



science & innovation

Department:  
Science and Innovation  
REPUBLIC OF SOUTH AFRICA



SAASTA

South African Agency for Science  
and Technology Advancement

**DEVELOPMENT AND SUPPORT FRAMEWORK FOR  
SCIENCE, TECHNOLOGY, ENGINEERING,  
MATHEMATICS AND INNOVATION OLYMPIADS AND  
RELATED COMPETITIONS IN SOUTH AFRICA**

DRAFT VERSION 3.1

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## ACRONYMS

4IR	Fourth Industrial Revolution
AMESA	Association for Mathematics Education of South Africa
ASTEMI	Association of Science, Technology, Engineering, Mathematics and Innovation
DBE	Department of Basic Education
DSI	Department of Science and Innovation
Expo	Eskom Expo for Young Scientists
FET	Further Education and Training
GET	General Education and Training
MEF	Monitoring and Evaluation Framework
MST	Mathematics, Science and Technology
NDP	National Development Plan
NSMSTE	National Strategy for Mathematics, Science and Technology Education
NSO	National Science Olympiad
OECD	Organisation for Economic Co-operation and Development
SAASTA	South African Agency for Science and Technology Advancement
SAMF	South African Mathematics Foundation
SAMO	South African Mathematics Olympiad
SAMS	South African Mathematical Society
SES	Science Engagement Strategy
SET	Science, engineering and technology
STEM	Science Technology, Engineering and Mathematics
STEMI	Science Technology, Engineering, Mathematics and Innovation
YiSS	Youth into Science Strategy

## CONTEXTUAL DEFINITIONS

**Adaptive reasoning** – the capacity to think logically about concepts and conceptual relationships. Reasoning is needed to navigate through the various procedures, facts and concepts to arrive at solutions (NRC, 2001).

**Conceptual understanding** – an understanding of concepts, operations and relations. This frequently results in students comprehending connections and similarities between interrelated facts (NRC, 2001).

**STEMI Olympiad** – a structured national contest, usually leading to regional and or international contest, where learners feature in groups or as individuals with an intention to enhance their scientific knowledge, mathematical proficiency, scientific and technological innovation or personal enjoyment, which in any event further endeavours to identify, engage and nurture potential talent for the STEM human capital pipeline.

**Procedural fluency** – flexibility, accuracy and efficiency in implementing appropriate procedures. Skill in proficiency includes the knowledge of when and how to use procedures. This includes efficiency and accuracy in basic computations (NRC, 2001).

**Productive disposition** – positive perceptions about mathematics. This develops as students gain more mathematical understanding and become capable of learning and doing mathematics (NRC, 2001).

**Related competition** – a competition, which like STEMI Olympiads is conducted with the intention to contribute talent search and/or nurturing in the building of the STEM human capital pipeline, even though its structure may differ from Olympiads.

**Strategic competence** – the ability to formulate, represent and solve mathematical problems. This is similar to problem solving. Strategic competence is mutually supportive with conceptual understanding and procedural fluency (NRC, 2001).

## EXECUTIVE SUMMARY

The youth development endeavours of the DSI includes the school-based science engagement initiative under the Science Engagement Strategy. This initiative, which seeks to create a culture of science in schools incorporates STEMI Olympiads and related competitions that are supported by the DSI in an endeavour to build the STEM human capital pipeline.

It has been years that the DSI has supported STEMI Olympiads and related competitions. Notable progress has been made to date, particularly the growth in number of organisers of these extra-curricular activities and the number of participating learners. However, it has become clear that if improvement in South African STEMI Olympiads and related competitions is to be sustained and accelerated, attention needs to be given to creating and maintaining the enabling environment. Efforts in this regard needs to be on correcting the weakness in the system, leading to a well-coordinated and well-supported system that embraces the participation of learners from all backgrounds. It is for this reason that this Development and Support Framework for STEMI Olympiads and related competitions is required.

The Framework presents a suite of interventions, which need to be collectively implemented to bring the much-needed improvement in learners' participation levels and introduction of a system that has coordinated and effective implementation structures on the ground, as well as collaboration of key stakeholders and role players. On the same note, the Framework creates a focused approach by prioritising four content development categories that are considered integral to the development of the future skills of work. These are scientific knowledge, mathematical proficiency, scientific and technological innovation, as well as robotics and coding. Prioritisation of the three content areas has led to three existing major STEMI Olympiads and related competitions serving selected as the key levers in driving the required change in a "Lead Agent" capacity. Of course, the envisaged change would not be brought about by a narrow focus on the three STEMI Olympiads and related competitions, only. It would have to be driven through a streamlined collaboration with smaller STEMI Olympiads and related competitions, which are expected to play a meaningful role of executing plans on the ground operating as "Implementing partners".

Keeping an understanding of how the local landscape of STEMI Olympiads and related competition evolves and the overall change brought about by the implementation of this Framework depend on continuous collection and analysis of performance data. It is for this

reason that in alignment with the Science Engagement Monitoring and Evaluation Framework of the DSI, the types of data to be tracked and the purpose thereof have been identified.

