional facilities, equipment and support for effective mathematics and science teaching and learning.

Over the last decade there has been massive curriculum reform in South Africa. In the old curriculum (NATED 550) all students took general science and mathematics up to the end of the Grade 9 year. In the Grade 10 year, students could choose to enrol for mathematics, physical science or biology. In 1997, Curriculum 2005 (C2005), with an outcomes-based education (OBE) philosophy, was launched. In terms of the new curriculum – in the General Education and Training phase (Grades 1–9) – the Natural Sciences, Mathematics and Technology learning areas became compulsory for all students. The OBE curriculum for the Further Education and Training phase (Grades 10–12) was introduced in 2006. This curriculum is underpinned by the principle of high knowledge and high skill levels emphasising quality outcomes. All students in this phase must study mathematics, either in the form of mathematical literacy or mathematics.

In addition to government programmes aimed at improving the quality of education and, in particular, mathematics and science education, there have been many nongovernment initiatives. We do not have a full list of the initiatives, and the last known documentation of initiatives was “Projects Speak for Themselves” (Levy, 1994). Many NGOs and business have, as part of their social responsibility programmes, initiated school intervention programmes.

One such out-of-school initiative is the Youth into Science Strategy (YiSS) driven by the Department of Science and Technology (DST). This strategy aims to enhance the participation and performance of school-going youth and undergraduates in Science, Technology, Engineering, and Mathematics (STEM) by

- enhancing science and technology literacy among the public in general and the youth in particular
- nurturing youth talent and potential for science, engineering and technology-based careers.

The interventions of the YiSS began in 2005 and targeted both students and educators. These interventions include 1) DST/Thuthuka Mathematics and Science Development camps; 2) National Science Week (NSW); 3) Educator Support Programme workshops; and 4) camps for educators.

The remainder of this chapter will focus mainly on *three* intervention programmes from which best practice could be derived: the DST/Thuthuka student camps, National Science Week and educator camps. Both the DST/Thuthuka camps and the NSW interventions target youth with the aim to increase awareness, participation and performance in school mathematics and science and thus to contribute to efforts to develop high level skills in the country. The Educator Camp intervention targets mathematics and science educators at Grade 10 to 12 level, with the aim of strengthening their expertise to conduct mathematics and science extracurricular activities. These activities should in turn stimulate students' interest in the subjects.

This chapter briefly reviews the literature regarding out-of-school interventions for students. We will then describe the YiSS interventions and the methodology used in the studies and report on a few findings from the HSRC-conducted evaluation and tracking of the YiSS. Based on the lessons from the evaluation, key elements of a successful intervention programme are recommended as well as pointers for the way such an intervention programme may contribute to human capital development in the biodiversity sector.

LITERATURE SUPPORTING OUT-OF-SCHOOL INTERVENTIONS

It is recognised that a strong and growing population of scientifically literate graduates is essential to the development and maintenance of an economically prosperous country (Gascoigne & Metcalfe, 2001). In-school and out-of-school attempts to attract and publicise science as a worthy and exciting subject have been steadily growing in many countries. The out-of-school activities include programmes such as the National Science Week, targeting the general population and intended to stimulate interest, and the student camps, composed of an intense set of activities for a short period.

Camps

The use of camps as an intervention is a new concept in South Africa, but they have been held internationally for many years. The camps have been used for improving mathematics and science education and awareness. The concept of a camp involves students living together in temporary lodgings under the supervision of counsellors or mentors for a short period of time. Among the countries that have held camps are the USA, Brazil, England and India. In the USA, for example, camps have focused on general youth development and have been conducted for more than 150 years (Henderson, Thurber, Schueler, Whitaker, Bialeschki & Scanlin, 2006). These have been primarily in the form of "summer camps", intended to instil interest in the target group at an age when their interest in those learning areas/subjects starts to diminish.

The shortage of skills and the needs of the workforce in many countries have forced governments and various stakeholders to tap the usually untapped talents through the use of camps. Most camps appear to target students from underprivileged backgrounds, the minorities, as well as the underrepresented women/girls from the minority racial groups. According to Powell (2003), youth attend camps for various reasons and research suggests that camp participation impacts on youth in multiple ways. These include enhancing self-esteem and self-concept (noncurriculum benefit), as well as increasing knowledge, skills and abilities (curriculum benefit). Literature shows that academic camps are used to stimulate and enhance Mathematics, Science and Technology knowledge for disadvantaged students (Miller, 2007; Bradley & Reyes, 2000). According to Miller (2007) camps serve as platforms for the target group to be involved in hands-on Science experiences or a different side of Mathematics and, through the use of hands-on activities, the camp organisers aim to make the activities fun for the students. In addition, camps encourage the target groups to explore the Mathematics, Science and Technology fields as career options, presenting a completely different side to Mathematics and Science to the attendees.

