

## Short Summaries of STEM Engagement Projects available for Secondary Schools in 2023

*The GMMDC is a specialist engagement entity based in the Science Faculty of the Nelson Mandela University. The Centre's mandate includes the implementation of innovative educational support models for teachers & learners, STEM skills development and the promotion of STEAM education in secondary schools.*

### O. Background

The ongoing poor learner performances in Mathematics and the Physical Sciences in most public schools in South Africa continue to pose a serious risk to sustainable economic growth in our country. This crisis continues despite urgent calls for more learners to achieve above 50% in Mathematics at National Senior Certificate level and for the bolstering of the professional training of Mathematics teachers. Many key challenges continue to contribute to the dire state of education which is particularly acute in rural parts of provinces. These challenges range from historic disparities in education based on ethnicity, socio-economic challenges in large sections of the educational sector in South Africa and the sub-standard academic teaching due to a lack of sufficient skills, content knowledge and quality resources.

Hence, an urgent need exists for the implementation of change strategies in the form of innovative and viable practical solutions to improve the quality of teaching and learning of Mathematics and Physical Sciences in public schools in South Africa. Any approach to improve the situation in school education should also embrace the global paradigm shifts in education. The perception of Mathematics teaching in South African schools is still very much traditional and teacher centred. There is a dire need for teaching, in general, to become more modern and learner centred. It is imperative that teachers be assisted to become creative innovators who unlock the potential of experiential learning approaches and ICT-assisted pedagogies in the 21<sup>st</sup> century classroom. This approach is underscored by the Future Jobs report that was recently published by the World Economic Forum. In the list of top ten skills for the workplace in the era of the



Figure 1. Ranking of Skills in the Job Market

**Fourth Industrial Revolution (4IR)**, five skills are linked to problem-solving with creativity, active and technology-assisted learning also featuring prominently. Teachers will have to become creative and innovative when applying their knowledge and skills to prepare learners for the 21<sup>st</sup> century challenges in the workplace. The importance of exposure to trans-disciplinary real-life problem-solving through experiential learning cannot be over emphasized. (see Figure 1 - WEF Future Jobs Report, 2020).

In response to the said crisis, the Govan Mbeki Mathematics Development Centre (GMMDC) has, over the past five years, developed and successfully implemented a series of innovative Mathematics and Physical Sciences development and support initiatives for secondary school teachers and learners in several provinces.

The Centre’s innovative hybrid techno-blended teaching and learning models, digital resources and programmes were used extensively. The basis of this approach is customized interactive applications that covers the complete CAPS curriculum for Mathematics and Physical Sciences across all grades. Implementations of these models for STEM development have had a noticeable positive impact on access to quality offline digital resources at under-resourced schools, access to HE for selected project learners and also the teaching practice of in-service teachers – particularly in the Eastern Cape Province (ECP).

## 1. Learner incubation and support via the MobiTutorZA Academy Programme

The MobiTutorZA Academy Maths & Science project is a consolidation of the GMMDC’s highly successful Maths & Science incubation project for in-school learners aimed at improved access and success with STEM-related study programmes at higher education level. The programme offers a structured hybrid techno-blended support programmes for selected Grades 11 & 12 learners and also caters for second-chance

**GMMDC**  
Govan Mbeki Mathematics Development Centre  
*empowering young minds*

**Hybrid Techno-Blended Model for In-school and Out-of-School Learner Incubation**

**NELSON MANDELA UNIVERSITY**

**MobiTutorZA ACADEMY**  
*empowering young minds*

- Maths Applet Support via Phones
- Complete Set of Topic Video Lessons for Access & Download GMMDC
- Offline Application Maths Support via Personal Android Phones
- Structured Topic Learning Cycles & Support over Distance
- Learner Guides for Soft Skills & Self-Directed Learning
- Online Application Support via Any Online Device for Topic Tests and Examination Revision

out-of-school matric learners in the Eastern Cape Province who want to improve their Maths and Science marks to gain access to further studies.

The MobiTutorZA Academy Mathematics programme for matric learners offers an after-school self-directed incubation programme over 7-months. This programme is facilitated by GMMDC experts and integrates the use of a range of traditional & digital support platforms including a virtual classroom, social media platforms and the GMMDC's customized mobile apps that are aligned with the secondary school curriculum.

