

The Imprint of Education

The Imprint of Education (TIE) is a project of the Human Sciences Research Council (HSRC), South Africa, in partnership with the Mastercard Foundation that is exploring the post-graduation trajectories of Mastercard Foundation Scholars Program alumni. TIE is investigating topics such as ethical and transformative leadership, give back, employment and entrepreneurship, student support and mentoring. It consists of five sub-projects or learning activities. The TIE project principal investigators are Prof. Sharlene Swartz, Dr Alude Mahali and Dr Andrea Juan.



Reimagining the African University – Conversation Series

Learning Activity Four consists of a series of conversations with experienced scholars and thought leaders on the future of higher education in Africa. In Reimagining the African University, they discuss challenges, best practices, and the potential for innovation to initiate further dialogue. This transcript is part of a series of interviews conducted in 2021 and may be used with appropriate attribution for scholarly purposes. The learning activity is coordinated by Prof. Thierry Luescher, under the intellectual leadership of Prof. Crain Soudien.

Interview with Prof. Neil Turok

Interview conducted by Prof. Crain Soudien on 21 June 2021

Soudien: Could you provide a sense of what your relationship is with the African academy?

Turok: Well, I grew up as a child of political activists in Africa who were connected with universities. My father [South African anti-apartheid stalwart Ben Turok] worked at the University of Dar es Salaam in Tanzania and I grew up in a culture where universities were a key element; and, of course, many seminal ideas in the liberation struggle were incubated at universities. My father also set up the Institute for African Alternatives which is a pan-African think tank involving pre-eminent economists and development theorists across the continent. So, all that influenced me from when I was a child.

But then in my own career, I focused on pure research in theoretical physics and mathematics which sort of disconnected me from my background. So, once I had established myself as a researcher in those fields at Princeton, and Cambridge universities, I realised there was something missing in my life which was a connection to my roots. As a consequence, when I came to Cape Town in 2001 for a sabbatical, I explored the idea of some kind of collaboration between the University of Cape Town (UCT) and Cambridge University with the goal of providing a low-cost, high-quality opportunity to brilliant young mathematical minds in Africa.

I had already realised that there was great untapped potential in the region because, when I was 17, I taught for nine months at a mission school in Lesotho and had seen village kids

solving tricky conceptual problems in maths and geometry. So, I knew African pupils had just as much talent as kids in the West and a lot more motivation besides – and that such a project would work.

I came to the idea without any background as an educational or development theorist, but I had a practical advantage – my eldest brother is an entrepreneur who has established a chain of fitness centres. So, I approached him for help. I said to him: “I want to set up training centres where people learn maths and these would be residential and you would get the top lecturers in the world to come and live with them. How should I go about this?” And he said: “It is just like a fitness club. You have got to have a business plan, you have got to prepare the food and the facilities, and you need to make sure the toilets are clean.” He mentored me.

So, all in all, I sort of came to the project from left field. At the same time, it seemed to me that the existing institutions – and it sounds harsh – provided examples of what not to do.

The simple fact is there is an abundance of human talent in Africa, but it has not been coming through into advanced technical fields. Looking at the number of publications from Africa, the number of patents submitted, the number of innovative companies, there is a dearth on the continent – but there is no reason for that given the relative youth of the population and the drive among the young people, who are more motivated to learn than their peers in the West. The youth in Africa have got everything going for them except the channels that are required to gain the skills that they need.

So, in an experimental mode, the decision was taken to buy an old hotel, convert it into a state-of-the-art centre for learning maths and computer skills and try and expose African students to frontier fields. On the practical side, the courses explored such technologies as remote sensing for agriculture, which includes how satellites can be used to identify the conditions for growing crops across a country (which can help farmers decide what to plant). Meanwhile, other courses taught theoretical stuff, such as abstract mathematical thinking. So, a unique mix of courses was created which would have been impossible in the more conservative environment of a university.