The environment that this Framework aims to create would only be realised if various key stakeholders are effective in the roles they are expected to play – in particular the DSI, education authorities in the country at both national and provincial levels, as well as SAASTA in its capacity as a national coordinator of science engagement. The Framework includes a risk management plan to ensure that mitigation measures are timeously invoked, where necessary.

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# 1 INTRODUCTION

## 1.1 Policy and strategic background

The White Paper on Science, Technology and Innovation (2019) recommitted the Department of Science and Innovation (DSI) to its longstanding programme to develop a science literate and science aware society. Lately, initiatives towards the envisioned society are guided by the 2015 Science Engagement Strategy (SES) – focusing on advancing science knowledge among the citizens, enabling them to independently form opinions on science issues and building their scientific literacy.

Youth development, which is a national priority is pursued in several ways within the DSI, including the science engagement-driven approach. Prior to the adoption to the adoption of the SES, the science engagement-driven youth development was guided by the Youth into Science Strategy (2007). This Strategy has since been discontinued as a standalone plan and has been incorporated into the SES – where it manifests itself in the SES Implementation Plan as (i) a “*structured school-based science engagement initiative*” aimed at developing a culture of science among learners; and (ii) the national youth service, which uses science to inculcate the culture of volunteerism and community service in young people. The understanding is that these interventions would increase youth participation in science – where youth participation in science means the following:

- (a) Learners’ choice of the gateway subjects of Mathematics and Physical Science in Grade 10;
- (b) Learners’ participation in extra-curricular science, technology, engineering, mathematics and innovation (STEMI) activities; and
- (c) School leavers’ pursuit of post-school STEM studies, and ultimately STEM careers; and
- (d) Young STEM professionals giving back to the community by providing voluntary mentorship and coaching to learners and students.

Youth’s participation within the aforementioned context complements the DSI-led human capital development programme that seeks to develop high-end skills required



for research, development and innovation, as well as the human capital development targets of the National Development Plan (NDP). It is expected that this kind of youth participation would contribute more to the development on high-end skills needed for scientific research and innovation, as well as the general increase in university enrolments. The NDP seeks to increase enrolment at universities by at least 70 percent by 2030, which translates to about 1.62 million from 950 000 in 2010, while aiming for an increase in the number of students eligible to study towards maths and science-based degrees to 450 000 by 2030.

## **1.2 STEMI Olympiads and related competitions**

Any successful human capital development programme requires a pipeline that consistently supply of potential talent. STEMI Olympiads and related competitions are a STEM human capital pipeline development endeavour within the school-based science engagement initiative of the DSI. This is because STEMI Olympiads and related competitions are useful for identifying and nurturing learners with potential talent for STEMI careers. Through STEMI Olympiads and related competitions, such learners are provided with a platform that puts them on a path to unleash the full potential of their talent. STEMI Olympiads are therefore crucial for any meaningful participation of young people in STEMI careers, which in turn largely depends on the existence of an enabling environment.

## **2 UNDERSTANDING THE CONCEPT OF AN ENABLING ENVIRONMENT IN STEMI OLYMPIADS AND RELATED COMPETITIONS**

An enabling environment would be a set up where a suite of appropriate interventions described in this Framework is sustainably implemented to maximise inclusive participation and performance of learners in an effectively and efficiently coordinated STEMI Olympiads and related competitions – all these taking place to an extent that allows and encourages inclusive involvement of a diversity of stakeholders and role players. Within the policy and strategic environment established and resourced by the DSI, the South African Agency for Science and Technology Advancement (SAASTA) will coordinate the implementation of this Framework, leading to an environment ideal for STEMI Olympiads and related competitions thrive in the country.

However, such an environment would be difficult to attain, especially if the interventions in this Framework are thumb-sucked. In order to arrive at an appropriately informed suite of interventions, the descriptive analysis of the current landscape of STEMI Olympiads and related competitions in the country was conducted and summed up below.

- STEMI Olympiads and related competitions in South Africa dates back to the mid-60s and have evolved over the years to a point characterised by an increase in the levels of participating learners and number of Olympiads and related competitions.
- STEMI Olympiads and related competitions in South Africa are organised under the Association of Science, Technology, Engineering, Mathematics and Innovation (ASTEMI), an umbrella body with non-profit status and a membership of no less than 19 STEMI Olympiads and related competitions. Some duplication of content and scope exist among ASTEMI-affiliated Olympiads and related competitions.
- Based on the size and reach, there are three major STEMI Olympiads and related competitions in the country, namely the National Science Olympiad (NSO), the Eskom Expo for Young Scientists (Expo) and the South African Mathematics Olympiad (SAMO) and a related competition.
- Although performance data management is a serious weakness in the country's STEMI Olympiads and related competitions, available data on 2010 to 2019 academic years show that between 250 000 and 300 000 learners annually participate in the NSO, SAMO and Expo which is almost 70% of the overall number of learners participating in all STEMI Olympiads and related competitions organised under ASTEMI. The NSO, SAMO and Expo at participation rates of 30%, 38% and 25% of the total participants across the ASTEMI community, respectively could well be considered a reliable barometer for the system in determining future plans for the country.
- As at January 2019, there were about 13 million learners in South African schools (both public and independent) and less than 3% of these learners participate in STEMI Olympiads and related competitions. Participation in STEMI Olympiads and related competitions by learners in independent schools is disproportionately high as these schools only represent 4.5% of all schools in

the country. However, independent schools constitute 19% of the participants in Expo's national finals. About 80% of the national winners who participate in the regional and/or international legs of STEMI Olympiads and related competitions through SAMO and Expo are from independent schools and quintile 5 public schools. The same trend holds true for the national top performers in the NSO.