One example of a Mathematics camp which is linked to knowledge acquisition is the USA/Canada Mathcamp (www.mathcamp.org). The camp is run over five weeks where students are allowed to choose courses tailored to their backgrounds and interests. Subjects include linear algebra, number theory, fractals, real analysis, projective geometry and topology. These subjects introduce students to the rigours of university level mathematics while incorporating fun applications.

National Science Week

The National Science Week has been celebrated in a number of countries for a while now. These countries include the United States of America, Britain, Australia, Ireland, India, Germany, Brazil, China, Malta and Belgium. The principal aims are to celebrate science, to inspire ordinary people about science and to encourage more youth to consider careers in science. To achieve this, a range of activities are organised at multiple sites that enable people of all ages to have an experiential encounter with science and scientists. The NSW seeks to highlight the importance and relevance of science in everyday life, and also raise awareness of the function of science and technology in the advancement of society. The activities of the NSW include exhibitions, expos and fairs, presentations, quizzes, theatre, debates, forums, and so on. The activities foster science enthusiasm by raising awareness of the relevance of science, using simple, readily available apparatus and cheap materials (King, 2006).

In the United Kingdom, the National Science Week (NSW) has been running for the past ten years. It is driven by the British Association for the Advancement of Science, which is endorsed by the British Government. The main aim of the NSW is to celebrate science, to inspire ordinary people about science and to encourage more youth to consider careers in science. To achieve this, a range of activities are organised at multiple sites that enable people of all ages to have an experiential encounter with science. In addition, as of 2007, NSW will be renamed National Science and Engineering Week with the aim of raising the profile of engineering as a career in Britain. National Science Week in Ireland shares identical aims with Britain, though it is officially called “Discover Science and Engineering” (DSE).

The National Science Week event is also Australia’s major annual science extravaganza which runs for nine days in the middle of August (Australian Culture and Recreation Portal, 2007). August 2007 marked the 10th annual National Science Week for Australia, funded by its government. The NSW is an opportunity for all Australians to get involved in science with an emphasis on hands-on, participatory experiences with science activities. The broad goal is to highlight the importance and relevance of science in everyday life, and also raise awareness of the function of science and technology in the advancement of Australian society (http://lists.collectionsaustralia.net, 2005). Also, Science Week provides a good opportunity for Australians to consider their scientists’ contributions to the world of knowledge and to point to some Internet resources of interest (Australian Culture and Recreation Portal, 2007). As in Britain and Ireland, the week’s activities are not aimed solely at learners and teachers, but at the Australian public in general, with a wide range of activities offered at different sites.

In Europe, the Science Week aims to put the “wow: factor into science by generating excitement through participatory and fun experiences (Cordis.europa science week, 2006). The aim is to move away from a didactic approach and information dissemination towards a more exploratory, hands-on style of sharing science information. During European Science Week, multiple activities at numerous sites in Greece, France, Britain, Bulgaria, Finland and Germany are conducted. These activities are all aimed at various facets of society and are not specifically targeted at school-age children.

As in other countries, the NSW in China is an annual event aimed at promoting science (Crienglish.com,). This event has been going on since 2001 and is organised by the Chinese Ministry of Science and Technology. To achieve its purpose, various activities are carried out including exhibitions in schools, communities and rural areas. The 2007 NSW was focused on "Building a country of scientific innovation".

The National Science Week also gives scientists the opportunity to interact with the public and discuss their work. Through this process they gain an understanding of the public's view (King, 2006). Also critical is to assist in making a connection between science studies and science-based career opportunities, as well as to foster partnerships between the community, research organisations and industry (Australian Department of Education, Science and Training, 2007).

The ultimate goal of this intervention is to increase the number of youth who choose science-related careers. According to the Cordis.europa website, young people are the perfect place to begin. They argue that if young minds cannot be stimulated by the wonders going around them, what hope is there? Where are tomorrow's scientists and investors? Therefore, the primary goal of National Science Week is to bring the challenge and excitement of world science to young people.

DESCRIPTION OF THE YISS INTERVENTIONS

DST/THUTHUKA Mathematics and Science Development Camps

The DST/Thuthuka student camps are a formalised intervention that targets the top-performing students in both mathematics and science nationally. These are students in Grades 11 and 12, mostly African (except in the Western Cape Province where coloured students dominate the camps), and 55% of the participants are girls from previously disadvantaged backgrounds. The DST/Thuthuka Student Camps are planned and organised by the South African Institute of Chartered Accountants (SAICA). The camps target the top-performing students in mathematics and science who are selected by their teachers with the assistance of the education district office. These camps are usually held during the school vacation for 5 to 8 days on a tertiary institution campus or at a youth camp site where outdoor fun and leadership activities are also experienced.

