An Innovative High School Mathematics Enrichment Programme

A Pilot Project:
Mariannridge Senior Secondary School

Managed by The Rotary Club of Durban Umhlatuzana

JUNE 2022

UMHLATUZANA
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South Africa

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Executive Summary

Mathematics is the language of science and technology. Proficiency in mathematics is steadily becoming an essential skill in many other areas such as business, economics, and management, to name just a few examples. Mathematics at the level of the Pure Mathematics Matric Exam is a prerequisite for entering university in all the STEM fields and also in medicine. Yet in many less privileged schools, the majority of learners are encouraged to follow a lower-level Mathematics Literacy track, which does not qualify them for university admission in these subjects. Moreover, there is a shortage of competent mathematics teachers at the high school level. This problem is exacerbated by the large fraction of the best teachers concentrated at elite high schools, requiring payment of tuition fees by families.

This program, which was initiated slightly under two years ago at Mariannridge Senior Secondary School, brings university students in the STEM subjects from the University of KwaZulu-Natal (UKZN) to Mariannridge on Saturdays in order to provide free tuition to learners in grades 8 – 12. During the 2021 academic year, tutors from UKZN's School of Chemistry and Physics and School of Mathematics, Statistics and Computer Science began with an 8th grade cohort, providing instruction free of charge every Saturday during the school year. Thanks to some seed funding, the Rotary Club was able to finance the transportation of the tutors from two pickup points in Durban to the school each Saturday. The school leadership helped provide appropriate

pedagogical materials. Our plan is to continue with the 2021 grade 8 cohort through grade 12 and each year add another grade being served by this project. In 2022 we successfully expanded the programme to provide tuition to 8th and 9th graders and in 2023 to three grades (8th, 9th, and 10th), in 2024 to four grades (8th, 9th, 10th, and 11th), and finally in 2025 and onward to all grades from 8-12. The programme is open to neighbouring schools as well.

We are seeking funding to continue and expand this project. In addition to covering the transportation costs and other minor expenses as we have been able to do, we would like to be able to buy our own pedagogical materials to complement the existing maths teaching in an innovative way, emphasizing problem solving skills and creativity. We also plan to add a hands-on computing component as part of this program. We also feel that there is a need to provide the tutors with a modest stipend. So far, the tutors have worked on an entirely volunteer basis, but almost all the tutors do not come from privileged backgrounds. Many work part-time to supplement their university bursaries. Being able to pay a modest stipend will help us expand the base of tutors, as will be required for the program to expand in coming years. The management of this project will continue on a completely volunteer basis by members of the Rotary Club.

This programme has a number of overarching goals: (1) to provide mathematics learners with the confidence needed to choose the Pure Mathematics track leading to the Pure Mathematics Matric Examination in Grade 12, thus greatly enlarging the range of options available for subsequent post-grade-12 study; (2) to fill in any gaps in knowledge and maths skills from previous grades; (3) to introduce learners to problem solving skills involving a broad range of problems, both practical and more abstract; (4) to expose learners to the variety of career options available in the STEM fields; (5) to teach basic computer skills and (6) to increase the number of STEM students in higher education coming from less privileged schools.

Photographer unknown

We also hope that the lessons learned from this project can in the future be extended to other schools.

Background, Objectives and Methodology

Mariannridge Senior Secondary School is a no-fees (quintile 3) school located in the community of Mariannridge. It is the only secondary school in the community and the only English-medium secondary school in the zone. Mariannridge is a small community about 20 km from the city centre of Durban. It is a peri-urban community with an estimated population of about 25 000. Mariannridge is in Ward 13 of the Ethekwini Municipality in the KwaZulu-Natal province, which according to the 2011 South African census is 74 % Black African, 17% Coloured, and 9% Indian or Asian, and the main language spoken at home is 62% isiZulu, 30% English, and 8% other languages. *

The township was established 42 years ago as a consequence of the apartheid laws of "separate development." At that time 600 coloured families were relocated from different parts of the City of Durban into four-roomed council flats and semi-detached houses. Today Mariannridge

Eighth grade learners attending a Saturday morning tuition session

**[Source: 2011 Census data, https://wazimap.co.za/profiles/ward-59500013-ethekwini-ward-13-59500013/]*

has grown into a diverse web of communities with English and isiZulu as the main spoken languages. The area has seen growth in its population and additional housing development. Its socio-economic make-up includes large numbers of poorer households depending on state cash payments as their primary income.