- Participation by female learners in SAMO and NSO are not on equal footing with male learners. Over the period 2016 - 2018, female learners formed only 23% of the top performers in SAMO. This trend was repeated in the NSO's Physical Sciences, where 80% of top performers were male learners. However, females' performance in the NSO's Life Sciences improved in 2017-18, constituting 50% of the top performers. In Expo, which is a science fair, females' participation and performance is excellent. This trend is applicable to district, regional and national events where females make approximately 57% of Expo participants.
- There is lack of a common and consistently applied marketing strategy to promote STEMI Olympiads and related competitions to schools, resulting in unbalanced geographic coverage of existing STEMI Olympiads and related competitions in the country. This is visible from the varying popularity patterns of the NSO, Expo and SAMO. The NSO has consistently been most popular in Limpopo, Gauteng and the Eastern Cape. With the SAMO, most of the participants come from Gauteng, KwaZulu-Natal and Eastern Cape, while the highest number of participants in Expo are from KwaZulu-Natal, followed by Western Cape and Gauteng.
- It is a common practice for the national winners of STEMI Olympiads and related competitions to be afforded an opportunity to compete in regional and international legs of similar or related competitions. Of the three big STEMI Olympiads and related competitions, only SAMO and Expo feature their selected national winners in regional and/or international legs – whereas the NSO only takes its selected winners abroad on an educational excursion. Within the group of smaller STEMI Olympiads and related competitions that are collectively responsible for around 30% of the overall participants, only three local Olympiads are known to regularly or at times feature their national winners

in regional and/or international legs. Although there is progression to regional and/or international legs associated with some local STEMI Olympiads and related competitions, there is no country-level protocol for local winners to participate in regional and/or international legs. So far, it mainly depends on the links that individual organisers have with foreign like-minded organisations. Under the circumstances, it has become difficult to consider South African learners featuring in regional and international legs of STEMI Olympiads and related competitions as formally representing the country. Furthermore, learners and their chaperones are not trained on how to be their “country’s ambassadors”. Further complications arise when individual organisers seek government support to enable learners’ participation in such events. The DSI is usually inundated with funding requests from individual organisers and even parents, which is always difficult to handle.

- The benefits of mentoring, coaching and any other form of interaction between professionals and learners involved in STEMI Olympiads and related competitions are well-documented through various research studies. In South Africa, there is not any form of arranged guidance by professionals or experts for learners involved in STEMI Olympiads and related competitions. However, there is some evidence that parents who are scientists, engineers or possess relevant technical know-how support their children, particularly in science fair projects.
- Whereas the Department of Basic Education (DBE) has published a “Protocol on events involving learners” that seeks to protect learning and teaching, it does not seem all organisers of the STEMI Olympiads and related competitions are aware of and/or at least observing it.
- While there is a developing trend in some countries to digitise STEMI Olympiads and related competitions, STEMI Olympiads and related competitions in South Africa are paper-based or live events and if there is anything happening in e-means, it is negligible. There is however, a developing interest in digitising STEMI Olympiads and related competitions among local organisers, as it has emerged from the 2018 STEMI Olympiads and competitions Community of Practice Conference.

- Public sector is the main source of funding for STEMI Olympiads and related competitions in South Africa, providing almost 80% of the funding per annum. Nevertheless, more of such funding is used for organisers' overheads costs and national finals that are highly publicised, with less spent on grassroots development. Grassroot development is further hampered by the lack of a clearly defined development and support plan by the DSI, which would guide SAASTA, as well as other key stakeholders and role players. The renewed collaboration arrangement between the DSI, the DBE and the Department of Higher Education and Training (DHET) in the implementation of the National Strategy for Mathematics, Science and Technology Education (NSMSTE) provides an excellent opportunity for the DSI to clearly define its developmental role in STEMI Olympiads and related competitions, more so because the NSMSTE implementation framework adopted by the three departments acknowledges and assigns the DSI's leadership role in STEMI Olympiads and related competitions.
- There are no minimum operating standards that apply to all STEMI Olympiads and related competitions in the country. Consequently, organisers conduct their affairs as they see fit and not obliged to at all times uphold essential practices.

From the above descriptive analysis, it can be concluded that more work still needs to be done to reach an environment that is ideal for the development and growth of STEMI Olympiads and related competitions, i.e. an enabling environment should be created.