The student camp initiative seeks to bring the thrill and excitement of science, engineering, technology and accounting-related careers to students by creating a fun-filled environment for them that is conducive to learning mathematics, science and accounting. Participants are taught relevant study skills and examination techniques. The mathematics, science and accounting lessons are geared to enrich, stimulate interest and inspire the youth to better performances in these subjects. There is a life skills component that includes activities on purpose, goals and goal setting, change and change management, self-confidence and assertiveness training, among others. The camp may also include short excursions to places of educational or vocational interest. They have a career day where various organisations exhibit or present up-to-date career information and opportunities for the youth. Camps are concluded with an awards ceremony where the top performers at the camps are acknowledged.

The HSRC evaluated and monitored the Camps Programme from 2005 to 2008 in terms of schools reach; students reach and impact on students' performance; career intentions and career choices. The key findings from the evaluation and tracking of students over time showed the following:

The Camps Programme has been reaching an increasing number of provinces and schools since 2005. By 2008, the Camps Programme had reached close to 12% of secondary schools, almost double from 6.3% reached in 2005.

Trends over time show that the number of students attending the camps has increased from each province, with, in 2005, 1 111 students participated in the camps. This number was doubled by 2008 with a total of 2 005 participating from all nine provinces. The majority (over 90%) of students attending the camps are African. In the Western Cape about two-thirds of students who attend the camps are coloured and one third are African.

There has been an increasing percentage of females attending the camps in almost all the provinces and in 2008 participants were 57% female and 43% male. The camps target students from both Grades 11 and 12. The national analysis shows that, in 2005, 2007 and 2008, there were a higher proportion of Grade 12 students.

Students who participated in the camps performed well in the examination with pass rates greater than90%, and 70% of Grade 12 students gained an exemption pass. The top career intentions for students are: accounting and commerce fields (37%); engineering (31%); medicine (11%) and science 5%.

Of the students who have completed Grade 12, 70% are registered at tertiary institutions, 20% are unemployed and around 10% are repeating Grade 12. Of those registered at tertiary institutions, the courses they are registered for are: 63% commerce; 14% sciences; 12% engineering; 4% IT; 3% medicine; 2% arts; and 2% law.

South Africa's National Science Week

The National Science Week (NSW) is an annual week-long countrywide celebration of science and technology, coordinated by the DST and the South African Agency for Science and Technology Advancement (SAASTA). The NSW is celebrated under the theme "Tomorrow's Science and Technology are in our Youth's Hands". The event targets students, educators, the public, politicians and the broader community, and a range of science-based activities are conducted at different sites countrywide. Its major objectives are to

- create awareness of the important role that science plays in people's daily lives
- encourage the youth to continue studying and improving their performance in mathematics and science
- attract more youth into science, engineering and technology careers.

In comparison to the DST/Thuthuka Student Camps, the NSW targets **all** students irrespective of their ability in mathematics and science education, or their career aspirations. Schools, in cooperation with their school districts, transport students to various sites where the event is hosted. During this event, students learn about different scientific and innovative technologies from scientists and other professionals, thus the event creates opportunities for students to interact with scientists and pose some of the questions they might have.

The key findings from the evaluation of the NSW (2005–2008) and the tracking of participants who attended the NSW are

- the number of grant holders and sites involved in NSW has increased from 2005 to 2008, with the biggest increase from 2007 to 2008. In 2008 there were 67 grant holders and 60 sites.
- the number of sites offering outreach activities has increased steadily from 2006 indicating that outreach activities have become increasingly popular for grant holders.

We cannot provide exact numbers of schools reached, but it would seem that the NSW reaches just over 2000 schools each year. This constitutes around 7% of all the schools in the country. It would seem that a higher number of high schools (around 60%) than primary schools attend the NSW.

We had surveyed a sample of Grade 11 and 12 students (those taking mathematics and physical science) who attended NSW 2007, from across the country, to gain baseline information about their participation, performance and career aspirations. We followed up with them in 2008 to see what they were doing:

- Of the students who were in Grade 12 in 2007; around half of them passed with a matriculation exemption and two-thirds of the students passed mathematics and physical science.
- 86% of the Grade 11 and 12 learners who were surveyed indicated that they wanted to study further (63% at a university and 23% at a technical tertiary institution). Thus students have high career aspirations.
- Of the students who completed school; one third were unemployed at the time of the survey and a quarter were at a tertiary institution. Around 40% would have failed and are repeating or upgrading their marks.
- Of the students who are registered at tertiary institutions, around 30% are registered for engineering qualifications and around 15% for courses in Information technology.