Having forged the plan for the centre, I sought support for its establishment at a meeting of the mathematics faculty at Cambridge. I said: “I want to suggest something really unusual and risky. We are going to put students from all over Africa in one building. The students may riot, they may set fire to the building and this will all be done in your name. But I want you to officially endorse this centre.” And, to my total amazement, they said: “Yeah, this sounds good.” Subsequently, Oxford University did not want to be left out, so they signed up too. And then the ball started rolling and UCT, Stellenbosch University and the University

of the Western Cape (UWC) also offered their support which provided important academic legitimacy.

At the same time, it was made clear from the outset that the project was experimental in nature: Put these very bright kids together with some of the best lecturers in the world and see what new ideas emerge as a result.

So, the *modus operandi* of the centre was to be quite different from that provided by most universities, which is not to decry the value of these institutions. In my view, the university is the greatest invention of all time without question. It is the place where ideas are discussed for their own sake. It is the place where we get to think about what we are doing with the world. The problem is that universities also tend to get in each other's way a lot and can be quite conservative in their approaches to pedagogy and research.

In response, the goal in establishing what came to be called the African Institute of Mathematical Sciences (AIMS) in Cape Town was to create an autonomous boutique centre which would be beyond the control of any one university. The ethos of the new institution was to bring together a bunch of bright people with very few constraints and to provide them with a space in which they could share their skills and ideas – that is, a comfortable environment but also a challenging one. The students were presented with an opportunity to show what they could do. In general, the aim was to foster the production of new ideas from both the students and the lecturers.

In this regard, the lecturers are told: “Throw away your usual notes, you have got some very bright kids coming from all over Africa – the brightest. They are extremely motivated, but they will not have any background in your field. This is your chance to tell them why your field is exciting, but you only have three weeks.” The lecturers are asked to pick what they consider to be the three most amazing ideas in their field and share these with the students. So, in the morning, they offer a lecture and, in the afternoon, they have a problem-solving session during which they work with the students in real time to find solutions. The institute offers two courses at any one time which are run side by side; and the lecturers teaching these live in the same building as the students for the duration. In addition, there are tutors on hand to support the lecturers. So, the pedagogy is intense.

In seeking to address the problems raised by the lecturers, students can use computers and, of course, the internet. In this regard, the educational model offered by AIMS would not have been possible without the digital world. The internet is used to recruit the teachers and the students; and to provide an abundance of material in support of the actual courses. In addition, during the early days, the provision of free high-bandwidth, 24/7 internet

access created a real sense of excitement among students, many of whom had previously been spending a large fraction of their income going to internet cafés across the continent.

The enthusiasm and efforts of the students have been a further major factor in the establishment of the institution. For example, a nice library of mathematical books was donated but it was not catalogued. Normally it costs about a dollar a book to catalogue properly. So, one of our tutors wrote a programme with the United States (US) Library of Congress and then the students typed in the book titles, printed the labels and applied them. In two or three days, 5,000 books were catalogued.

Then it became necessary to institute a system for checking the books in and out. One technological solution was to institute a detector arch, but this would have cost \$10,000. So, instead, volunteer students in need of money were paid a modest sum to check which books were on each shelf once a week. Thus, a real sense of ownership was established among the students – this was their library – and in the whole history of AIMS, I have never heard of more than one book going missing from that library of 5,000 over the course of a year.

It must also be acknowledged that this project could not have been realised anywhere else but Africa. In North America and the United Kingdom (UK), the students are, as a general rule, fairly privileged and may even feel entitled. But the students coming from Africa are just the opposite. They have been deprived and they are really hungry for learning, so there are incredible levels of enthusiasm and excitement.

And then of course their cultural diversity makes it really interesting for any lecturer. You come in and you have got Muslims and Christians and Francophone and Portuguese and Arabic speakers all in the same class; and they are all looking at you like are you going to tell something ground-breaking.