In any socially challenged environment typical of contemporary South Africa, education becomes a key pillar for improving the livelihoods of the local people. In Mariannridge, where unemployment, poverty, and inequality present the biggest challenges, the need for quality and effective teaching and learning is seen as a pivotal development tool to change the lives of young people caught up in the poverty trap. Providing this environment within the confines of a socially challenging community environment is a huge task and riddled with day-to-day issues of substance abuse, ill discipline, low self-esteem, poor family systems, and lack of motivation on the

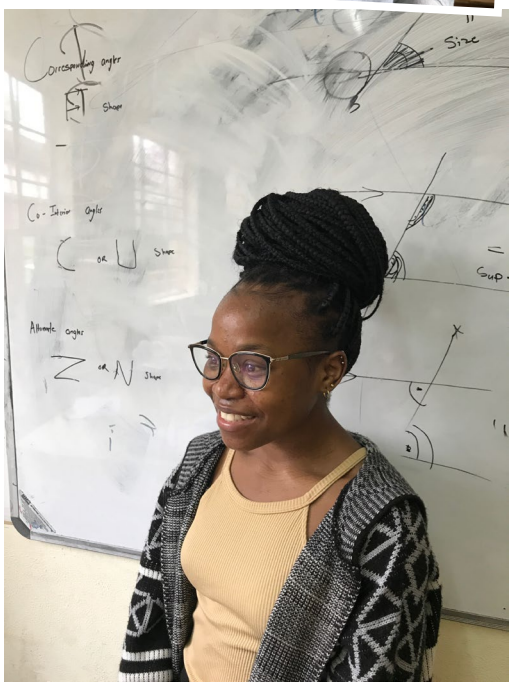
Left to right: Rotarian Mr Preggie Naidoo, Deputy Principal Mr Reagan Naidoo, Principal Mr Lucky Mtungwa and Rotarian Mr Martin Bucher.

part of many young learners. Educators find it equally difficult to function at their optimum in this situation. A large part of the engagement with children requires more than just educational input, but some social and sometimes even spiritual support for learners to cope, and therefore to remain at school, is also needed.

Mariannridge Secondary School is doing its best to live up to the school motto "strive to attain." In the 2020 school year Mariannridge obtained an 87 percent pass rate for the Grade 12 learners taking the NSC exam. Moreover 80 of the students were successfully registered into higher education with the support of the school principal. However, these achievements can be taken further. The quality of the passes can be raised if the conditions under which teaching and learning takes place are improved.

The school faces a number of day-to-day challenges: class overcrowding, absconding across all grades, high drop-out levels in the middle phase, poor classroom participation, and in many cases a bad attitude to learning. The teaching methods remain old and there is no technological advancement in the classroom. The state subsidy is already spread very thinly on the basic inputs to manage the school program.