Educator Development Camps

The YiSS has indentified an intervention with educators, the Educator Development Camps, to provide educators with skills to assist and support students in mathematics, science and technology areas. These camps are five-day residential camps and target 50 Grade 10 to 12 science and mathematics educators in each province. The educators teach in schools that would be classified at ex-Department of Education and Training – considered the most disadvantaged schools in the country. The aims of the Educator Development Camps are

- to provide educators with the necessary skills to conduct extracurricular science and mathematics activities (e.g. competitions and Olympiads) at school level and to support identified talent and potential
- to provide educators with the necessary skills and knowledge to develop confidence in problem solving
- to create an enabling learning environment in which problem-solving activities are promoted
- to provide meaningful access and materials so that students can participate in out-of-school activities
- to popularise maths and science
- to provide educators with career education training to enable them to provide relevant information to their students on STEM careers.

The key findings for the group of mathematics educators who attended these workshops are

- there were more male than female educators in this group. The majority of the educators were in the age range of 30 to 39 years, they have high teaching qualifications (70% with a degree or higher), and are experienced, with 61% having taught mathematics for more than five years
- 70% of educators had not entered their learners in Olympiads, while 83% of educators indicated that they had entered learners into mathematics competitions

- the extent to which educators are undertaking mathematics extracurricular activities varied from one classroom to another, with most not undertaking the interesting activities.

HSRC EVALUATIONS OF THE YISS INTERVENTIONS

The HSRC undertook evaluations of the DST/Thuthuka Camps Programme (Reddy et al, 2008) and the National Science Week (Reddy et al, 2008) and also monitored the impact of the interventions in the Youth into Science Tracking Studies Report (Reddy et al, 2009). Based on these three DST YiSS evaluation and tracking of participant, reports and the literature review, we have identified some of the key elements of a successful intervention which could be used by the biodiversity sector to design programmes which would increase the awareness of the school-going population about the biodiversity sector and attract them to biodiversity careers.

METHODOLOGY USED IN THE YISS TRACKING STUDIES

The learners who attended the camps and National Science Week 2007 completed questionnaires which provided baseline information on individuals. This baseline data included the biographical details of each learner and their contact details such as telephone, cellular phone or their relatives' telephone numbers.

Follow-up questionnaires were developed by the HSRC to track the Grade 11 and 12 learners who attended the NSW and learners who attended the 2007 camps. The questionnaires were developed with particular tracking indices. The HSRC developed a Computer Assisted Telephone Interview (CATI) system and in 2008 and 2009 we engaged a call centre to telephone the students on the database and elicit relevant information from them.

KEY INDICATORS IN A SUCCESSFUL INTERVENTION

The following key elements should be considered in the design of an out-of-school intervention programme to attract more learners to take up careers in biodiversity:

- increasing awareness and interest in biodiversity by both students and educators
- increasing participation in science subjects at both the school and tertiary levels
- increased science and mathematics knowledge in students and educators
- shaping career intentions and choices
- providing resources and support.

Increased awareness and interest in biodiversity by both students and educators

In considering a human capital development strategy for biodiversity, and if we are targeting the school-going population, the first element is to ensure that students are aware of this discipline of study and of the careers in this area. If awareness of this area can spark a “wow” effect, it is the first stage of attracting the youth into this sector.

The NSW is a strategy for increasing public awareness about the important role of science and technology in society. It has done this by inviting exhibitors to set up attractive stands and providing the public with a special experience, thus attempting to change views and attitudes. The NSW programme also introduces a set of events whereby exhibits and exhibitors visit schools. While these outreach activities cost more than bringing a group of 30 to an exhibition, the benefit is that it would provide exposure to students in remote areas and would provide access to a whole school rather than a small group. Thus awareness could be increased by biodiversity organisations visiting schools, setting up exhibitions at schools, facilitating short excursions to illuminate biodiversity concepts and setting up biodiversity competitions for school-going students.

Another strategy used by the YiSS intervention programmes to increase awareness was the media. The aim of media coverage was to ensure advertising of the event and to provide a wider awareness of the NSW activities. In our evaluation we monitored the media (TV, radio and newsprint) for the extent and nature of coverage of NSW activities. An analysis of the media reporting the activities of National Science Week (2007) shows that the event was covered in the mainstream media; however, most of the media reports occurred when the Minister of Science and Technology appeared at an event, rather than covering the science issues. The NSW provided an opportunity to use the media to reach groups of the population who would have not attended an exhibition site, but our analysis indicated that this was not used effectively to inform the public about science issues and debates. In order for a media campaign promoting awareness to be successful, there needs to be a clearly defined media strategy and use of local politicians and celebrities to sell the ideas and make them more attractive.