A more informal technology-assisted After-school Peer Support programme (TAPS) is used by the centre to provide support for all learners at each project schools via scheduled sessions that are facilitated by local teachers. School-based TAPS sessions are supported by special printed skills development guides and various interactive offline & online digital resources and apps of the GMMDC. Thousands of learners from schools in the ECP and beyond have benefitted from the incubation and TAPS support programmes of the centre over the past decade. [View Recent Incubation Results Link](#)

**Technology-assisted After School Peer Support (TAPS) Programme for Self-Directed Learning**

"... having an expert explaining the syllabus visually anywhere, anytime is just what I need."

Learner Support with **GammaTutor** and **TAPS Learner Guides**

**TouchTutor®**

Covers the complete CAPS Syllabus for All Grades

"Interactive, Visual and Offline"

Video Lessons, Self-tests + Scoring & Solutions, Simulations, Exam Support ... and more

## 2. Professional development of in-service Mathematics Teachers:

The GMMDC offers a modern professional skills development programme for in-service educators that integrates the use of 21<sup>st</sup> century Technology at project schools. This Professional Learning Network (PLN) programme integrates Content (±40%),

**GMMDC's Teacher Skills Development Model Professional Learning Network Programmes**

**Classroom** | **TouchTutor® Package**

Combining Classroom and TouchTutor® Package

or **gamma Tutor Plug & Play**

Additional Digital Source Software and CAPS Aligned T&L Material: **GeoGebra**

**Integrated Approach**

- \* Content , Pedagogy & ICT Skills
- \* CAPS Aligned
- Focus on Classroom Practice
- Includes GeoGebra for T&L
- STEAM education exposure

**SACE** South African Council for Educators

**GMMDC** Govan Mbeki Mathematics Development Centre

**Separate Mathematics Programme over 2 years for FET & Senior Phases.** Formal programmes consists of eight Short Learning Programmes worth 10 SACE Credits each with certification. Face-Face or Live Zoom sessions are combined with WhatsApp, MobiTutorZA app, GeoGebra Applets and GMMDC YouTube channel support.



Pedagogy ( $\pm 20\%$ ) and Technology ( $\pm 30\%$ ) in an integrated way with reference to the innovative Techno-blended models & customized digital resources for CAPS Mathematics that was developed by the centre.

Since 2020 the PLN programme was adapted to be fully aligned with Post COVID-19 teaching and learning needs in under-resourced schools.

The goal of the PLN programme is to establish viable professional learning networks of in-service secondary school Mathematics & Physical Sciences educators in South Africa who actively integrate modern 21<sup>st</sup> century teaching pedagogies to deliver the CAPS curriculum.

**See video link below:**

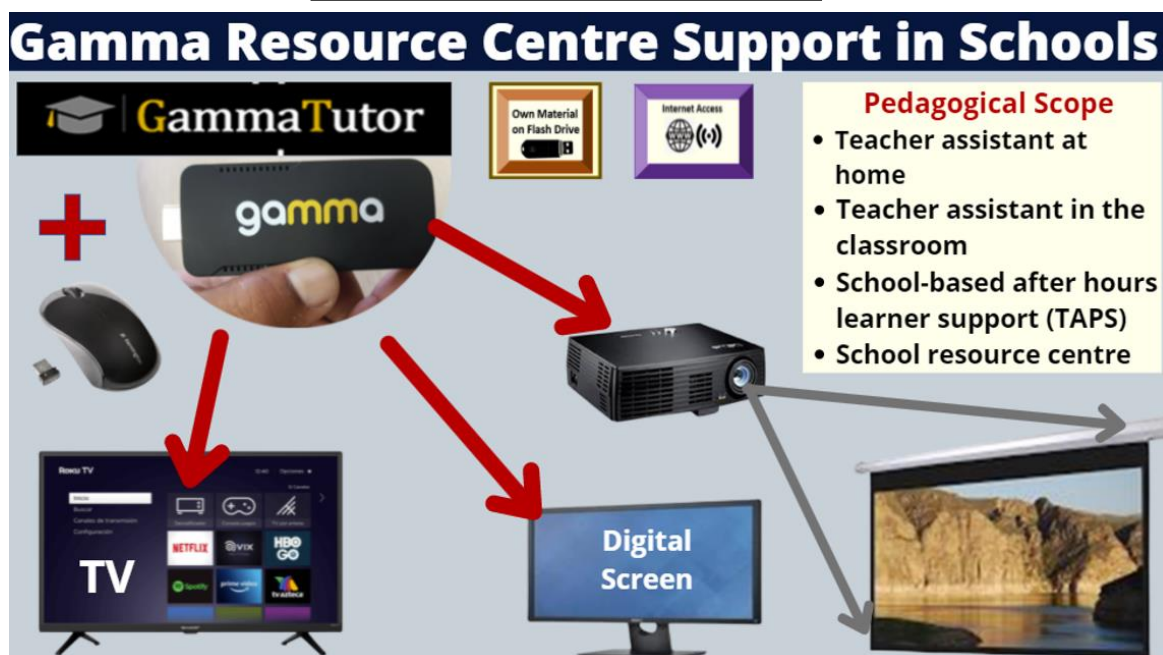
[Professional Development of Teachers Promotion Video](#)