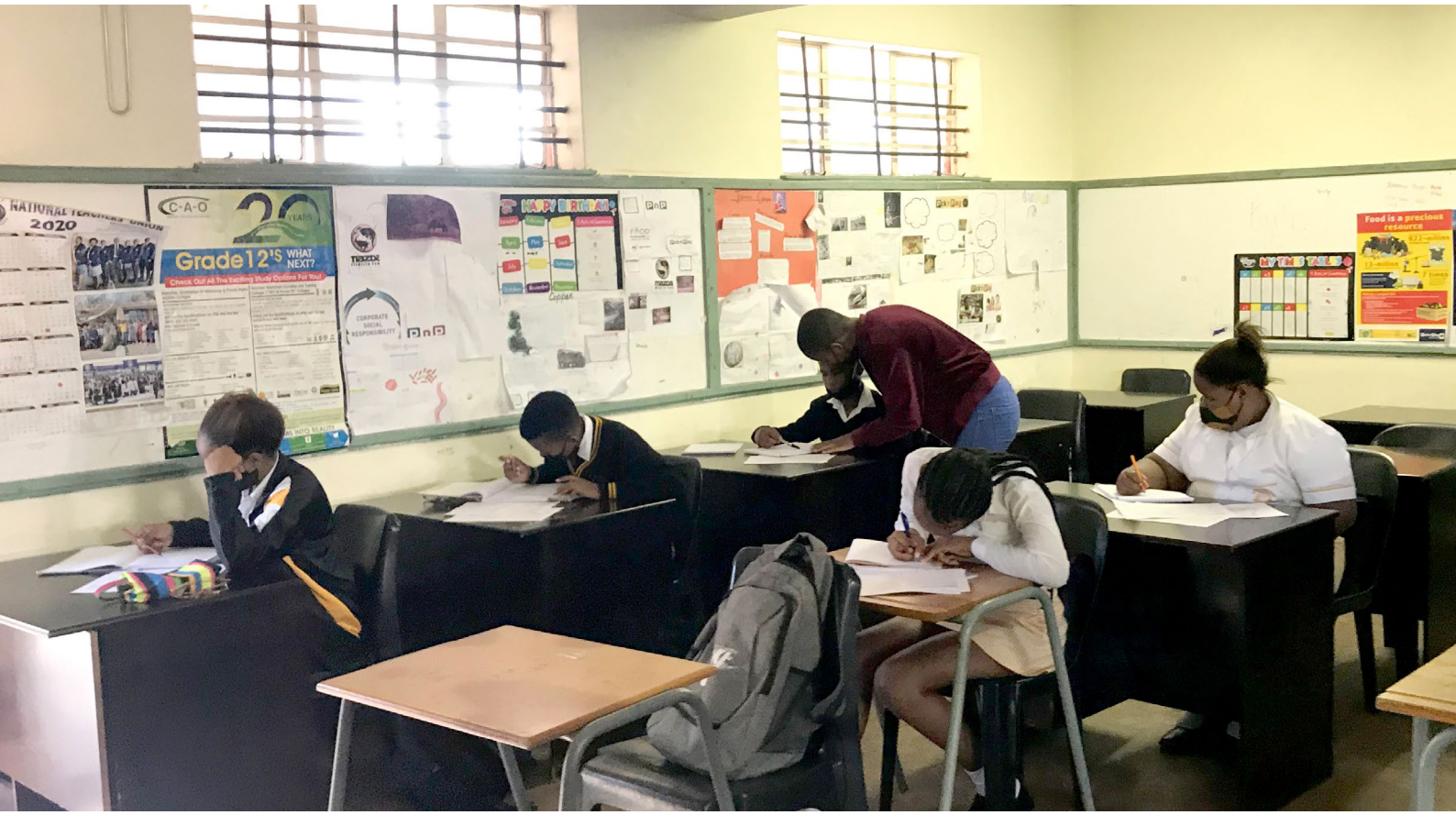
The post-apartheid South African Constitution guarantees a right to education, and efforts have been made to end discrimination and to prioritize funding to disadvantaged schools. However, these measures have brought limited results, and pre-university schooling in South Africa remains grossly unequal.



UKZN Tutors Nonsikelelo (top) and Mininhle Buthelezi (bottom) at work at Mariannridge

Under the present set-up, designed in part to avoid the proliferation of private schooling, state schools in South Africa have been encouraged to charge user fees where possible, which has the effect of attracting the best teachers to schools in more affluent communities through financial incentives and also encouraging parents able to afford the fees to send their children to more affluent fees-charging schools. Despite limited efforts to direct funding to less affluent schools in communities unable to pay fees, the end result is a state school system unable to provide quality educational opportunities to a large fraction of the South African population.