### **3 CHARACTERISING THE ENABLING ENVIRONMENT FOR STEMI OLYMPIADS AND RELATED COMPETITIONS**

To turn around the current landscape of STEMI Olympiads and related competitions as depicted by the foregoing descriptive analysis, a suite of eight interventions will be implemented in order to:

- (a) build coordinated and collaborative networks to expand and enhance STEMI Olympiads and related competitions in the country;

- (b) promote the development of problem-solving skills in schools;
- (c) foster meaningful and inclusive participation of learners in STEMI Olympiads and related competitions; and
- (d) lay a solid foundation for the development of a society that is scientifically literate, knowledgeable about science and confidently form independent opinions on science issues.

In that regard, the suite of interventions will be as follows:

### **3.1 Adoption of guiding principles**

South African STEMI Olympiads and related competitions will be guided by common principles that take into consideration matters of national importance and enhance personal development of learners:

- (a) opportunities will be created to promote the priority areas of the DSI through STEMI Olympiads and related competitions in an attempt to develop a cohort of science policy conscious learners;
- (b) opportunities to complement Mathematics, Science and Technology (MST) education will be created and/or exploited as and when they emerge in the process of implementing STEMI Olympiads and related competitions;
- (c) commercialisation opportunities will be further explored, as and when such potential is noticed from the learners' projects featured in STEMI Olympiads and related competitions;
- (d) participants will be exposed to intellectual property literacy to enable them to protect their ideas and prevent potential exploitation;
- (e) possible creation and/or enhancement of entrepreneurship opportunities will be explored in the process of implementing this Framework in order to contribute to the country's economy;
- (f) inclusive participation will be prioritised at all times to be congruent with the country's transformation agenda; and
- (g) the scope of science domains covered by STEMI Olympiads and related competitions supported by the DSI will be consistent with the contextual definition of science adopted by the SES to encompass social sciences and humanities, in addition to mathematics, engineering and natural sciences.

## 3.2 System differentiation

The dawn of the 4<sup>th</sup> Industrial Revolution (4IR) has signalled that the future of work will never be the same and will forever be evolving, needing a new set of skills. Since STEMI Olympiads and related competitions are supported by the DSI as an instrument to develop STEM human capital pipeline at school level, it makes sense to align them with the skills required for the future of work. Experts usually list up to 10 skills that are needed in the future of work, but there seems to be a consensus that there are four stand out such skills, which are creativity, problem-solving, critical-thinking, and innovation. On that basis, a differentiated STEMI Olympiads and related competitions system will be established to create an extra-curricular environment that lays a base for the development of the four skills for the future of work. As a result, the STEMI Olympiads and related competitions supported by the DSI will be classified under the following four categories:

### 3.2.1 Scientific knowledge enhancement

The way the learning environment is structured, it is understood that learners gain basic scientific knowledge from normal classroom learning and teaching that takes places under the DBE. Across various fields of science, STEMI Olympiads and related competitions provide a platform for learners to extend the knowledge gathered from formal classroom learning and teaching. STEMI Olympiads and competitions that potentially contribute to this cause will be established as a branch because of their distinguishable value add to the building of scientific knowledge in learners, which could well be considered a basic building block of the skills for the future of work.

### 3.2.2 Promotion of mathematical proficiency

Mathematics is not just important to science, but very much at the core of analytical and critical thinking. As Lefkowitz put it, *“studying mathematics not only will develop more engineers and scientists, but also produce more citizens who can learn and think creatively and critically, no matter their career fields. The workforce of tomorrow, in all fields, will demand it”*. It would be a sound approach to categorise space for STEMI

Olympiads and related competitions that enable learners to sharpen their mathematical proficiency. The National Research Council (2001) described mathematical proficiency as a function of conceptual understanding, procedural fluency, strategic competence, adaptive reasoning and productive disposition – all which are intertwined.

### 3.2.3 Encouraging scientific and technological innovation

The OECD defines scientific and technological innovation as the transformation of an idea into a new or improved product introduced on the market, into a new or improved operational process used in industry and commerce, or into a new approach to a social service. Scientific and technological innovation are important to economic growth and development. They also shape societies, influencing the way people live and sometimes completely changing the way people do things, just like how the 4IR is seen to be changing the future of work. The DSI-led human capital development programme seeks to produce skills required to drive scientific and technological innovation. The need to identify young people with that potential talent and creating an environment that enables the unleashing of this talent provides sufficient motivation for the existence of a standalone category of STEMI Olympiads and related competitions.

### 3.2.4 Robotics and coding

Contextually, robotics and coding fits very well with any of the three categories described above. However, there are very compelling factors to establish robotics and coding as a distinct category. Additional to creativity and problem-solving, coding according to literature develops and improves collaboration, persistence and communication skills. Robotics on one hand do not only build scientific knowledge, but create a technology learning platform, exposure to engineering sciences and has significant applied mathematical connections – while like coding, develops collaboration skills because of group work opportunities. Furthermore, participating in robotics and coding is a very exciting and stimulating experience, which are useful in attracting learners to mathematics and science subject streams. It gets more



exciting as the world today is dominated by smartphones that use apps and the robots, which are reshaping the relationship between people and the future workplace require software programming.