### 3. Offline Gamma Resource Centres at Schools for CAPS Mathematics & Physical Sciences Support – all grades

This project will establish a local offline ICT-assisted support hub for Mathematics and Physical Sciences to help address some of the key STEM education challenges at under-resourced schools in the ECP.

The Gamma device and accompanying GammaTutor software is an innovative new product that was developed for education by the GMMDC in 2019 after years of action research in under-resourced schools in the ECP. It is designed to provide teachers and learners at secondary schools with flexible offline access to a comprehensive digital Mathematics and Physical Sciences package. This user-friendly plug and play device can be used with any data-projector, digital screen or smart TV.

“Teacher assistant in your pocket”



The interactive GammaTutor software covers the complete CAPS syllabus using structured video lessons, animated PowerPoint lessons, self-assessments with scoring and feedback, structured exam revision, multiple interactive language support and much more.

Gamma is uniquely positioned as an offline educational presentation device for schools to make it easier for teachers to facilitate interactive and learner-centred lessons of good quality in classrooms or after-school hours.

### More about the GammaTutor™

The Gamma device and GammaTutor™ software are designed to also provide teachers and learners at secondary schools with flexible offline access to a comprehensive pre-installed digital mathematics and physical sciences package, including the TouchTutor® package. This user-friendly and interactive digital package covers the complete CAPS curriculum using structured video lessons, animated PowerPoint lessons, self-assessments with scoring and feedback, structured exam revision, multiple interactive language support and much more.



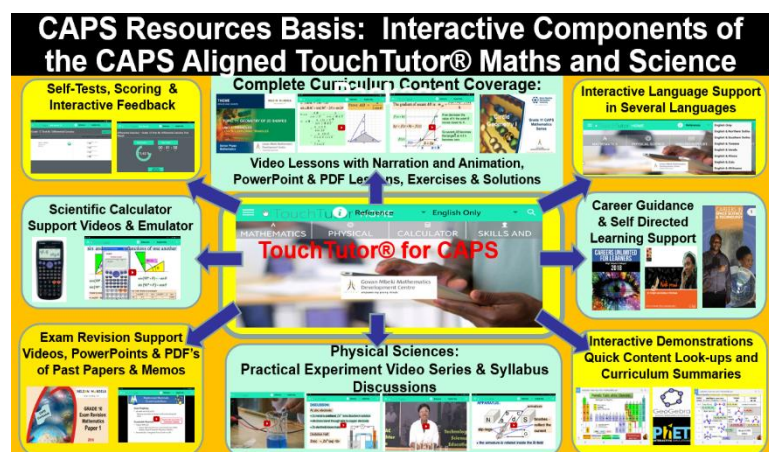
### “assistant teacher in your pocket”

The Gamma is a unique and exciting new Android presentation device for education that will make it easy for Teachers and Tutors to teach or facilitate interactive learner centred sessions in classrooms or in venues of choice after school hours. Gamma is a flexible plug and play Android mini-PC device which can be used with any data-projector, digital screen or smart TV.

