

# COVID-19 International STEM\* Collaboration for Transformation Through Outreach, Awareness and Education

*"The power of education extends beyond the development of skills we need for economic success. It can contribute to nation-building and reconciliation."* Nelson Mandela

The International Collaboration for Transformation Through Outreach, Awareness and Education STEM\* is a group of voluntary international scientists, educationalist and outreach practitioners working together to contribute to a better society during and beyond the COVID-19 pandemic.

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**Rationale** The need for transformation of African and other developing countries' science landscape is now more crucial than ever. The COVID19 pandemic has highlighted the weakness of countries having large economic and social differences, where the pandemic spreads rapidly in the poorest areas (<https://www.aljazeera.com/news/2020/07/covid-19-cases-soar-grow-india-south-africa-brazil-200713145223397.html>, <https://www.wsj.org/en/articles/2020/07/04/covid-19-cases-soar-grow-india-south-africa-brazil-200713145223397.html>). Lockdown measures can decelerate, but cannot stop the pandemic throughout entire countries. As soon as the lockdown measures are relaxed – and they must eventually be relaxed due to economic constraints – there is a sudden surge in infections due to migration and increasing interactions, which affects the whole country. Although at the beginning of the pandemic the poor are the most affected, the spread of the disease quickly reaches the entire population without considerations on race, gender or wealth. Research, education and awareness are the most effective tools to deploy in combating this and other pandemics. Access to these, specially in STEM (Science, Technology, Engineering and Mathematics), is often unequal within the population, in both the Basic and Higher Education sector, in resource-limited countries. It is therefore imperative to develop programmes to increase STEM education of educators, learners and students using relevant and timely issues, such as the COVID-19 pandemic.

**Vision** A transformed STEM workforce. We believe that the negative and grim impact that COVID-19 is having in our lives can be tunneled positively to accelerate transformation, awareness and education worldwide.

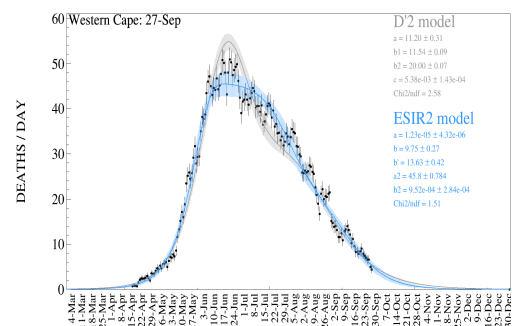
**Project outcomes** The end goal is to accelerate transformation through timely education based on Maths, computer science, data handling, modeling, physics, statistics, biology, chemistry and epidemiology. Particularly focusing on COVID-19, we want to sow the seeds for a new society with a high level of computer literacy and mathematics skills. A new society who understand the predictive power of science and can plan their future accordingly, supported by scientific facts, and is prepared for future pandemics.

## Project Description

### Research

Within the umbrella of COVID-19 – but not restricted to – we have developed computational programs, android apps and other computational and fundamental-science tools, which involve CERN-based ROOT codes in C++, Python, FORTRAN, Monte Carlo simulations, etc. These are based on simple epidemiological models that we have developed to follow the evolution of COVID-19 coronavirus worldwide (<https://arxiv.org/abs/2005.06742>) and use official data from Worldometer:

<https://www.worldometers.info/coronavirus/>



The overall program encompasses the fields of epidemiology, modeling, computation, mathematics, biology and physics. Some of it is already being implemented at the Universities of Pretoria, Western Cape, Nelson Mandela and Zululand. This project is open to any South African and international Universities and institutions who wish to join. The idea behind this proposal is to expand this project to high-school learners and the layman in general, as a well-educated country is the principal key to transformation.

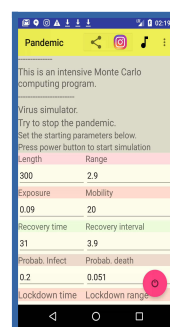
Our simple models have been proven successful in characterizing the different stages in the evolution of the COVID-19 pandemic in many countries and provinces and have predicted the end of the exponential phase or the localization of the pandemic peak. A plot showing our prediction for the Western Cape is shown above. Further research is being undertaken in order to improve our models and predictions, where postgraduate students will be involved.

## Education

Covid 19 presents an opportunity for us to re-imagine the mathematics and science content at school level. In South Africa, the number of learners who study pure mathematics beyond Grade 10 has been on a decline in recent years. Majority of those that follow this stream tend to perform poorly at Grade 12 level. We will work with Science and Education departments at universities to develop teacher and learner resources that can easily be deployed in the classroom. A similar program is already ongoing in the Physics & Astronomy department at UWC - as shown in the right figure - which will be expanded to other fields. Good quality teachers will, in turn, increase student retention, throughput and success in the Sciences at high school as well as awaken learners creative mind towards the 4<sup>th</sup> Industrial Revolution and STEM awareness about issues which affects them. Through science awareness, we also want to keep teachers up to date about current issues which affects society, our everyday life and might have implications for our society's life now and in the future.



You can do your own Monte Carlo simulation in your Android!



This project is at an international scale with collaboration across countries which imply that small scale programmes, teacher Development workshops and Short Continuing Education Courses to enrich Teachers knowledge on computer science and the skills to research will be part of the PC and research laboratories at universities. Postgraduate students will also be involved in this massive outreach, teaching & learning program. We show above one of the Android apps created by the collaboration, where students can simulate and stop the pandemic from spreading by changing some of the parameters involved. Besides using WhatsApp, ZOOM and other platform meetings and illustrative videos (e.g. <https://www.youtube.com/c/NicoOrce>), we shall visit school learners at their respective schools in order to engage with them and encourage them to pursue further studies with the fun of learning new computing skills and Android apps. Preliminary computational practices have already been carried out and these are some of the feedback from 2<sup>nd</sup> year Physics students at the University of Pretoria:

*"These practicals showed me that it is important to remember that the modelling of a relationship is based on many assumptions and that predictions remain subject to tiny changes in data as it progresses. Our power of prediction however increases greatly with an increase in data. I think this is an important lesson for science in general, the more we observe the more we learn."*

*"It was nice to hear from one of the authors on the topic."*

This work is solidly founded in a recent paper entitled "Global analysis of the COVID-19 pandemic using simple epidemiological models" published in one of the highest-impact Mathematical journals "Applied Mathematical Modelling" (impact factor: 3.633) by José Enrique Amaro, Jérémie Dudouet and Nico Orce. <https://www.sciencedirect.com/science/article/pii/S0307904X20306028>

Yours Sincerely

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