### **3.3 National coordination model**

Effective and efficient coordination is a necessary intervention to transform the face of local STEMI Olympiads and related competitions and ensuring that their strategic intentions are attained. In that direction, a “*Lead agent – Implementing partner coordination model*” that is aligned to the differentiation system described earlier (section 3.2 above), will be used – featuring a Lead Agent and an implementing partner..

#### **3.3.1 Lead Agent**

In the context of this coordination model, a Lead Agent will be an Olympiad or related competition, which based on the described criteria has been assigned custodianship of a particular STEMI Olympiad and related competition category in accordance to the differentiation system of this Framework. For an Olympiad or related competition to qualify for consideration as a Lead Agent it needs to:

- (a) Have an equipped office, a permanent staff component of at least five people and not less than five seasonal or temporary employees;
- (b) Proven adherence to corporate governance practices, in particular having a governance structure aligned to the way it is legally constituted;
- (c) Have reporting systems that are accurate and transparent, and that have a system of adequate checks and balances;
- (d) Provide diversified content streams within a differentiated category of STEMI Olympiad and related competitions for which the custodianship status is under consideration;
- (e) Have a reliable website;
- (f) Have a national footprint;
- (g) Have regional and/or international links with like-minded organisations to facilitate local national winners to engage with their foreign counterparts;
- (h) Be tax compliant, if required to do so by law and

- (i) Be registered in the Central Supplier Database for the South African government.

Following the differentiation approach adopted by this Framework, four existing STEMI Olympiads or related competitions need to be identified as Lead Agents. Data associated with the selection criteria for a Lead Agent was analysed, resulting in the NSO, SAMO and Expo filling the bill as briefly described below.

(a) *NSO appropriate for Scientific knowledge enhancement Lead Agent role*

Hosted by the Pretoria-based government institution SAASTA, the NSO has been taking place annually since 1964 and is reasonably resourced, receiving funding from both public and private sectors. This question paper-based Olympiad comprises two specific (namely, Life Sciences and Physical Sciences) and one general (natural sciences) content streams, catering for General Education and Training (GET) and Further Education and Training (FET) bands in different ways. The SAASTA's is by far the most stable Olympiad because of its natural links to the government budgeting processes, governed by the Public Finance Management Act and part of the National Research Foundation (NRF), which is governed by a board of Directors. SAASTA has a permanent staff component of not less than 40 people.

(b) *SAMO appropriate for Mathematical proficiency Lead Agent role*

SAMO is organised by the Pretoria-based South African Mathematics Foundation (SAMF), a legally constituted non-profit organisation that receives funding support from both public and private sectors. Having being founded by two professional societies for mathematics in the country, the South African Mathematical Society (SAMS) and the Association for Mathematics Education of South Africa (AMESA), SAMF brings together the entire mathematics community in South Africa. SAMF is governed by a board of directors. SAMO and the South African Mathematics Challenge respectively accommodate learners in grades 8 - 12 and 4 - 7, covering both the GET and FET bands. SAMF has a permanent staff component of not less than five people. Selected national winners of SAMO feature in the annual Pan-African Mathematics

Olympiad of the African Mathematics Union and the International Mathematical Olympiad, which is a World Championship Mathematics Competition for High School students.

(c) *Expo appropriate for scientific and technological innovation Lead Agent role*

Globally, a common platform to advance in learners is through science fairs – where learners are able to showcase projects from their own investigations, development or design. The Boksburg-based Eskom Expo for Young Scientists, is so far the only well-established science fair in South Africa and receives funding support from both public and private sectors. Expo is a non-profit organisation with a board of directors and accommodates learners in Grades 5 - 12, covering both the GET and FET bands through a variety of science 13 categories and more than 50 sub-categories across natural sciences, humanities and social sciences. Selected Expo national winners participate in the International Science and Engineering Fair, among other international events.

(d) *I-SET UNISA and Tshwane University of Technology appropriate for robotics and coding Lead Agent role*

Although robotics and coding are not necessarily new developments, it has been the dawn of the 4IR that enhanced and renewed interest in these areas. As a result, the choice of a suitable Lead Agent is much more about the potential not only to grow learners' access to robotics and coding, but do so in a manner that practically displays the relationship between the two areas, including related skills development capability. I-SET (Inspired towards Science Engineering and Technology) is a Community Engagement flagship project of Unisa's College of Science, Engineering and Technology and Research and Innovation portfolio. The project seeks to inspire awareness and interest in the fields of science, engineering and technology (SET), targeting learners in both GET and FET bands. Furthermore, UNISA's School of Computing offers i-set robotics - components and pedagogy short-learning programme aimed at producing robotic coaches. This would come handy in developing Implementing partner's skills. In the same vein, Tshwane University

of Technology (TUT), which is another higher education institution has been consistently involved in robotics. TUT is the operational partner of First Lego League and various related robotics competitions catering for different school-going age groups. Training of teams and the hosting of competitions are held in selected areas and provinces. The footprint of these competitions is primarily in Gauteng, with a growing participation from other provinces. Very encouraging is the fact that TUT and I-SET UNISA already have some collaboration arrangement and will jointly determine the practical possible arrangement to pursue the assigned joint Lead Agent responsibility. Both institutions have a location advantage of access to academic staff with engineering and computer skills that are necessary for robotics and coding activities to thrive.