In addition to awareness, students need to be *interested* in a particular area (be it science and technology or biodiversity) for studying it further and seeing the area as a potential career. Internationally, there is declining interest in science studies (Van Driel, Beijaard, & Verloop, 2001), as students have a range of career options.

One of the ways to spark an individual's interest in relatively unknown fields of study is to encourage specialists in the field to inform the public about their work, and thus positively influence the attitudes of the public. Findings from the evaluation of the 2007 National Science Week (Reddy et al, 2008), show that a number of students admitted to having their interest raised by their interactions and engagements with scientists. In addition, 40% indicated that they learnt about careers they had not known about before and one-third indicated that, as a result of exposure to different careers, they had changed their mind about what career they would follow. Students responded positively to the activities and exhibits at NSW 2007. In response to the item on the impact of the NSW on students' attitude to science, a sample of responses indicated a positive impact:

- "It changed my attitude and my mind also seeing science as an important subject because it has many job opportunities" (Grade 10–12 pupil at Highveld Comprehensive School).
- "I saw that what I think about science it's not true that science is so difficult" (Pupil – Holmdene Secondary School).

- "It make me (to be) more on learning this subject because it got many changes in our lives … get bursaries … and get more information" (Pupil – Highveld Secondary).

This encouraged them and made them aspire to being future scientists. Also, as part of developing interest, excursions or outings to places where learning about the field of study could be conducted.

Increased participation

Participants in the science and engineering or biodiversity sector workforce have to have a high school education and to have enrolled for mathematics and science subjects. Thus, the growth of the science and technology sectors depends on the extent to which the youth enrol in these subjects at the school level.

There is a common curriculum for all students up to Grade 9; at the end of Grade 9 students make choices about which fields of study to undertake in the FET phase. The numbers of students who studied mathematics and science subjects in the FET phase is low. In the previous FET (NATED 550) curriculum, around 60% of high school learners enrolled for mathematics and of those around 20% took mathematics on a higher grade level. In 2008, for learners following the new FET national curriculum, 53% enrolled for mathematics and 47% enrolled for mathematics literacy. This pattern of enrolment creates a very small pool of students that could venture into SET fields.
The DST/Thuthuka Camps intervention is directed at students in Grades 11 and 12, and therefore does not influence subject choices. The NSW intervention is directed at students in all grades and thus has the potential to influence more students. In our evaluation of NSW, we found that the majority of students who attended were from secondary schools. Our recommendation was that the NSW should target all grade levels if it wants to influence subject choices at the end of Grade 9.

Increased knowledge

The DST's Ten Year Plan for South Africa (2008–2018) outlines the importance of South Africa progressing away from a resource-based economy towards a knowledge-based economy. This knowledge-based economy is highly dependent on human resources and skills (DST, 2007). It depends on the availability of educated people and the quality of knowledge workers. There is a causal link between increased science and technology knowledge and the creation of positive attitudes towards science and technology (Bauer, Allum & Miller, 2007).

One of the requirements for individuals interested in any field of tertiary education is to have the prerequisite knowledge, which would have been gained from the schooling system. The access requirement for someone interested in pursuing a biodiversity career at a tertiary institution is that they possess good matriculation symbols, usually in mathematics and sciences.

The bottleneck for the access to higher education institutions is the low numbers of students with high quality education. One of the DST objectives for the Camps and NSW initiative is to increase performance in science and mathematics. However, in our evaluation we reported that an intervention in the last two years of schooling to improve mathematics and science knowledge was unrealistic. The structure of the subject knowledge is that it is hierarchical and dependent on foundational knowledge and skills. Thus, the benefits for participating in the NSW would be to increase awareness and stimulate interest in science and science careers. Similarly, the impact of the one week's participation in the camps (Grades 11 & 12) would be less about improved performance in mathematics and science and more about increased awareness of opportunities, stimulating interest and motivating students to participate in mathematics and science careers. There is now widespread recognition from government and research that, for improved performance in mathematics and science and improving the quality of education, we have to improve the whole schooling system and the interventions to improve performance have to be made in the earlier, rather than later, years of schooling. Thus the Department of Education has initiated the Foundations for Learning Campaign.

Shaping career intentions and choices

For the country's economic growth and prosperity, we want students from the school system to be, firstly, aware and interested in following SET careers and then to actually enrol for qualifications leading to SET careers. In our evaluation and tracking studies we wanted to determine the career intentions and choices made by learners.

This unique panel dataset allows the opportunity for such analysis. Firstly, in the camps evaluation, we elicited students' career intentions before the start of a camp and then, having heard the different presentations, evaluated whether the intentions of students changed. The second aspect we were interested in was whether the intentions translated to career choices. Thus, a year later, we contacted the participants again and recorded their actual choices.