In general, these students have been marginalised from the discourse, from leading-edge intellectual thinking – and they know it, and they really want to be part of it. These levels of enthusiasm create a special atmosphere and a number of excellent outputs have been produced as a result. For example, the best book that has been written on quantitative estimates in climate change, *Sustainable Energy – without the hot air* by David MacKay, emerged one year when the author was lecturing at AIMS on statistical physics and computer modelling and the topic of climate change was raised. A series of 24/7 conversations started, which continued over breakfast, lunch and dinner – even into the middle of the night – as the students posed questions relating to the connections between the climate and energy production. And this volume, which is now a standard text book on

the subject, was written based on these discussions – and as a product of a new set of cultures coming into science.

The courses can also fulfil an important myth-busting role. For example, in teaching a course on the electro-magnetism of relativity, I like to say to the class that our forebearers – the pioneers of our fields – all got it wrong in that their theories were always eventually superseded by better ones. For example, Albert Einstein showed that Isaac Newton’s laws of motion are wrong – and, when teaching, I give an instance of where they fail. At which point, during one of my classes, one of the students, who was studying physics in the Congo, revealed that this was just not something that was taught in his country, that no one knew that Newton was wrong. This is a particular problem in Africa where technical subjects especially are taught as if this are gospel – which, I think, derives from a general lack of confidence on the continent.

But the reality is, if you have got certain key quantitative skills; you are good with numbers and you are good with computers; and you have got a logical mind, you can enter any field in science. You have just got to have the drive.

In this regard, African students also enjoy the advantage of not having been brainwashed into thinking within academic silos like so many of their peers in the global north. They tend not to see the silos, which enables them to take bits and pieces from here and there and put them together in new ways. That feeling of not knowing something, of not claiming any prior right to knowledge is actually a very good spirit in which to enter research.

So, what happens at AIMS is that the students start to appreciate what they are able to contribute academically and their self-confidence grows. The process is also helped along by their day-to-day proximity to these brilliant academics. They live with them, which makes them feel special. It is like a football academy run by star players. You just put the kids next to Cristiano Ronaldo or whoever and it is going to rub off.

From a systemic point of view, the success of AIMS has revealed a shortcoming in the international university system – which is that there is a need to create more fast-tracks. The system is too slow for many students. For example, during the Scottish Enlightenment of the late 18th and early 19th centuries, children as young as 14 were going to university, including the philosopher David Hume, who went on to start writing his classic treatise *An Enquiry Concerning Human Understanding*, in his 20s. So, returning to the present day, the question is: What are we doing to slow people down? In this regard, it seems that the university system is operating at an extremely sub-optimal level.

Although it may be too difficult to solve this big problem all at once, it is possible to create little avenues here and there – and especially in Africa because it is so very important to demonstrate that young Africans have the same potential as anyone. And one of the best ways of doing this is through the power of example. To take just one of the many examples at AIMS: a student from a large peasant family in Cameroon who was driven by his love of pure maths took his master's at the Institute before going on to Stellenbosch for his PhD, where he won the prize for the top mathematics doctorate in the country – no mean achievement. He is now a lecturer at UWC.

In other words, the possibilities are great. So, the mission must be to open universities up to this idea. There is an ocean of talent. The question is: How do we remove the barriers preventing this talent from flourishing?

Soudien: Is there anything more that you think you could be saying around the purposes and the roles of the university; the issue of relevance; competing visions for the university; and the issues of access, funding support and transitions?

Turok: My own experience has been of a small initiative aiming to do something quickly and of high quality. So, I would say that universities must try to do more to enable such initiatives and to challenge their faculties to propose such initiatives. If universities become too cloistered, they will fail.

In this context, I think a further fundamental problem at universities is that academics in general have zero skills in initiating projects which are external to the university. I was never trained to do this kind of thing, I was basically told to publish papers, and encouraged to win prizes and seek promotion – all within the narrow confines of the discipline. But buying a building, fundraising: that requires a completely different set of skills.

Therefore, I think more academics need to be trained in how to produce a business plan so that they can foster greater change. Students also should learn how to write a business plan so that they can turn their ideas into reality more effectively. The approach should be to empower students – to foster the belief that they can put their skills to great use. Again, this is particularly important for African students who feel disempowered by an educational system which focuses on rote learning and in which the pedagogic method is very prescriptive.