Comparatively, university education in South Africa, having been funded at a relatively high level, is in better shape. But many of the learners entering university from disadvantaged schools struggle to succeed because of the lack of an adequate preparation. Consequently, a large fraction of those entering university do not finish, and this especially applies to students from less advantaged backgrounds. Moreover, many schools do not teach or encourage those subjects required for university admission.



Students benefit from individual attention from the tutors

We consider it important to encourage learners at an early age to develop their mathematical abilities

In this proposal, we have chosen to focus on mathematics education, because maths serves as the foundation – or one might say common language – of all STEM subjects. With the rise of information technology, automation, and robotics in all sectors of economic activity, a solid foundation in mathematics will become increasingly important in the future. A trained workforce will be essential to maintaining and improving South Africa's place in the world economy.

The national Matric Examination, taken at the end of 12th grade, has two mathematics tracks: a higher level "Pure Maths" track, which is a prerequisite to university admission in all STEM fields and in medicine; and a more basic "Maths Literacy" track, covering a smaller range of topics. Many less advantaged schools encourage learners to follow the "Maths Literacy" track in order to improve pass rate statistics.

We consider it important to encourage learners at an early age to develop their mathematical abilities by providing an enrichment program where university students in STEM fields come to the school every Saturday during the school year for a half-day providing supplemental mathematics instruction.

Description and Evaluation of the 2020 and 2021 Pilot Programs

The outcomes in the 2020 year were that the pass rate for the pupils improved from 57% to 83%. The improvement was attributed to the intense support provided by the tutorials. Results of the success with the 2021 8th grade cohort are discussed in the support letter from school principal Mr Lucky Mtungwa (following page). A 96.3% pass rate was achieved for 2021.

We were able to secure the voluntary services of about 25 university students, who volunteered their Saturday mornings to the tutorial. They were picked up at one of two pick-up points and transported to the school. We subsidized the costs of their transport from home to these spots, and provided refreshments for the morning break.

FUNDS RECEIVED			81 774 ZAR
	Club member donations	8 500	
	Thathiah family donation	7 000	
	Fuller birthday donation	1 500	
	District grant 2021	5 500	
	Wu/Zhu donation	59 274	

FUNDS DISBURSED				
	July-Dec 2020			4 450
		Books	3 000	
		Transport & snacks	1 450	
	Jan-June 2021			6 012
		Transport & snacks	6 012	
	July-Nov 2021			11 144
		Transport & snacks	3 968	
		Legends acknowledgment	7 176	
			Total	21 606 ZAR

FUNDS AVAILABLE	(Nov 2021)		
			60 168 ZAR

MARIANNRIDGE SECONDARY SCHOOL

PO Box 11005
MARIANNRIDGE
3601

Tel No.: 066 243 0199

Email: mariannridgesec@gmail.com

ATT: Martin Bucher

The Grade 12 Maths Lit extra classes has been run during the year 2020. In 2020, the programme started with assisting Grade 12 Maths Lit learners and we had a tremendous improvement with learners moving from 60% to 86%.

In 2021, the programme focused Grade 8 Mathematics. This programme has been extremely helpful to the learners in this school and impacted positively on the performance of learners in Mathematics.

We had 53 learners who achieved Level 4 (50%) and above. This is a first for this school in achieving a large number of quality passes in Grade 8 Mathematics.

This programme was organised and co-ordinated by the Rotary Club – Durban Umhlatuzana. We recommend that this programme be expanded in 2022 to include the Grade 9 learners as well.

Analysis of Grade 8 Mathematics Performance - 2021

Number Wrote: 192

Number Passed: 185

Number Failed: 07

Percentage Passed: 96.3%

Thanking you in advance for your co-operation and dedication in the transformation of our school.