The analysis of their responses shows that the majority of the camp students indicated their intention to enrol at a university after Grade 12 (see Figure 3.4).

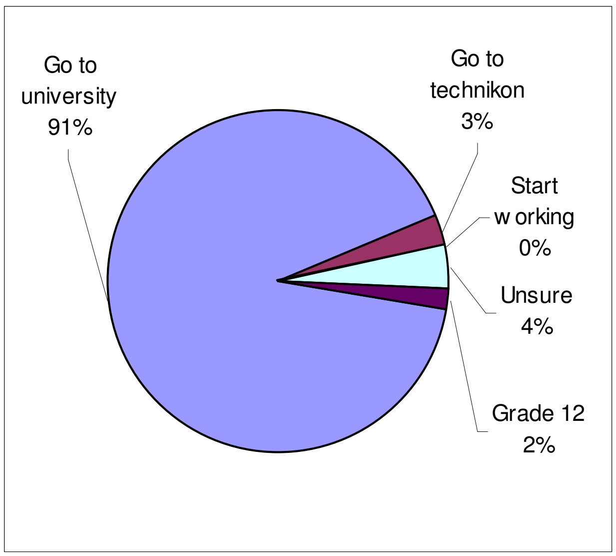

Figure 3.4: Post Grade 12 study intentions for 2007 camps

When students were contacted a year later, the results showed that most of the surveyed students pursued their aspiration of going to university (Figure 3.5). This is to be expected as the camps targeted the top-performing students in a province.

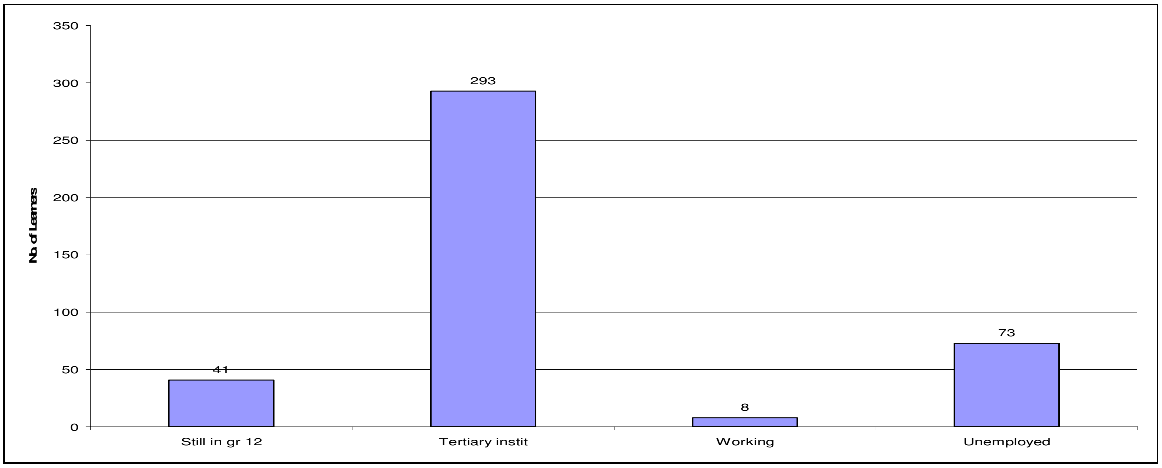

Figure 3.5: Post Grade 12 study choices for 2007 camps cohort

When students were surveyed at the camps during their Grade 12 year, the majority of students indicated a high interest in following a career in mathematics and science areas (and the inputs at the camps were intended to increase students' interest in SET areas). When we interviewed students in their post-Grade 12 year, the majority (63%) of students had registered for a qualification in the commerce field rather than science or engineering (29%).

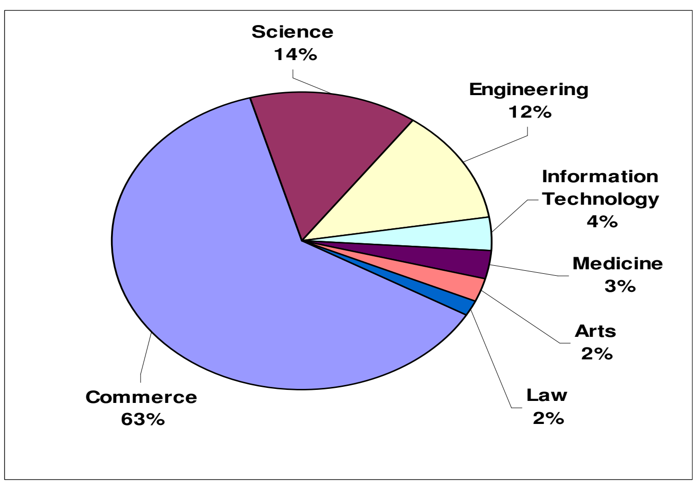

Figure 3.6: Distribution of courses registered for at tertiary institutions

We do not have data that indicates the reasons students switched from science and mathematics career intentions to enrolling for commerce qualifications, but we do know that during the Camps week SAICA offered students the possibility of bursaries if they chose to study commerce. This was not so for the SET areas.