### 3.3.2 Implementing partner

A Implementing partner will be a STEMI Olympiad or related competition, which based on a defined set of criteria has been selected by the Lead Agent to be the custodian of the relevant STEMI Olympiads and related competitions in a school service delivery area. A school service delivery area could be a circuit, district or province(s). The extent of the area allocated will depend on the capacity of a Implementing partner and could, where possible extend across more than just a province. For an Olympiad or competition to qualify as a Implementing partner, it needs to:

- (a) Be a member or has applied for membership of ASTEMI;
- (b) Be a legally constituted or registered;
- (c) Uphold relevant corporate governance practices;
- (d) Have a business account;
- (e) Be tax compliant;
- (f) Be registered in the Central Supplier Database for the South African government (for in case the disbursement of grants requires that route).
- (g) Submit to a detailed proposal for consideration by the Lead Agent (or other relevant body assigned that responsibility) in response to an issued public invitation for proposals.
- (h) Hold a potential Implementation Partner certificate attained after participating in training offered free of charge by the Lead Agent.

STEMI Olympiads and related competitions that become Implementing partner will maintain own identity, allowed operational independence while adhering to prescribed minimum operating standards. The intention is to accommodate operational diversity as much as possible as it is considered integral to the emergence of best practices needed for continuous improvement. This Framework does not incorporate the prescribed minimum operating standards in an attempt to create room for self-regulation by the STEMI Olympiads and related competitions community. As such the minimum operating standards will be developed by ASTEMI. These operating, which will be reviewed annually at ASTEMI annual general meeting will form Annexure A of this Framework.

### **3.4 Mentoring and coaching**

Generally, mentoring and coaching are fundamental to developing and nurturing potential talent and therefore attempts need to be made to facilitate access to this service by participants in STEMI Olympiads and related competitions in an endeavour to maximise impact. However, before paying attention to how mentoring and coaching will be approached in STEMI Olympiads and related competitions, it would be useful to draw the distinction between these two concepts. With a clear understanding established in that regard, nuanced approach would be adopted and duly applied in STEMI Olympiads and related competitions. Based on CIMA (2008), mentoring relates primarily to the identification and nurturing of potential for the whole person and can be a long-term relationship, where the goals may change, but are always set by the learner. The learner owns both the goals and the process. Feedback comes from within the mentee and the mentor's role is to develop insight and understanding through intrinsic observation helping mentees to become more aware of their own experiences. Coaching on its part relates primarily to performance improvement in a specific skills area, which is often, short-term. The goals, or at least the intermediate or sub-goals, are typically set with or at the suggestion of the coach. While the learner has primary ownership of the goal, the coach has primary ownership of the process.

In most cases, coaching involves direct extrinsic feedback – meaning that the coach reports his or her observation to the coachee.

The four Lead Agency categories of STEMI Olympiads and related competitions have varying preparation needs. Therefore, a one size fit all mentoring and coaching approach cannot be an option. Each Lead Agent will generate a mentoring and coaching plan, which will be adopted for implementation upon ratification by key stakeholders, in particular the DSI, SAASTA as the national coordinator of science engagement and ASTEMI. The mentoring and coaching plans, in the order in which the lead agency categories have been listed in section 3.31 above, will form Annexures B to D of this Framework. Building further from the earlier distinction between mentoring and coaching, indications are that mentoring will be only applicable to a few selected learners, whom through their participation in STEMI Olympiads and related competitions would have displayed outstanding potential talent. Coaching on the other hand would be made accessible to any potential and/or participant in STEMI Olympiads and related competitions. A national database of professionals who have made themselves available to play the mentoring and coaching roles will be made available through selected platforms such as websites. In generating a mentorship and coaching plan for STEMI Olympiad and related competition category, the Lead Agent in charge will incorporate training sessions to equip professionals who volunteered to serve as mentors and coaches with the relevant skills.

### **3.5 Funding support**

Funding for the implementation of this Framework will largely be provided by the DSI. This Framework does not inhibit Lead Agents and Implementing partners to secure themselves sponsorships to enhance their work and are at liberty to enter into sponsorship arrangements as they see fit – whether a title sponsorship, media sponsorship, presenting sponsorship and so on. As for the DSI funding support for STEMI Olympiads and related competitions, SAASTA will in its capacity as a national coordinator of science engagement disburse such funds to the Lead Agents and Implementing partners using procedures that are consistent with the applicable grant management system and the enabling legislations.

### 3.5.1 Disbursing funds to Lead Agents

Lead Agents will be required to submit their costed three-year proposals in response to a closed call by SAASTA. Upon assessment of the proposals by a specially convened evaluation committee, SAASTA could accept the proposal as presented by the Lead Agent or advise the Lead Agent to effect some adjustments that would usually be prompted by the quality of the proposal or a quest to align the proposal to available funds.