This device comes pre-installed with the GammaTutor software which also includes the complete TouchTutor® Maths and Science interactive digital package for learner support (Grades 8-12).

The main components of the TouchTutor® digital package for CAPS mathematics & Physical Sciences include:

- A complete series of content video lessons for each Grades (10-12);
- A comprehensive Physical Sciences experiment video series recorded in a professional laboratory environment;
- Interactive multiple choice self-assessments and feedback linked to each content topic;
- Comprehensive sets of examination revision video, PowerPoint and PDF material consisting of past national and provincial mathematics papers and memoranda;



- CASIO video series with on-screen emulator demonstrations on how to utilize the scientific calculator to solve mathematics problems that are linked to the CAPS curriculum;
- A series of quick look-up summaries for reference before Tests and exams;
- Interactive mathematics language support in the form of concept explanations in English and any one of seven indigenous languages – Tswana, Northern Sotho, Southern Sotho; Venda, Xhosa, Zulu & Afrikaans
- Guidance and information on STEM careers and how to gain access to study programmes at HE institutions;

The following **additional CAPS aligned digital resources for teachers** are also pre-installed on the GammaTutor™ Software Package:

- Animated CAPS PPT Lessons for the classroom – Grades 8-12;
- Special Exam revision PowerPoint lessons for facilitation of holiday support programmes;
- More than 50 Past Provincial and National Exam Papers with Memos in PDF format;
- A range of free apps for additional CAPS teaching support in the classroom.

Users can make full use of all the aforementioned pre-installed digital resources by simply a click of a wireless mouse. Hence the logistics of presenting lessons and support material in classrooms or elsewhere becomes very simple. This presentation device also supports learner-centred classroom practices to create rich constructivist learning environments. Teachers who use this device with a wireless mouse can move around in classrooms while facilitating quality CAPS aligned digital material. The pre-prepared nature of the digital material will also allow much more time for teachers to interact with learners to explain concepts and to share more examples. Its small size makes the device easy to manage in respect of security and movement between sites of presentation (classrooms/presentation venues).

**See video link:** [Gamma Promotion Video](#)

#### 4. M-Learning Learner Support - Problem Solving and CAPS Curriculum Support via GMMDC's MobiTutorZA application for mobile phones

As part of its hybrid techno-blended approach to STEM development in schools, the GMMDC has developed an innovative digital software mobile application for learner support called MobiTutorZA™.

MobiTutorZA



An offline-only version of the Android software package for phones contains all the Mathematics and Physical Sciences curriculum support materials for self-directed learning support across all Grades **without any data costs**. This app can be installed on the personal phone of any learner. The online version of the app provides support for the TAPS learner support programme and for the MobiTutorZA Academy project with structured self-assessments, content & exam support and multi-language support – also over distance. The GMMDC also uses the online app to offer Mathematics competitions in schools. A recent new project called **MobiMetric** allows all Grade 12 Mathematics learners to do mock exam papers (with scoring and automated feedback) via the app prior to formal examinations during their final schools year.

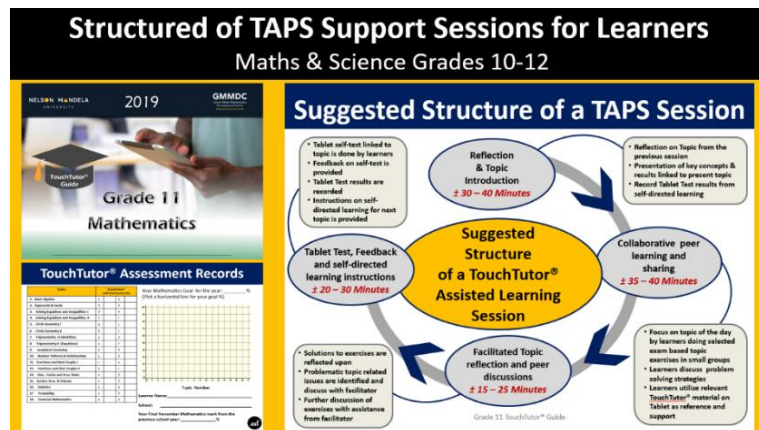
#### 5. Learner Development Programme: Technology-assisted After School Peer-Learner Support (TAPS)

The TAPS concept is innovative and effective to address key challenges in under-resourced schools ...