In this regard, the main challenge for universities in Africa is to help the students change their mentality from passive to active. The students have got to realise they have it within themselves to reconceptualise the world and to make their own future in it. And the capacity is there – as is the required depth of experience. For example, one of the courses

at AIMS teaches mathematical modelling for epidemiology – and the South African students who engage in this, particularly when the topic is HIV/AIDS, bring new levels of intensity, relevance and authority to the discussion because they know the consequences – it is their own communities they are talking about.

Soudien: So, what has been the impact of how the lecturers and students have experienced AIMS in relation to the partner institutions with which the Institute has been working? How have the insights that have been gained rebounded back into these really difficult spaces?

Turok: The lecturers from around the world who come to AIMS invariably say this is the best ever teaching experience – which I think offers a valuable lesson for universities in terms of keeping academics motivated. One of the best ways to motivate scholars and lecturers is by showing them what they can do – for example, that they can get a whole new body of people interested in academia. The experience may be compared with that of teaching in neglected communities or prisons in the US or the UK, which is voluntary work that a number of good, spirited academics in those countries undertake. However, the divisions in these societies are deeply entrenched and the students there are often suspicious – and a huge amount of exhausting effort on the part of the academics is required. By contrast, African students who come from deprived backgrounds are desperate for education which they believe is their avenue to the future – so the feedback is more positive and the impacts are more visible.

Since it was established in 2003, AIMS has produced about 2,300 graduates at master’s level, of whom 600 have undertaken PhDs, which is a very high yield on the cohort. This indicates a high level of motivation among the students. So, the example of AIMS should encourage universities to be more creative and ambitious in their projects.

Another aspect of AIMS from which universities may learn is its multi-cultural nature and support for gender equality. A minimum of 30% of every class are women and at least 70% must come from beyond the host country. Indeed, the selection process aims to bring together students from across the continent. Mixing students from Egypt and Nigeria, from South Africa and Madagascar, produces its own energy and provides an educational experience in its own right. Often universities are constrained by national policies under which, understandably, governments seek to prioritise local efforts; but, unfortunately, this deprives them of the dynamism of multi-cultural education. In this regard, AIMS offers an example of a dynamic, competitive, relevant approach to education – of a spirit that modern higher education institutions tend to lack.

Soudien: Could you talk a little more about the implications of new technology in relation to pedagogy, as well as the role of indigenous knowledge as you see it?

Turok: The internet and the wide availability of tools such as laptops has been extremely empowering. With a little bit of guidance and some online networking, the students at AIMS quickly learn to filter what is on the internet and find the good stuff. So, the new technology has been a significant plus for AIMS and it has meant that the Institute kept going through the pandemic – although online teaching and learning is definitely second best. The new technology has also produced the possibility of expanding the educational offering in an engaged way. For example, we are contemplating establishing parallel online classes. For each 50 students in the room another 50 will be online, each of whom will be able to engage in the actual proceedings through a proxy student. Although it will not be as good as actually being there for the online students, it wouldn't be as disconnected as a MOOC (massive open online course). The aim is to find a balance between in-person and online which would allow the Institute to expand its class sizes.

On the issue of indigenous knowledge, one of the big messages that we try to convey at AIMS is that mathematics was invented in Africa. So, all of it is indigenous knowledge. Some of the oldest mathematical artefacts are African: 80,000-year-old equilateral triangles are etched in stone at Blombos Cave in the Western Cape in South Africa; all the prime numbers below 20 are notched into the 20,000-year-old Ishango Bone which was found in what is now the Democratic Republic of the Congo; and, famously, pyramids comprise an ancient astronomical observatory in southern Egypt. So, let us reclaim mathematics, which is one of the most valuable pieces of intellectual property in the world.

Indigenous knowledge also makes an invaluable contribution through belief systems. I have never gone along with atheists such as Richard Dawkins who disrespect faith. Their views are not helpful, because the truth is: we do not know. In addition, religion can provide people with moral courage and an appreciation of the virtues of tolerance – as has been shown in South Africa through the example of Archbishop Desmond Tutu and others. When people enter into religion, and acknowledge something bigger than themselves, it helps get rid of some of their egotism.