### 3.5.2 Disbursing funds to Implementing partners

Working in collaboration with the Lead Agents, SAASTA will publish a closed call inviting Implementing partners to submit their qualifying organisers of STEMI and related competitions to submit three-year proposals on the work they intend to do in the service delivery boundaries assigned to them. Such proposals need to be aligned to Lead Agents' master plan and consented to by the provincial department education and the DSI. The Lead Agent will be part of the committee evaluating the Implementing partner' proposals, and unless the situation does not permit, a relevant provincial department of education will be represented in the committee assessing Implementing partners' proposals.

## **3.6 Structured access to schools**

The DSI has signed formal collaboration agreements with provincial education authorities and only platforms created through these collaborations will be used by Lead Agents and Implementing partners to access schools. Annually, the DSI will facilitate a process involving SAASTA and provincial departments of education to establish an overall workplan of DSI-supported extra-curricular activities for an academic year, including STEMI Olympiads and related competitions.

### **3.7 Sustaining and strengthening of knowledge sharing platforms**

Learning from each other as like-minded individuals or organisations is necessary for continuous improvement and instilling an understanding of the value constructive engagement. For the STEMI Olympiads and related competitions in South Africa to evolve into a distinguishable community, some work has been done to date that led to the establishment of two bodies that need to be strengthened through continuous support.

#### **3.7.1 Association of Science, Technology, Engineering, Mathematics and Innovation**

ASTEMI was formed in 2016 with the support of the DSI as a single body representing the STEMI Olympiads and related competitions in the country. Its membership is open to existing STEMI Olympiads and competitions, creating a platform of their organisers to reason and plan together on matters involving their work. The establishment of ASTEMI has provided the DSI and SAASTA with a streamlined interface with the STEMI Olympiads and related competitions community, making communication of policy and strategic development more seamless.

#### **3.7.2 STEMI Olympiads and related competitions Community of Practice**

Wenger-Trayner (2015), defined communities of practice as groups of people who share a concern or a passion for something they do and learn how to do it better as they interact regularly. Against this background, organisers of STEMI Olympiads and related competitions, educators and their labour movements, learners, relevant government officials, academics and researchers with interest in related topics, as well as government departments and non-governmental organisations are appropriate individuals and structures to be part of the STEMI Olympiads and related competitions community of practice. Significant progress has been done in this regard, where such a community of practice was established in 2015 and a few conferences have since been held. This initiative will be sustained and escalated to a higher level, with attention being given to that:

- (a) conferences are conducted at regular intervals;



- (b) accreditation of the conference is prioritised;
- (c) members actively interact virtually between conferences; and
- (d) a hybrid conference funding model is introduced over a period of time.

### **3.8 Recognition of performance excellence**

Contest is naturally part of STEMI Olympiads and related competitions. Since competition is usually used to encourage participants to achieve more, at issue here is putting in place a well-structured system to recognise best achievers and even facilitate their participation in international platforms as country flag bearers or ambassadors. The achievements by learners in STEMI Olympiads and related competitions is out of a collective contribution by other role players and stakeholders who also need to be recognised for their good work. Without providing details, the following is a high-level outline of the system recommended for recognising excellence in South African STEMI Olympiads and competitions:

- (a) There will be a single annual national event to recognise best performers and celebrate excellence led by the Minister of Higher Education, Science and Innovation.
- (b) Each Lead Agent will determine the structure of the contest, including recommending what would constitute prizes awarded to best performers in earlier legs of the contest – which will be part of Annexure A. The current structure, if considered adequate may be retained with some or no adjustment.
- (c) Lead Agents will be the only conduit for local learners' international and/regional participation and learners who independently arrange for their own participation in international competitions will not access support provided in terms of this Framework.
- (d) All learners who took part should be acknowledged by being awarded a certificate of participation.
- (e) Best Lead Agent will be recognised at national level only, while Implementing partners' recognition of excellence will have school service delivery boundaries leading to national finals.

#### **4 PERFORMANCE MONITORING**

STEMI Olympiads and related competitions are part of the DSI-led science engagement programme. In 2018, the DSI adopted a system-wide Science Engagement Monitoring and Evaluation Framework (MEF), which presents guidelines for establishing whether, and tracking the extent to which, the science engagement programme is realising its intentions. To enable these, the MEF comprises sets of performance indicators and also defines forms of evaluations that will be conducted. In preparation for those evaluations and related understanding of the evolution of the landscape of the STEMI Olympiads and related competitions in the country, there will be continuous collection and analysis of data associated with relevant performance indicators in the MEF, as presented in Table 1 below.

