

STEM Education: disruptions and the future

STEM – Science, Technology, Engineering, Maths – education has become increasingly significant to the world, and invaluable as it offers advantages in a myriad of fields. It is changing as countries embrace advanced technologies for teaching and learning. There are also new expectations from the Department of Basic Education (DBE), as robotics and coding have been added to the national curriculum so that all learners can learn about digital technologies.

At the same time, there have been many major disruptions to education in South Africa over the past three years: the Covid-19 pandemic with school closures and rotational teaching, riots in KwaZulu-Natal (KZN) and Gauteng in 2021, and flooding over a large part of KZN in April that destroyed houses and schools and killed more than 430 people.

Professionals in science, engineering and technology (proSET) – a membership sector of the National Science and Technology Forum (NSTF) – hosted an online forum on 29 and 30 August to unpack STEM education. The discussion focused on five key areas of concern:

- The effects of recent disruptions on STEM education
- Remote learning
- The urgent need for awareness of STEM subjects
- Creativity and STEM education (or STEAM)
- Exposure to 4IR technologies such as robotics and coding

The event had three core objectives: raising concerns on behalf of the science, engineering, technology (SET) professional associations in the NSTF; approaching STEM education from the perspective of various stakeholders and experts; and collating the best ideas for solving the challenges to STEM education.

Inclusivity and innovation in STEM education

Dr Nnditshedzeni Eric Maluta, Vuwani Resource Centre and Head: Department of Physics, University of Venda; and 2022 NSTF-South32 Communication Award winner, was the keynote speaker on Day 1. He unpacked the importance of awareness of STEM subjects among learners and the role of the Vuwani Resource Centre. He opened the discussion with a deep dive into the value that the centre offers the community.

Maluta explained that the centre is surrounded by four secondary schools and six primary schools that are within walking distance and its focus is to offer a more rural lens on STEM subjects, particularly as some children reach grade 12 without having touched science equipment. He said it's a painful reality that needs to be addressed so learners can understand the world around them and use technology to engage with it.

For Maluta, the Vuwani Resource Centre plays an invaluable role in providing interactive, hands-on experiences with science that are both relevant and understandable. He concluded with an emphasis on collaboration with industry and organisations to create awareness and connections so as to drive engagement

with learners in rural areas and push for the advancement of STEM subjects.

Doing digital offline and finding creative solutions

Dr Derek Fish, Director: Unizulu Science Centre, University of Zululand, (also an NSTF award winner some years ago), and a keynote speaker on Day 2 discussed 'Doing digital offline and finding creative solutions to bridging the digital divide in South Africa'.

Fish emphasised that the children of South Africa need to have access to good science and maths teaching. In some ways, the pandemic was a disruption which allowed us to break the digital divide in more ways than before and made learning more accessible to rural communities, he said. Not all children have the same opportunities, most are "looking through the window" at STEM education.

However, if learning is done with offline digital materials, all learners can have access. It can be the use of innovative technologies that brings education to everyone. He shared many examples of digital learning materials compiled by the Unizulu Science Centre and saved on a USB stick for distribution to schools. These are exciting and interactive materials presented in a way that will assist teachers to incorporate the material in their teaching, he said.

Disruptions due to Covid-19

Dr Andrew Paterson, Innovation and Research Specialist, JET Education Services, spoke about the impact of the pandemic on education. Research undertaken during the most acute period of Covid-19, while it has dated in some



respects, provides insights to identify what is considered relevant today. The report, published in partnership with the Commonwealth Secretariat in 2021 and commissioned by Rhodes University and the Open Society Foundation, found that it's important to engage with parents and support them so they can interact positively with their children. There appears to be a gap between the roles of parents and schools, with parents needing guidelines on how to assist them. The pandemic and lockdown showed that parents continue to have an important role to play in their children's schoolwork.

Ellie Olivier of the South African Mathematics Foundation (SAMF), talked about the 'Challenges in mathematics education from the perspective of a mathematics Olympiad organiser'. She started with an overview of the obstacles in mathematics (maths) education – overcrowded classrooms, poorly qualified teachers, few matric distinctions and schools without maths teachers. Olivier said it is essential that learners master the content presented at each level so they can grasp the next level. Many learners are unaware of how interesting maths can be, or how it can expand their knowledge. She has

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found that through olympiads, learners discover a love of maths. These competitions can become an invaluable learning resource with research showing that schools regularly competing in olympiads show improved performance. At SAMF, awareness of the importance of maths is advanced through competitions, engagement and making it fun for learners so they can expand their understanding and grow their skills.