- Design a set of quality digital lessons, quality exercises with examples, self-tests with feedback, exam support and soft learning skills that guide high school learners and their facilitators through the CAPS mathematics and physical sciences syllabus.
- Put this set of learning materials together in user-friendly interactive online and offline software applications for **anytime anywhere access and support** (called TouchTutor® on **Gamma** Devices and MobiTutorZA™ on mobile devices).



- Design a structured Technology-assisted After-School Peer Support (TAPS) programme consisting of **Topic Learning Cycles** over the academic year. This programme provides syllabus-aligned **self-directed learning** support to reinforce curriculum delivery in secondary schools.



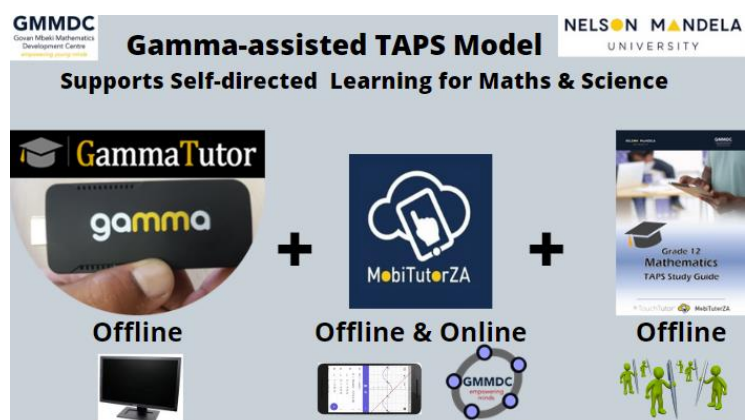
- Provide learners from under-resourced schools who have potential to achieve in mathematics and physical sciences **24/7 access to digital materials via MobiTutorZA apps on their mobile phone or a Gamma resource centre** at a second site of learning (at school or elsewhere in a public space).
- **Train and resource facilitators to manage after-school TAPS Topic Learning Cycle sessions** using printed TAPS Guides for reflection and self-directed learning support.

### The result?

- A significant improvement in school marks in these subjects, along with a better aptitude for university studies. It is a step towards breaking the cycle of poverty through improved education.

Apart from being a T&L tool for classrooms, the GammaTutor™ also serves as an ideal support platform for learners after school hours. Structured TouchTutor® guides that are aligned with school curriculum pace setters are also available to support TAPS sessions with learners on an individual or group basis.

The TAPS learner project, designed and implemented by the Govan Mbeki Mathematics Development Centre (GMMDC) of the Nelson Mandela University, was specifically developed to solve the problems encountered by many high school learners with potential from poor and rural schools. Many of these learners are disadvantaged by inadequate school infrastructure, learning support facilities, inadequate teaching capacity and poor home environments that damage their ability to do adequate homework. The focus of TAPS is to empower learners to teach





themselves via facilitated self-directed learning and support, where teaching is either insufficient or even lacking entirely at their own school. Provision of offline digital resources that supports content from lower grades also make TAPS support viable and valuable to assist learners to address content gaps. The centre has delivered its latest hybrid techno-blended model with great success to support both in-school as well as repeat out-of-school matric learners during the COVID-19 pandemic period in 2022 & 2021.

The most important part of the TAPS programme is that **it creates flexible anytime access to after-hours support via a second site for self-directed learning.**

Link: [View Recent GMMDC Learner Incubation Successes](#)

## 6. M-learning support via Innovative Pedagogical Practice (GIPP) & Skills Development using GeoGebra applets for phones

Over the past decade, the open-source dynamic graphics Mathematics & Science software GeoGebra has been a most valuable free online educational support platform with a vibrant global user community of practice with millions of STEM educators and students using it. The GMMDC houses a local GeoGebra institute chapter and has successfully offered various webinars and training programmes locally and nationally to promote the use of GeoGebra amongst in-service teachers to enhance the quality of their teaching practice. The Centre recently developed innovative GeoGebra Mathematics applet series for the CAPS school curriculum that are customized for use with mobile phones. These interactive applets, which can easily be accessed and shared via social media, are designed to assist Mathematics teachers to integrate technology in their classroom practice and to support self-directed learning in schools.