**Table 1: STEMI Olympiads and competition performance data collection guideline**

<b>Performance Concepts</b>	<b>Trackable Performance Variables</b>	<b>Tracking Rationale</b>
Input	Sources of funding and related expenditure patterns	To establish the investment the country is making in STEMI human capital pipeline development
	Demographically disaggregated participation levels of professionals as mentors and coaches	To assess the existence and spread of volunteerism and community service, as well as the role they are playing in youth development
Output	Demographically disaggregated participation levels of learners	To establish growth of the STEMI Olympiads and related competitions in South Africa, including whether it is happening in a balanced manner and in consistency with the transformation agenda
	Geographic coverage or spread according to school service delivery boundaries	
	Schools' participation and performance according to schools quintile system or applicable schools categorisation system	
Outcome	Learner participation retention rate	To establish whether learners' interest in STEMI is being sustained
	School leavers post-school formal learning paths	
Impact	Graduates destinations	To establish whether potential talent unearthed through STEMI Olympiads and competitions took up STEM-related careers, as well as their general contribution to the country's economic development

## **5 INSTITUTIONAL ARRANGEMENT**

The benefits that this Framework seeks to create will be realised through collective roles played by the following institutions:

### **5.1 The Department of Science and Innovation**

The DSI will:

- (a) Provide core funding for the implementation of this Framework.
- (b) Create and maintain an enabling policy and strategic environment for STEMI Olympiads and related competitions.

- (c) Broker the relationship between education authorities and STEMI Olympiads and related competitions community.
- (d) Monitor adherence of the STEMI Olympiads and related competitions to the guiding principles of this Framework.

## **5.2 Provincial Departments of Education**

Through the collaboration arrangements with the DSI, provincial departments of education will:

- (a) Facilitate STEMI Olympiads and related competitions Lead Agents' and Implementing partners' access to schools to organise learners' participation.
- (b) Provide any other support they deem appropriate from time to time in order to enhance learners' participation and performance in STEMI Olympiads and related competitions.

## **5.3 South African Agency for Science and Technology Advancement**

In its capacity as a national coordinator of science engagement in the country SAASTA will:

- (a) Disburse grant funding to the Lead Agents and possibly Implementing partners, depending on the adopted approach.
- (b) Organise an annual national event to celebrate excellence in STEMI Olympiads and related competitions in South Africa.
- (c) Collect and manipulate performance data as identified by this Framework.
- (d) Implement an appropriately structured science Olympiad and related competitions as the Lead Agent for scientific knowledge enhancement STEMI Olympiad and related competitions – including getting Implementing partners on board and setting up of assessment systems.
- (e) Provide logistical support as and when necessary to ensure attainment of the intentions of this Framework are attained.

#### **5.4 Association of Science, Technology, Engineering, Mathematics and Innovation**

ASTE MI will:

- (a) Develop and conduct periodic review of the minimum operating standards for STEMI Olympiads and related competitions.
- (b) Be the co-organiser of the STEMI Olympiads and related competitions community of practice conference.

#### **5.5 Lead Agents**

Lead Agents, namely Expo, SAMO, NSO and I-SET/TUT will carry out the following with regard to Olympiads and related competitions under their custodianship:

- (a) Implement an appropriately structured Olympiad and related competitions – including getting Implementing partner on board and setting up assessment systems.
- (b) Develop and offer training to potential Implementing partners and refresher training to keep existing Implementing partners up to date.
- (c) Establish and maintain proper systems to enable local best performers to compete in regional and international competitions.
- (d) Develop and implement a mentoring and coaching plan.
- (e) Market the Olympiad and related competition, including seeking sponsorships.
- (f) Ensuring that Implementing partners uphold the minimum operating standards.

#### **5.6 Implementing partners**

Implementing partners will:

- (a) Implement approved provincial plans to ensure that learners within the school service delivery boundary under their custodianship participate in a STEMI Olympiad and related competition.
- (b) Collect data in the prescribed format.

- (c) Market the STEMI Olympiad and related competition under their custodianship, including seeking sponsorship and any other support that could enhance their work.

## 6 RISK MANAGEMENT PLAN

If not given the necessary attention, the risks identified in Table 2 below, could negatively affect the successful implementation of this Framework.

**Table 2: Risk management plan**

<b>RISK</b>	<b>POTENTIAL IMPACT</b>	<b>RISK MANAGEMENT</b>
Unabated disputes between the Lead Agent and Implementing partner	Weakened service delivery	A dispute resolution mechanism would be put in place
Overwhelming participation growth resulting in systems not coping	Quality issues may arise and mistakes intensify	A hybrid model would have to be pursued, combining manual and digitised approaches
Failure to appreciate and adjust to change by the Lead Agents and Implementing partners, such that they attempt maintaining status quo	The benefits of the Development and Support Framework for STEMI Olympiads and related competitions would not be realised	Monthly monitoring, which would be reduced to quarterly interval as the situation improves to be instituted
Conflating roles and responsibilities by SAASTA as a science engagement national coordinator and host of NSO, which is a Lead Agent	The entire system may be brought into disrepute and rendered dysfunctional	Strict role delineation of roles within SAASTA, including separation of staff involved in the two separate roles
Reliability of collected performance data	It would not be possible to establish the correct changes in the STEMI Olympiads and related competitions landscape, including making good decisions	Uniform data collection instruments, accompanied by user training necessary

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## **ANNEXURES**

The annexures listed below exist as separate documents that should be read in conjunction with this Framework.

*Annexure A:* Minimum operating standards for STEMI Olympiads and related competitions

*Annexure B - D:* Lead Agent - Implementing Partner Mentoring and coaching plans

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