Remote schooling and digital learning

Bez Sangari, Sangari South Africa, talked about 'Education technology solutions for remote schooling'. For Sangari, there hasn't been as great an innovation in teaching and learning since the printing press as online learning, but that requires a change in the strategies that shape learning. He said that content, learning methodologies and training are key to ensuring the success of online learning and engaging with both learners and educators.

Kgaugelo Pule of the NSTF shared the NSTF/proSET's digital learning tool, STEMulator.org and demonstrated how it provides STEM career information in context. The application can be used offline and is distributed to high school teachers on USB sticks.

STEM education and creativity

Tshidi Morabi, the owner of Ginini Consulting, an IT business consulting and IT training company, examined 'How to teach learners to be innovative? Does it make sense to include creativity as an aspect of STEM teaching and learning?' She highlighted how she had seen a need for STEM education and established her company to inspire learners and teach them how to become innovative within STEM. Morabi said that by adding creativity, learners enter the classroom to collaborate and are stimulated by engaging with teachers. It is a way of building confidence and enthusiasm that blends the different disciplines and allows for curiosity, exploration and sound learning.

Skills: practical and cognitive

Prof Ian Moll, School of Education, University of the Witwatersrand (Wits), spoke on the 'Pedagogy of technical and vocational skills: robotics and beyond in the South African school curriculum'. Moll said that it is important for learners to acquire skills but he is critical of the way in which robotics and coding have been included in the curriculum without thinking it through and explaining the context and pedagogy. Learners should understand why these aspects are taught and they should not be approached merely from the perspective of practical skills. Understanding and critical thinking skills are essential to education. The meaning and societal implications of the Fourth Industrial Revolution should be approached critically, he said.

The future unpacked

During the event, important points around skills development, learning, education equality and STEM, as well as STEAM (including the arts), were raised. The discussions were intense and focused, drilling down into the essentials of the

topic and finding inventive ways of approaching the various challenges to effect real and lasting change.

Recommendations

1. Education should be aligned with the skills needs of industry, entrepreneurial skills, 21st century skills and societal needs.
2. STEM educators must be capacitated on both pre-service and in-service levels.
3. Good STEM teaching should be modelled for teachers and not only taught.
4. The national curriculum should be revisited on a regular basis and teacher training provided when new aspects are added.

5. All learners need to have the basics of STEM subjects and awareness of the future choices these subjects can open up.
6. A 30% pass mark is not enough.
7. Learners who intend to go to university need to be better prepared, while others have an urgent need for practical and vocational skills.
8. Systems thinking skills are very important and lead to making connections across various subjects and with real-life applications, such as climate change and sustainability.
9. Critical skills are essential to learning and preparing learners better for the future and to counter misinformation spread by

10. social media, politicians and news media.
10. Good practice to boost STEM education includes: well-managed team work, independent learning, hands-on learning, creative and critical thinking, the building of understanding and learners' confidence, exposure to technologies, cross-disciplinary work, and opportunities to participate in national and international competitions and olympiads.
11. Parental support is always important, and is critical during remote learning.
12. Initiatives to improve STEM education and well-made, educationally responsible digital learning materials should be supported.



NSTF's booklet on Science Based Career fields is a useful tool for high school learners, parents and teachers – especially Life Orientation teachers. More than 100 careers are described. It assists learners to choose subjects for grade 10, and to pursue studies after grade 12. Engineering, Medical and Social Sciences are included.

What makes the booklet truly unique is that careers are labelled according to their relevance for the future, with the use of icons. There are careers related to the 4th Industrial Revolution, Green careers (that are important for environmental sustainability) and careers that involve some creativity. Bringing creativity to careers is important for the future, as automations and artificial intelligence take over jobs that were done by people until recently.

Find the Booklet on www.nstf.org.za under Youth.

We hope that you will find this compact booklet a great help in navigating the confusing world of careers.

The NSTF provides neutral collaborative platforms where issues and sectors meet

- One of the National Science and Technology Forum' (NSTF) functions is to hold discussion forums, bringing the private and public sector together in a quadruple helix of stakeholders to address important issues and engage with government policy.
- Information and videos from these discussion forums are publicised and made accessible.
- Recommendations are made as part of the SET community's (science, engineering and technology) efforts to give feedback on policy-related matters.
- proSET (Professionals in SET) represents the professional societies and councils in the NSTF and has about 40 member organisations participating as key professions of the SET and innovation community. The proSET Committee plans and hosts an annual discussion forum.

Other presentations

- STEM education innovations, including remote learning, robotics and coding, and any other innovations, by Dr Kgadi Mathabathe, Deputy Director: Education, University of Pretoria.
- Career guidance and awareness of the importance of STEM by Kgaugelo Pule, STEMulator Research Assistant, NSTF-proSET
- Enabling innovation through creativity and collaboration by Kathryn Kure, CEO: STEAM Foundation NPC.





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