Yours in Education

Mr N.L Mtungwa - Principal

MARIANNRIDGE SECONDARY SCHOOL
TEL: 031 703 1112
2022 -01- 21
FAX: 031 703 1931
P.O. BOX 11005, MARIANNRIDGE, 3601

Description of Expenses and Budget

As detailed above, learners enter our programme in grade 8 and continue all the way through grade 12, so that each learner will have participated in the program for a total of 5 years. Our work with the first 8th grade cohort began in 2021, and in 2022 the programme doubled in size, taking on two grades simultaneously, that is grades 8 and 9, and in 2023 we will again add another grade, taking on grades 8, 9, and 10. The pilot programs in 2020 and 2021 were funded by seed funding from various sources, including a Rotary District grant for 2021 (for 5 500 ZAR), a gift from Drs Yang Wu and Yong Zhu for 59 274 ZAR, a gift of 7 000 ZAR from the Thathiah family, and various donations from members of the Rotary Club of Durban Umhlatuzana (amounting to 8 500 ZAR).

Instruction takes place in small groups with 1-2 tutors and about 10-15 learners.

The expansion and continuation of this programme, however, will require additional funding. We are seeking funding now for following the 2020 and 2021 cohorts all the way through to grade 12, and funding of future cohorts to be added in subsequent years, especially the new cohort starting in 2023. We believe that the present management structure of our programme has proven effective for two cohorts in 2022 and should work for three cohorts in 2023. This year (2022) we will invite the tutors to organise themselves as a student group, taking on at least part of the responsibilities for the day-to-day management of the Saturday tutoring and also participate in its pedagogical direction. We also intend to involve members of the Mariannridge community, who were identified as part of the Community Needs Assessment in preparation for submission of a Rotary International Global Grant application. These actions together with involvement of other neighboring Rotary clubs in this project should facilate eventually taking on five grades at a time and lead this project on the path of self-sustainability for an indefinite period, which is our ultimate goal.

Nature of expenses

The expenses for this project fall into three categories:

1. *Transportation:* We provide free transportation of the tutors to the school and back each Saturday during the school year. At present, we rent a large taxi, or sometimes two taxis, from two pick-up points, one at the Varsity Pharmacy near the UKZN campus and another in front of the Workshop shopping centre in downtown Durban. In some cases, we subsidise transportation to the pick-up point on an as-needed basis. We also provide refreshments for the tutors during the break.

2. *Tutor stipends:* To date tutors have contributed their time to the programme on a completely voluntary basis. We have not provided any remuneration to the tutors, and tutors have willingly volunteered. A good rapport exists between the tutors and the learners, and the tutors have expressed that they find their volunteer experience rewarding. We propose, however, when it becomes financially possible for us, to provide tutors with a modest stipend in order to partially remunerate their contribution. We propose to do so for two primary reasons: (1) the demographics of the tutors are not representative of UKZN students as a whole but rather more closely resemble the

demographics of the Mariannridge community, and the bursaries for study at UKZN do not suffice to cover all expenses for those UKZN students not receiving help from their families. As a consequence, many UKZN students find it necessary to supplement their university bursaries with income from part-time work. We therefore believe that it is worthy to remunerate this work in part in order to alleviate competition between class and study time, part-time work, and participation in this programme. Moreover, we believe that teaching is a valuable activity that deserves to be remunerated. (2) A risk for this programme is whether we will be able to recruit a sufficient number of tutors as the number of cohorts is increased. According to the above plan, our programme will be serving twice as many learners at Mariannridge in 2022 as in 2021, and three times as many in 2023 as in 2021, and so forth. One of the part-time employment opportunities for UKZN students is tutoring high-school students from more privileged families, or tutoring other university students through university student employment. After investigating the remuneration scales in these sectors, we have come to the conclusion that offering a stipend in the neighbourhood of 250 ZAR per Saturday is reasonable, as it is slightly below the market rate but at the same time provides a non-negligible supplement to the tutors' university bursaries.