At AIMS, the mixture of religions among the students has produced contestation but also greater tolerance and a deeper understanding of different ways of seeing the world. In addition, traditional beliefs can provide an interesting perspective on some of the theoretical physics taught at AIMS. When I am telling students about the big bang, black holes, the universe and neutron stars; and they are coming at this with a frame of mind which includes ancestral spirits and magical creatures which appear in the dark, that is actually a very interesting conversation. Both of these models of seeing things are predicated on uncertainty and both of them involve narratives. After all, what is theoretical physics anyway? It is a tale that is told in which some strange things happen. For example,

according to quantum physics, a particle is never in one place; it is everywhere at once. But how can this be? How can it be a particle if it is everywhere at once? So, this is a story which in some respects does not make sense, but it is a tale we tell ourselves – and then we conduct experiments and say: “Yes, it has some validity.” So, in this respect, I think it deepens our understanding to encounter other stories, other creation myths, other perspectives and to try to justify our own stories in the context of these cultures.

The interaction between different frames of reference can be productive and enriching. For example, AIMS teaches mathematics in what may be called the western anglophone style. It is an empirical approach which uses examples to illustrate and teach. However, there is another more abstract, French style, in which students from francophone Africa are inducted. This can lead to a clash of styles at AIMS, but also to a fruitful comparison of their virtues and drawbacks and a deeper understanding of the practice of mathematics.

The first year that AIMS was established, a Congolese student, who had previously been taught in the French way, presented a short lecture contrasting the anglophone and francophone styles of mathematics. He went through the differences – this is more empirical, that is more theoretical; this is more practical, that is more abstract – but he did not pass judgment. He concluded by asserting that he was not saying one way was better than the other, but just that they were two different approaches – which shows a level of maturity that would not be found in the West, where most students would not even know that there was such an issue. This student subsequently went to Stellenbosch University where he produced publishable – that is, original – work for his master’s in quantum physics, which is a great achievement. This example shows that mixing cultures fosters open-mindedness which goes hand-in-hand with originality and which is a driver of new thinking.

Soudien: Is there anything else that would be valuable for us to know about, as we think about the future?

Turok: People in South Africa and Africa more widely who work in academia do not realise the treasure house in which they are sitting. They often, quite understandably, feel overwhelmed by the problems, by the obstacles, by the slowness of the bureaucracy, and by the enormous challenges they face with the students they are teaching. What they do not usually realise is the latent dynamism of their situation.

When people come from outside South Africa to visit, to lecture, to interact, they find the work energising and important. So, I wish universities and academics in South Africa, which is one of the very few black-majority, advanced democracies, had more of a sense of

the leading, trailblazing role they are playing – and how crucial their success is for the world and the shape of its future.

In this regard, it is important to find ways of supporting and encouraging higher education institutions and staff in South Africa; and there is a willingness among the international academic community to help in this regard. The success of South Africa’s democracy is seen as critical for the future of the world; and engagement to support its education system is viewed as worthwhile, and a more meaningful use of one’s time than many of the projects that have been launched in developed countries.

For example, Moustapha Cissé, who made a name for himself by pointing out the bias in Google’s search algorithms and now works at the internet giant, came and taught at AIMS and then recommended the Institute to other pioneers in the field. As a result, he came to establish what is now perhaps the best course in the world for machine learning and artificial intelligence (AI) at the Institute – and AI is currently the hottest field in science. That is the spirit in which AIMS works –only the best lecturers are good enough for Africa – and that should be the spirit in which academia in South Africa and the continent more broadly works. Africa has got to get into the game and it will not do that by following. The roots of the mathematical sciences were in Africa and now they are coming full circle and need to be brought back to the continent. Africa needs to own AI. In fact, those working in the technology sector know that there is an ocean of talent on the continent which they will need to deploy in order to keep innovating – and they have the money to invest. So, the question is: How can technology sector be encouraged to give back to Africa?