The goal of the GIPP project is to offer GeoGebra skills development to teachers and learners and to promote the online and offline use of this Open-Source software in schools via PC's, laptops or mobile phones.

**GMMDC** New Approach to Learning Maths & Science : NELSON MANDELA UNIVERSITY  
Gauteng Maths Mathematics Development Centre  
empowering young minds

**M-Learning Support via Mobile Phones**

**CUSTOMIZED GEOGEBRA APPLETS**

**Interactive & Visual Teaching and Learning Support for**

- CAPS School Mathematics
- Creative Problem Solving
- STEAM Workshops & Activities

ENJOY LEARNING WITH DYNAMIC ONLINE APPLETS

START USING IT TODAY!  
GEOGEBRA APPLET SERIES

## 7. STEAM Education Programme for Schools

The Science Technology Engineering Art Mathematics (STEAM) Educational approach in the era of 4IR emphasizes a multidisciplinary and creative problem-solving approach. This is aligned with global trends in education and seen as an important innovation for the workforce of the future. In response to these trends, the GMMDC has integrated the STEAM approach in its Mathematics and Physical Sciences development projects since 2017.

### STEAM Skills Workshops at Schools

The goal of the STEAM skills development programme is to introduce and encourage teachers to try new learner-centred approaches and also assist them in developing their own STEAM lessons. The centre offers STEAM activity workshops for teachers and learners, including **coding theory activities**, that are aimed at promoting **practical real-life problem solving** and **creative design** with references to STEM careers.

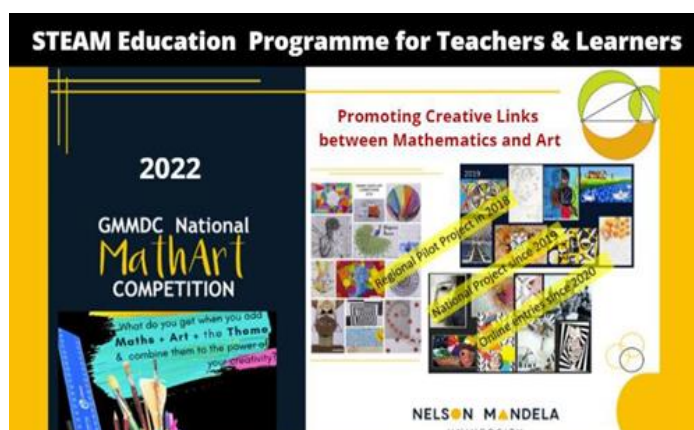
Follow video links below:

- [STEAM Education Promotion Video](#)
- [STEAM Workshop Example Video](#)

### National MathArt School Competition

Since 2018, the GMMDC offered a successful annual national MathArt Competition in secondary schools to promote STEAM education. Learners from grade 7 to 12 are challenged to look for the mathematics in the world around them and bring it to life through an artwork. They have to represent it in a two dimensional artwork which they have to photograph and submit digitally online.

As part of their submission each participant has to answer questions to explain the link between their artworks, mathematics and the annual theme. In the answers to the questions the participants must describe the mathematical concepts that they used and how their artwork links to the annual theme. Attractive competition prizes are offered to participating learners and an award function is held each year. Winning MathArt entries are also be displayed at local



public art galleries and at an international Math & Art conference each year. Annually GMMDC staff present a MathArt workshop series for teachers to promote the MathArt project in schools.

The MathArt school project of the GMMDC currently enjoys strong support from provincial and national education stakeholders in South Africa. Active international support and project links with key STEAM education organizations are also in place. The focus of the MathArt competition in schools is on creative thinking and original expression of links between Mathematics and Art. This approach to promoting STEAM education in South African schools has proven its great potential to be a valuable engagement project to support modern trans-disciplinary thinking and problem-solving. For more information annual MathArt competition please visit the GMMDC's project website ([www.mathart.co.za](http://www.mathart.co.za)) or follow the project marketing video whose link is given below:

**Follow video link:** [MathArt Competition Promotion Video](#)

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