We will continue to recruit tutors on a fully volunteer basis until we have secured the funds to be able to provide partial stipends in a sustained way, because once we provide some remuneration it would be difficult to transition back to the previous system.

3. *Pedagogical Materials:* At present the pedagogical materials consist of photocopied sheets prepared and provided by the school. We believe that the quality of the instruction and also its character as enrichment could be improved by providing each learner with their own textbook, as well as textbooks for the tutors, on loan for the school year. This would enable learners to continue their study at home and would provide a framework for a more coherent, organised enrichment programme. We propose a budget of R 500 per learner per year for pedagogical materials, accounting for collection and re-use in the next year.

4. *Computer education:* We feel that a hands-on basic education in computing would provide an invaluable supplement to the mathematics tuition that we are providing.

Proficiency in computing and an understanding of how computers function "under the hood" is becoming increasingly important in today's society. Moreover, as a rule, South African schooling in science and mathematics tends to be skewed toward learning facts and performing formal exercises, at the expense of providing opportunities for experimentation and creating things that work.

At present no instruction on computing is offered at the school. We intend to offer some computing as part of our mathematics enrichment curriculum. On a fundamental level, we would like to teach students the rudiments of one general purpose programming language, and to this end Python seems like the logical choice because of its simplicity

Some of the tutors in front of the school with Rotarians Mr Preggie Naidoo (left) and Mr Martin Bucher. (second from right). September 2021.

and widespread use. At the most basic level, Python can be used as a simple arithmetic calculator, but students will see how through the use of conditional structures and loops, more complicated programs can be put together. Moreover, students will learn how complicated programs can be structured using a hierarchy of functions and sub-programmes, and how libraries (such as matplotlib) can provide graphics and visualisation with a minimum of complexity. We will also teach a bit of HTML allowing students to create their own websites as well as some Excel and Word as some degree of proficiency with these standard software packages is essential for so many things. However, the main thrust of the computing instruction will focus on gaining a fundamental understanding of the computer, so that it is no longer simply seen as a black box hosting a variety of "apps."

We intend to purchase some computers for a school computer lab and also add some security features to secure to room against theft, as the computers from the previous computer lab were stolen. These computers will be used on Saturdays introducing learners to basic programming to enrich the maths education. We propose to design and implement a curriculum along these lines, drawing on our club's members who are university professors, who will work together with the tutors, called "Legends" by the school principal. The principal also reports that these computers will enable the school staff member in charge of administrative computing to teach an elective computing course taught during regular school hours.

Tutors and learners in the main hall at Mariannridge Secondary School.

Assumptions used in the budget calculations below: Currently there are approximately 250 learners per grade enrolled at Mariannridge Senior Secondary School, and the number of learners per grade attending the Saturday tutorials has fluctuated between 60 and 100. We use 80 learners per grade in our calculations below estimating the cost of this project. We also assume 8 tutors per grade in our calculations. There are approximately 36 weeks in the school year, which begins in January. The various categories in the budget below constitute our best estimation of the needs of this project, and the Rotary Club reserves the right to modify the distribution between the various categories according to the needs of the project keeping in the spirit of the aims of this proposal.

We promise to provide the funders yearly reports on the delivery of this project as well as detailed accounts.

Projected Budget for 2022-2026

We first establish a budget of projected spending per grade per year according to the following table:

Transportation	40 000 ZAR	
Tutor stipends	60 000 ZAR	
Books and other pedagogical materials	50 000 ZAR	
Total		150 000 ZAR (per grade per year)

Increasing the number of grades by one each year, we predict the following needs for the coming years:

Year	Grades	Number of grades	Cost (ZAR)	Cost (USD)*	Fundraising request (ZAR)
2022	8, 9	2	300 000	18 750	300 000
2023	8, 9, 10	3	450 000	28 125	450 000
2024	8, 9, 10, 11	4	600 000	37 500	600 000
2025	8, 9, 10, 11, 12	5	750 000	46 875	750 000
2026 & beyond	8, 9, 10, 11, 12	5	750 000	46 875	-
				Total ZAR	2 100 000
				Total USD	131 250

We intend first to raise 2 10 000 ZAR allowing us to expand the programme to its full size of taking on five grades during the 2025 school year. We also seek re current funding beyond contingent on continued success of the programme. As the programme progresses, we will revise the cost estimates based on improved estimates informed by experience.