Resources and support

There are costs associated with pursuing a post-school qualification – the costs relate to both the costs of attending tertiary institutions and the opportunity costs. Given the high levels of poverty in South Africa, especially for the African group, the costs for tertiary education would be an inhibiting factor. Literature on South African education (Letseka, Cosser, Breier & Visser, 2009) has identified a lack of financial resources as one of the main reasons for poor performances in South Africa.

However, resources without any further support at tertiary institutions could nullify the efforts to draw learners to tertiary institutions. Students who are bursary holders need to be supported throughout their programme by being assigned to a mentor. Students can consult their mentors to discuss some of the challenges they may experience in their course of study. Reciprocally, the mentors will follow up and monitor their progress. The SAICA effort in the Camps initiative involves the inputs during the Camps week, the provision of support and the allocation of a mentor to support the learners at the tertiary institution.

IMPLICATIONS OF YISS MODEL

The biodiversity sector, through its interventions, can also play a contributory role in strengthening the transformation of science and technology capacity by increasing the numbers of students who are interested in this sector and then enter tertiary institutions to study further and enter biodiversity professions. Where the sector has existing initiatives directed at students, monitoring and evaluation of these initiatives in terms of the stated objectives of changes in subject choices and career choices are crucial. So, for instance, to evaluate the extent to which student camps that are geared towards developing a passion for nature (adventure camps for instance), a key requirement for staying in the sector, also translate into changes in subject and career choices.

Based on the international literature and lessons learnt from the DST YiSS and the HSRC evaluation of these programmes, there are a number of strategies that may be considered by the sector to increase the number of learners who make subject choices and study choices that are related to the biodiversity sector. This assumes that where the sector has existing programmes, the evaluation and tracking results may provide pointers in terms of adjusting existing programmes to more usefully reflect the objectives of the sector, if necessary:

- Biodiversity-related camps for students
- Biodiversity-related camps for teachers
- Support for National Curriculum on sections related to biodiversity
- National Science Week as a platform to promote biodiversity
- Media programmes on biodiversity

BIODIVERSITY-RELATED CAMPS FOR STUDENTS

Biodiversity camps could be offered to students from previously disadvantaged backgrounds so that they could become aware of and interested in biodiversity fields; students who demonstrate potential to participate in this sector could then be supported in pursuing careers in the biodiversity fields. These camps could offer the students/youth opportunities not only for learning from the experts but also from their peers. The camps would offer opportunities for students to dream big and raise their motivation level to pursue the target subject areas at tertiary institution level. The camps could also help students gain knowledge of topics they consider difficult to learn at schools.

However, there are several issues that should be considered when embarking on the use of a camp strategy: 1) the age group that camps target; 2) the way beneficiaries should be selected; 3) when the camps should take place; and 4) what the key objectives of the camps should be. Based on the lessons learnt from the YiSS intervention programmes and the literature, we recommend that the following:

- Camps should target middle to high school students (Grades 6 to 9). These students are at a stage where they have to make decisions about their careers and further studies. Targeting students before they have made their subject choices (end of Grade 9) could influence choices.

- Camps should target students who are currently in ex-African and ex-House of Representative schools. This would represent students from homes with the poorest socioeconomic conditions.
- In order to participate in the camps, students should be asked to apply and fulfil certain criteria. One criterion could be to invite students to submit an essay related to biodiversity or conservation areas.
- Camps should be conducted during the school holidays, preferably June/July (school holidays).
- The venue for the camps should be a game park or an area that is linked to the biodiversity sector. The location of the camps could serve to raise awareness about biodiversity areas.

BIODIVERSITY-RELATED CAMPS FOR TEACHERS

Teachers are a key component in the success of any intervention or reform, for they are both the subjects and the agents of change (Sikes, 1992). According to the South African Department of Education (2001), improvement of student achievement is largely dependent on a competent teaching corps, especially for mathematics and science. The DST (2006) notes that effective educators are key to the successful implementation of innovative curricula. Biodiversity sections have been introduced into the new curriculum and thus there is a need to orientate teachers to these new areas and equip them with knowledge and the necessary skills for effective teaching. The evaluation of the Maths Educator Camps shows that although many of the educators in the programme were highly qualified (with masters and honours degrees), they indicated their lack of confidence in the new topics in the National Curriculum Statement.