Donors requiring a Section 18a certificate for exemption from South African income tax should contact us. **The above calculations assume an exchange rate 1 USD = 16 ZAR.*

Project Management

The members of the Durban Umhlatuzana Rotary Club will donate their time to the management of this project. This will be an in-kind contribution to the project. No Rotary Club member nor any of their family members will receive any remuneration. We will manage the budget, organise the recruitment of tutors, and in partnership with the school management organise the sessions each Saturday including the transportation. As the programme grows, we intend to establish partnerships with other Rotary Clubs in the area, so as to organise a larger pool of volunteers to draw from for each Saturday during the school year. We will also in consultation with school management define the curriculum for the Saturday enrichment sessions and provide appropriate training to the tutors. We also intend to form the tutors into a student group to take on part of the day-to-day management of the project each Saturday and to participate in defining its pedagogical direction.

About the Rotary Club of Durban Umhlatuzana

The Rotary Club of Durban Umhlatuzana founded in 1978 was initially intended to compromise the Bluff, Wentworth, Mobeni, Umlazi, Prospecton, and Chatsworth areas of Durban. The name Umhlatuzana means "a forceful little river running through a forest" in isiZulu. The Club is part of District 9370 (Southeastern South Africa and Lesotho) of Rotary International and meets weekly as a breakfast club. The club is currently composed of 13 members and meets at 7am every Thursday, now because of Covid in a hybrid format via zoom and in person at the Tropicana Hotel in South Beach.

Prof Thomas Konrad (left) and Dr Marco Mariola (right) from UKZN hand over learning materials to Principal Lucky Mtungwa (middle).

Umhlatuzana Education Fund (UEF)

The Umhlatuzana Education Fund (UEF) provides the financial management of this project. The Umhlatuzana Education Fund, NPC (https://umhlatuzana-education-fund.org/) is a registered South African Non-Profit Company (registration number 2022/383364/08). The UEF is overseen by a five-member board of directors, presently composed of three members of the Durban Umhlatuzana Rotary Club, a member of the Pinetown Rotary Club, and the Mariannridge Senior Secondary School Principal. An application to SARS (South African Revenue Service) for registration as a Public Benefit Organisation (PBO) with Tax Exempt Status and Section 18(a) status is pending. Section 18(a) status enables the UEF to issue certificates to donors allowing them to benefit from a deduction from South African taxation on their donations. The UEF has undertaken to provide audited annual financial statements. Arrangements are underway to allow US donors to make donations to this project through a US-based a 501(c)(3) organization participating in this project.

Umhlatuzana Education Fund bank account details:

Account Holder: Umhlatuzana Education Fund NPC
Bank Name: First National Bank
Bank Address: 6th Floor, 1 First Place, Simmonds Street, Johannesburg, 2001, South Africa
Account Number: 63002503068
Branch Code: 210835
Swift Code: FIRNZAJJ

Contacts

Professor Martin Bucher

CNRS Directeur de recherche (Université Paris Cité), Paris, France
and University of KwaZulu-Natal.
Email: bucher@apc.univ-paris7.fr; m.aaron.bucher@gmail.com
Tel: +33 (0)6 99 00 51 66 (current Rotary Club President)

Professor Thomas Konrad

Physics Department, University of KwaZulu-Natal,
Email: konradt@ukzn.ac.za
Tel: +27 82 389 3981

Mr Preggie Naidoo

PM Naidoo & Associates (Audiologists)
E-mail: pmnaidoo@dmc.org.za
Tel: +27 82 450 1686 (Club Project Coordinator)

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