An investment in teachers would contribute to higher quality teaching and hence improved performance by students. We recommend conducting Camps for Educators around biodiversity topics with the following being considered:

- The camps should target both primary and high school teachers. The teachers should be teaching either Natural Sciences or Life Sciences.
- To be selected for the programme, educators should participate in a competition involving biodiversity issues (e.g. an essay competition).

- The camps could be conducted during school vacation, preferable June/July, to avoid teachers being taken away from their classrooms and thus a loss of teaching time.
- The camp venue should be where they will be in interaction with biodiversity scientists (e.g. game parks), and thus increase their interest.
- The purpose of the camps should be to increase teachers' interest and confidence in teaching biodiversity, and provide them with the necessary knowledge and skills to assist their students in the area.

SUPPORT FOR THE NATIONAL CURRICULUM ON SECTIONS RELATED TO BIODIVERSITY

Analysis of the Revised National Curriculum Statement Grades R–9 and the National Curriculum Statement for Grades 10–12 shows that there is inclusion of biodiversity topics in the Natural Sciences and Life Sciences curriculum at both primary and secondary level (Revised National Curriculum Statements Gr. R–9, 2002 and National Curriculum Statements, Gr. 10–12). The South African report of the Trends in International Mathematics and Science Studies (TIMMS) (Reddy, 2003), analysed student performance in the Grade 8 general science sections. South Africa's performance was the lowest of 50 countries. However, students' performance in the content area of environmental science was better than physics.

To improve the quality of education, teachers should be supported in implementing the new curriculum. The support could be in the form of training workshops, resource and learning materials, and ongoing conferences that could keep them update to date. Teachers have participated in workshops organised by a range of service providers (government, NGOs, university) with varying degrees of success. The difference with this recommendation is that the workshops would be organised by professionals from the biodiversity field, rather than the generalist education field.

Successful support of the implementation of the National Curriculum is likely to improve the quality of education and therefore produce quality passes. This, in turn, will increase the pool of students who successfully leave the schooling system and can potentially follow biodiversity careers. Suggestions for support of the National Curriculum include:

- Provision of resources that will facilitate teaching and learning of this area of the curriculum. The provision of resources must be accompanied with training on how to use the resources
- Classroom visits by experts in biodiversity to discuss interesting topics will help both the students and the educators. There must be outreach programmes to cater for rural schools and students.

NATIONAL SCIENCE WEEK AS A PLATFORM TO PROMOTE BIODIVERSITY

The National Science Week is used by biodiversity organisations to promote their sector. The NSW takes place in all provinces and is attended by students from the various school types (rural, farm, township, private, and public). Currently, a few biodiversity organisations exhibit their activities during the NSW; however, this number could be increased. This opportunity could be used to increase awareness, interests, and student and public knowledge about careers in the biodiversity sector. We recommend the following:

- That biodiversity organisations form coalitions to decide on activities that will be exhibited during the National Science Week for maximum impact.
- That biodiversity organisations use the NSW platform to recruit students to biodiversity careers through presentations made by professionals working in this area.

MEDIA

Researchers argue that the more the public knows about science and technology, the more they will love it (Sturgis & Allum, 2004; Bauer, Petkova & Boyadjieva, 2000: Sturgis et al., 2005). The assumption is that more effective communication of science and technology to the public will result in positive attitudes and more interest (Gregory & Lock, 2008; Bauer et al, 2007). Similarly, the media could be used to inform the public about key biodiversity issues and improve awareness of career opportunities. A biodiversity communication strategy (involving television programmes, newspaper articles, articles in popular magazines) could play a critical role in communicating these messages.

CONCLUSIONS

The DST YiSS is part of a strategic government-driven initiative to increase the awareness of science among learners, and attract more learners to SET fields of study and careers. As a government initiative, it is supported by a department (DST) that has a strategic interest in all sectors that wish to improve access to, and opportunities in, science fields of study and careers. The biodiversity conservation sector, in building strategic alliances and inter-institutional relationships in its drive towards an HCDS, may draw upon lessons from within the DST YiSS model as well as outside.

Drawing from the literature and the evaluation of the DST YiSS there are some lessons that the biodiversity sector could consider in order to intervene at this level of the supply-side system, in the transition from school to higher education. This framework builds on the existing infrastructure in South Africa. Strengthening and consolidating this infrastructure, especially where it has shown success, would be important and definitely preferable to creating a new infrastructure.

The recommendations emphasise the exposure of students to biodiversity activities in the early stages of learning. It emphasises reinforcement of the schooling sector and the creation of opportunities outside the school system to improve awareness and interest in the biodiversity sector. In addition, we recognise that it is not only interest, awareness and knowledge that will attract the South African youth to the biodiversity sector; given the income levels in most South African homes, these students would need financial support for education at tertiary levels.

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